THE IMPLICATIONS OF RURAL AGRICULTURE ON WATER RESOURCE MANAGEMENT, A CASE OF THE LUNSEMFWA RIVER CATCHMENT

BY

ANNIE KALUSA

A thesis submitted to the University of Zambia in fulfillment of the Degree of Master of Science in Integrated Water Resource Management in the Department of Geology, School of Mines

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DECLARATION

This thesis was written and submitted in accordance with the rules and regulations governing the award of Master of Science in Integrated Water Resources Management of the University of Zambia. I further declare that the thesis has neither in part nor in whole been presented as substance for award of any degree, either to this or any other University. Where other people's work has been drawn upon, acknowledgment has been made.

Signature of Author:………………

Integrated Water Resource Management (IWRM) Centre

School of Mines, Department of Geology

APPROVAL

This thesis of **Annie Kalusa** is approved as a fulfillment of the degree of Master of Science in Integrated Water Resources Management of the University of Zambia.

Internal Examiner 1

Name:

Signature: ………………………….   Date: …………………………

Internal Examiner 2
Name:

Date: …………………………

Signature: ………………………….

External Examiner
Name:

Date: …………………………

Signature: ………………………….

Chairperson-Board of Examiners
Name:

Date: …………………………

Signature: ………………………….

Supervisors
Name:

Date: …………………………

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Name:

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ABSTRACT

Using a triangulation mixed methods design, this study looked at rural agricultural and implications on water resource management. The objectives that guided the study were: To determine key actors in water resource management in the Lunsemfwa River Catchment.To explore agricultural practices in the Upper Lunsemfwa River Catchment area and implications for sustainable water resource management. To establish water related conflicts by different users in the Lunsemfwa River Catchment.

The total sample size was 150 and the participants were selected using purposive and systematic random sampling techniques.

Key findings indicate that traditional leadership played a central role in water resource management, representing 25 percent of respondents, followed by the Water Resources Management Authority (WARMA), Forestry, and Mkushi District Council, each at 11 percent. The majority of respondents (75 percent) relied on streams as their primary water source for farming, with rivers being the secondary source at 23 percent.

In terms of agricultural practices, 68 percent of farmers identified conventional farming as their primary method. Notably, boundary disputes emerged as the primary cause of water-related conflict, accounting for 33 percent of the cases. This underscores the need for effective conflict resolution mechanisms.

In conclusion, traditional leaders emerged as pivotal figures in water resource management, with a significant role in conflict resolution among farmers in the Upper Lunsemfwa River Catchment. The study suggests a critical role for traditional leaders in water governance and emphasizes the necessity for government water governing bodies to engage them actively. This research contributes valuable insights to policymakers, water management authorities, and community leaders, fostering a more comprehensive and collaborative approach to water resource management in the Mkushi District.

DEDICATION

I dedicate this thesis to my husband Tendai Kapambwe who taught me that it's never too late to chase your passion. This piece of work goes to my children Jessy, Tawanda and Tapiwa too, who l almost named after rivers and catchments of my study area. Thank you for your constant love and support.

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ABBREVIATIONS AND ACRONYMS

7NDP	7th National Development Plan
DAFNE	Decision Analytical Framework for the water-energy-food Nexus
UNZA	University of Zambia
DWRD	Department of Water Resources Development
DWSS	Department of Water Supply and Sanitation
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
IUCN	International Union for Conservation of Nature (IUCN)
IWRM	Integrated Water Resources Management
MA	Ministry of Agriculture
MCDSS	Ministry of Community Development and Social Services
MGEE	Ministry of General Education
MWRD	Ministry of Water Resources Development
NGOs	Non-Governmental Organization
NWASCO	National Water Supply and Sanitation Council
OECD	Organization for Economic Co-operation and Development.
SDGs	Sustainable Development Goals
SIA	Social Impact Assessment
SPSS	Statistical Package for the Social Sciences
UNEP	United Nations Environmental Program

UNESCO	United Nations Educational, Scientific and Cultural Organization
WARMA	Water Resources Management Authority
WHO	World Health Organisation
WRD	World Development Report
WRM	Water Resources Management
WUAs	Water Users Association
ZAMCOM	Zambezi Watercourse Commission
ZEMA	Zambia Environmental Management Agency

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter gives an overview of rural agriculture and implications for water resource management. The chapter outlines the following subheadings: background to the study, statement of the problem, purpose of the study, research objectives, research questions, and significance of the study. A summary of the chapter shall then be given at the end of the chapter.

1.2 Background to the study

The Global Perspective presents that the nexus between rural agriculture and water resource management is recognized as a pressing issue with implications for food security, environmental sustainability, and socio-economic development. Organizations such as the United Nations Food and Agriculture Organization (FAO, 2022) and the World Bank emphasize the importance of sustainable agricultural practices and integrated water management strategies to address water related challenges in rural areas worldwide. Global initiatives, such as the Sustainable Development Goals (SDGs), particularly Goal 6 (Clean Water and Sanitation) and Goal 2 (Zero Hunger), underscore the need for coordinated efforts to promote water security and agricultural resilience on a global scale (United Nations, 200).

Meanwhile continental dynamics suggest that at the continental level, organizations such as the African Union (AU) and regional economic communities play a pivotal role in shaping agricultural and water management policies across Africa. The continent faces unique challenges, including water scarcity, climate variability, and limited access to irrigation infrastructure, which impact rural agricultural productivity and livelihoods. Initiatives such as the Comprehensive Africa Agriculture Development Programme (CAADP) and the Africa Water Vision 2025 provide frameworks for promoting sustainable agriculture and equitable water allocation to support rural development and poverty reduction.

Regionally, agricultural and water management policies are tailored to address specific challenges and opportunities within distinct geographic contexts. In regions such as Sub-Saharan Africa, where agriculture is the primary source of livelihood for a large proportion of the population, efforts focus on improving water use efficiency, enhancing irrigation infrastructure, and promoting climate-resilient farming practices. Regional organizations such as the South Asian Association for Regional Cooperation (SAARC) collaborate on cross-border water resource management initiatives to address shared challenges and promote regional cooperation (Williams 1999).

In Zambia, rural agriculture contributes or extremely contribute to its development in various ways as the majority of the population depend of rural agriculture. Furthermore, the contribution of rural farmers in industries such as food production is critical charging that rural farmers stand as the primary producers of staple crops such as maize, cassava, sorghum, and millet, which form the basis of Zambia's food supply. Furthermore, rural agriculture emerges as dependable source of employment in rural areas of Zambia, providing livelihoods for a significant portion of the population as smallholder farmers and agricultural laborers contribute to the labor-intensive activities involved in planting, tending, and harvesting crops, as well as in livestock management. In addition, rural farming activities contribute to household incomes and poverty alleviation. Income generated from agricultural production enables rural households to meet their basic needs, invest in education and healthcare, and participate in local economies through expenditure on goods and services (Maanga, 2017).

Therefore, rural agriculture remains a significant contributor to Zambia's Gross Domestic Product (GDP), although its share has declined over the years due to the diversification of the economy.

According to data from the World Bank, agriculture accounted for approximately 7-10% of Zambia's GDP in recent years (ministry of agriculture 2016). While this share has diminished compared to other sectors like mining and services, agriculture still plays a crucial role in the overall economy, particularly in rural areas which has resulted into decline in export earnings as rural farmers also contribute to Zambia's export earnings through the production of cash crops such as tobacco, cotton, and non-traditional agricultural products like horticultural produce. Export oriented agriculture provides opportunities for income generation and foreign exchange earnings, contributing to the country's overall economic growth and stability (Mwaba 2017).

However, rural agriculture still stands as one of the most delicate sources of livelihood because of its dependence on natural resources such water. Water is a critical input for agricultural production, essential for crop growth, livestock rearing, and irrigation. Agricultural activities account for the largest share of global freshwater use, with irrigation alone consuming approximately 70% of the world's accessible freshwater resources. Efficient management of water resources is, therefore, paramount for sustaining agricultural productivity, enhancing water use efficiency, and mitigating water-related challenges in rural areas (George, 2000).

Nevertheless, the expansion of agricultural land, intensification of farming practices, and increasing demand for water resources exert considerable pressure on freshwater ecosystems and groundwater reserves in rural areas. Excessive water extraction for irrigation can lead to groundwater depletion, soil salinization, and ecological degradation, posing risks to both agricultural sustainability and environmental conservation efforts. These agricultural activities, such as the use of agrochemicals (fertilizers and pesticides), livestock farming, and land clearing, can have adverse environmental impacts on water quality and aquatic ecosystems. Runoff from agricultural fields can introduce pollutants, including nutrients and sediments, into water bodies, leading to eutrophication, algal blooms, and biodiversity loss. Addressing these environmental concerns is crucial for ensuring the long-term sustainability of rural agricultural systems. In addition, Climate change exacerbates existing water management challenges in rural agriculture, altering precipitation patterns, increasing the frequency and intensity of extreme weather events, and exacerbating water scarcity in many regions. Rising temperatures and changing rainfall patterns can disrupt agricultural production, exacerbate water stress, and heighten vulnerability to droughts and floods. Adaptation strategies and resilient water management practices are needed to mitigate the impacts of climate change on rural agriculture and water resources (Chunga 2009).

The Lunsemfwa Sub-basin is one of the basins under pressure from commercial agriculture and hydropower. The Lunsemfwa River Basin is the most developed subbasin of the Luangwa River, signaled by the tripling in the size of the irrigated area between 2007 and 2013, from 6,634 hectares to 16,288 hectares, which translates into significant water withdrawals (Phiri 2022). On the other hand, investigation by Manda et al., (2019) revealed that the area presents the highest potential for growth in agriculture sector and hotspot for large-scale agricultural activities. Several reports by government agencies in Zambia reported that the increasing demand for water for agricultural coincides with an increasing demand for the generation of hydroelectricity resulting in water resource conflicts between main water users within individual river catchment areas. Several studies in the recent past reveals that many of the prevailing and looming water crises are not necessarily due to water scarcity or a lack of technological expertise, but rather because of poor management and governance of available water resources and infrastructure (Conway et al., 2015; Falkenmark, 1989; Favretto et al., 2015; Meigh et al., 1999). Agriculture is the main source of livelihood for the people of Lunsemfwa River Catchment. Agriculture accounts for 70 percent of total global freshwater withdrawals and more water will be needed for agricultural production (FAO 2014).

1.3 Statement of the Problem

Intensification and extensification of agriculture and the impact of climate change have exerted pressure on water bodies. Mushibemba which has been a perennial stream in Mkushi is dry. The Mkushi River which is one of the main rivers in the area and a source of water for agriculture has been at the verge of drying. Activities of farmers in the area if they are not conservative in nature, could have a ripple effect on the nation's water resource management mechanism as well as at an international level, because most of the water from the area ends up in the Zambezi River which is shared by multiple countries. Similarly, agriculture is the main source of livelihood for 72% of people in the area who are vulnerable to climate change and its effects that are shown largely through reduction of water in water bodies in the area. The implications of agriculture practices extend beyond mere productivity, it impacts the overall health of the people and availability of water sources to sustain their economic well-being. This intensification of agricultural activities in rural areas raises profound questions about the sustainable utilization of water resources.

Therefore, this study sought to determine rural agriculture practices and its implications on water resource management in the Upper Lunsemfwa River Catchment. The nexus between rural agriculture and water resource management is underscored by challenges such as over-extraction of surface water for irrigation, agricultural runoff contributing to water pollution, and the compounding effects of climate change on water scarcity. A comprehensive understanding of these challenges is crucial for formulating effective strategies that balance the imperatives of agricultural productivity with the preservation of essential water resources (FAO, 2017; Rockström et al., 2017; UN, 2018).

Many of these challenges are becoming clear as more people demand to use water for many developmental activities, especially agriculture. It is unclear how competing demands for water among various stakeholders were being addressed by different actors Agriculture intensification and its practices have not been understood and how it affects the river systems in the Upper Lunsemfwa River Catchment. Thus, this study was aimed at determining rural agriculture and its implications on water resource management.

1.4 Research Objectives

1.4.1 The General objective

The general objective of the study was to determine rural agriculture and its implications on water resource management.

1.4.2 Specific objectives

i To determine key actors in water resource management in the Upper Lunsemfwa River Catchment.

ii To explore agricultural practices in the Upper Lunsemfwa River Catchment area and implications for sustainable water resource management.

iii To establish water related conflicts by different users in the Upper Lunsemfwa River Catchment.

1.5 Research questions

1.5.1 General research Question

How does rural agriculture affect water resource management?

1.5.2 Specific Research Questions

The study addressed the following research questions:

i. Who are the key actors in water resource management in the upper Lunsemfwa River Catchment?

ii. What are the agriculture practices in the upper Lunsemfwa River Catchment?

iii. What are the causes of water related conflicts in the upper Lunsemfwa River Catchment?

1.6 Significance of the study

The study is important as it provides information on the key actors in water resources management, agricultural practices and the causes of water related conflicts in the Upper Lunsemfwa River Catchment. This is essential for achieving and sustaining integrated water resources management. The specific areas of significance of the study include:

i. Contribution to the baseline of water actors, agriculture practices and associated conflicts in Lunsemfwa River Catchment.

ii. Minimize associated conflicts among farmers over water for irrigation.

iii. Improving access to water and preventing economic losses for all water users.

iv. Utilize the Water Users Association in the allocation of the water in the area.

v. Contribution to water resources development and implementation data because planners will be able to use findings from this study for decision making in mainstream ministries such as Ministry of Water Development and Sanitation, Ministry of Agriculture, Ministry of Local Government and Housing, Ministry of Heath, Ministry of Education and Ministry of Community Development.

vi. Findings on water resources development and implementation will be used by planners in the mainstream ministries such as Ministry of Water Development and Sanitation, Ministry of Agriculture, Ministry of Local Government and Housing, Ministry of Health, Ministry of Education, and Ministry of Community Development.

vii. Assist in accelerating progress towards achieving Sustainable Development Goal 6 about “clean water and sanitation for all".

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents the literature review on the implication of rural agriculture on water resource management around Upper Lunsemfwa River Catchment. It reviews literature from other scholars who have conducted their studies on related topics. These areas are the empirical review of existing literature and theoretical review.

2.1 Key Actors in Water Resource Management

Researchers have articulated serious concerns that freshwater might become the most limited resource in the future due to significantly constraining relations between water use and the production of food, energy, and other goods and services (Godfray et al. 2010; Mulder et al. 2010). Additional pressure on water resources is being posed by a variety of social activities. The global population will continue to grow, a major correlation of this deceleration in population growth is increased wealth, and with higher purchasing power comes higher consumption and this demand will add pressure to the food supply system. At the same time, food producers are experiencing greater competition for land, water, and energy, and the need to curb the many negative effects of food production on the environment is becoming increasingly clear (H. Charles J. Godfray, et al 2010).

Further global projections indicate that demand for freshwater will increase significantly over the coming decades due to population growth, diversified diets, economic development, urbanization, and climate change. Agriculture accounts for 70 percent of total global freshwater withdrawals and more water will be needed for agricultural production (FAO, 2014). With a growing global population expected to reach 9.1 billion by 2050 and the increasing impacts of climate change, sustainable use of water and ecosystems for food security presents key development challenges (UNEP, 2011).

This realization has brought about the need to recognize that water resources management is not a one sector problem but requires a holistic approach. This realization necessitated the Integrated Water Resources Management (IWRM) framework. The IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (UNEP, 2022). The call for more integrated approaches in the domain of water management has turned collaborative approaches into an attractive prospect for water management Singh et al., (2009). One such framework is the IWRM, which offered the possibility of holistic management of water resources for social, economic and ecological optimization (Lenton and Muller, 2009). The nexus analysis of food, water and energy systems takes this integration up to a certain level of complexity, given that it crosses more sectoral boundaries and scales (Allouche at al.; 2015; Muller, 2015).

The reasoning behind the introduction of IWRM is competing demands for water resources that intersect at basin level. Balancing these competing demands and needs will lead to achieving sustainable water management (Gallego-Ayala, 2013). Integrated water resources management (IWRM) has been recognized by many actors as the appropriate approach to respond to challenges in water resources management in a sustainable way. The main players in developing and diffusing the IWRM concept have included expert groups, international organizations, and multistake holder platforms, which cooperated in various activities promoting the IWRM concept, such as knowledge generation and sharing, capacity building, and monitoring. A loose network of these actors has actively shaped and engaged in a global discourse on sustainable water resources management and managed to authoritatively shape the IWRM concept (Kramer and Pahl-Wostl, 2014). Despite these profound reports and findings from scholars on integrating competing needs for water resource management, there still exists the gaps on who key actors in managing the water resource at a lowest unit such as catchment were. This study endeavored to address this gap.

At the further point of the IWRM is an emphasis on stakeholder participation and environmental governance, whilst also emphasizing water as an economic good to be paid for by cost sharing and localized management at the river-basin level (Lankford and Hepworth, 2007; Muller, 2015) and to set out an enabling policy environment that allows a demand-led approach to the water supply and where users assume a significant role as local stakeholders in working out fair allocation of water resources through institutions such as Water User Associations (WUAs). The benefits of a participatory approach were assumed to be more likely to be sustainable and equitable (Cleaver and Toner, 2006).

Integrated management can also take the form of a collaborative governance arrangement, when cooperation and negotiation is organized among public authorities, water users and interest groups. Some of the key points consistently identified in the literature on resource management and water governance in particular (Pahl-Wostl et al. 2010) are a governance focus on social actors that recognizes who is doing what with water and why, within the regional or local system, who is causing or contributing to the problems, and who is willing or ought to be doing what, in order to mitigate and solve these problems (Lubell et al. 2008; Braden et al. 2009).

Literature suggests different management options for water resources. However, there has been little emphasis on bringing together key actors in management of water resources. Although literature on global recognition of water as a critical resource and limitation of its management is notable, the question is what clear recognition of mechanisms for water resources management that different actor utilized, and who are the actors involved in implementing these mechanisms. Answering this question will provide a management outlook on social structures and processes that can inform sustainability of current management regimes of water resources, as well as systematically identify intervention that points for improvements and can be easily adapted if applied to rural structures. This study endeavored to bridge this gap by determining who the key actors were in the Upper Lunsemfwa River Catchment in Central Zambia.

A study conducted by the World Health Organization (WHO 2022) revealed that there are five broad actors who are responsible for water resources management and these include those involved in planning and coordination; design and construction; regulation; social and environmental action; and operations management. Stakeholders can be individuals, organizations, or groups. According to (Gallego-Ayala, 2013; Grigg, 2008; Suhardiman et al., 2015) the key stakeholders may include: public-sector agencies involved in water resources for example, departments of agriculture, forestry, local authority, or various levels of public-sector agencies in the water sector, private-sector organizations and companies with water interests; environmental and professional NGOs, and representatives of those people likely to be affected, specifically including people who may have little knowledge or who may lack the means to participate. This description of potential key actors befits what would work for Zambia. These actors have a potential to manage water resources to the capacity that can benefit everyone by making sure they utilize water with ultimate perseverative mindset for future use. Cultural factors and decisions revolving around water include dealing with potable water supplies during annual drought, allocating water, repairing water or agricultural systems damaged by annual flooding and tropical storms, and supplying food in times of scarcity. Not enough rain results in decreasing water supply and quality, failed crops, and famine (Zwolsman, J.J.G.; van Bokhoven, A.J., 2007).

A notable example is a study done by the Chagga people of Tanzania which shows significant involvement of community collaboration in the construction, ownership and management of water infrastructures. The highest level of community involvement significantly transformed the landscape to reflect an agrarian society characterized by decentralized forms of socio-political and economic organization. Such organization involved conception, construction, and post construction management of water distribution systems, synonymous with high levels of sociopolitical complexity. Such approaches highlighted how Chagga people transformed from traditional irrigation technologies and infrastructures to a developed complex agrarian society. Results further show that community collaboration and stakeholder involvement was key in the management of water infrastructure and was vital for their home gardens, and this sustained Chagga society for centuries (Valence M. Silayo 1 and Innocent Pikirayi, 2023). The findings from the Chagga community presents a good example of what significant achievements that can be made when different actors get involved in safeguarding resources. In the same way this study in the Upper Lunsemfwa River Catchment, endeavored to determine who the key actors where in water resources management in the area.

When determining stakeholders in water resource management, the following has to be considered: identification of all individuals, groups, or organizations that are directly or indirectly affected by water resource decisions, including: government agencies, local communities, water users (farmers, industries), environmental groups, researchers, private sector companies involved in water infrastructure, and civil society organizations; considering their level of influence and interest in water management practices within a specific catchment. The governance of existing water resources is, therefore, a key issue in achieving water security at global and regional levels (Floress et al., 2019; Pigmans et al., 2019; Islam et al., 2020; Khandker et al., 2020; Sehring, 2020)

Resource and environmental management are crucial for sustainable development. Managing groundwater is complex, requiring coordination across various levels and involving multiple departments. Effective strategies must integrate scientific research, policymaking, and community engagement to ensure sustainable use of groundwater resources. More informal power can be effective in the allocation of funds, can often yield significant effectiveness when it comes to the distribution and allocation of funds (Schlager, 2007; Schlager and Blomquist, 2008; Saurav et al., 2022; Schipanski et al., 2023). Despite this review showing how ground water is complex, its management approach is similar to surface water. It therefore provides direction in coordination and distribution and allocation of water resources in the Upper Lunsemfwa River Catchment.

Water demand management measures include a range of strategies, including the use of economic incentives to encourage wider adoption of water-saving technologies (Bekchanov et al., 2010). In addition, efforts can be made to shift the economy toward less water-dependent production structures (Bekchanov et al., 2014), and much of this research tends to be a very important indicator of "integrated management," i.e., participation. The shareholders of (Carlson and Stelfox, 2011; Imran, 2013; Nash and Bray, 2014; Almeida et al., 2017) and improving the institutions of water management, including the market and water governance (Easter and Rosengrant, 1999; Dinar and Saleth, 2005; Bekchanov et al., 2014; Grafton and Horne, 2014; Wheeler et al., 2014; Najafi Alamdarlo et al.,

A variety of methods can be used to identify stakeholders. According to (FAO, 2022) the three of the simplest approaches are self-identification, third-party identification, and identification by the strategy team. Self-identification simply means that individuals or groups step forward and indicate an interest in participating. This when voluntarily done by the majority, water resource management could be achieved with great magnitude. Third-party identification uses knowledgeable parties, such as existing advisory committees, informal or formal community leaders, and representatives of known interests, to suggest people or organizations that should be included. This could be imperative in educating and sensitizing the community in possible ways the water resources can be managed. Identification by the strategy team relies on the team systematically identifying and approaching stakeholders. Social Impact Assessment (SIA), Environmental Impact Assessment (EIA), financial analysis and gender analysis can all help to identify stakeholders. The team should identify those parties essential to implementing projects, those who are benefitting or will benefit from water projects, and those who are bearing project costs and impacts. Most importantly, people who would be affected by water strategy. This study took the identification by strategy approach and identified actors who are key in supporting water resources management. Several experiences have been documented on integrated efforts by actors can help to stop calamity from happening.

Regionally, literature records how Cape Town presents key lessons of what combined efforts by key players can achieve in the face of crisis with the anticipated Day Zero that South Africa narrowly escaped from implementing stricter regulations would shut down water supply completely to prompt action from people to conserve water. The City of Cape Town began to call attention to impending and increasingly worrying water scarcity as a result of a multi-year drought. The possibility of a citywide water crisis became a source of deepening anxiety for the city's residents throughout 2016 and 2017. In November 2017, the city's worries about water scarcity became acutely visible as dam levels dropped to around 20%. At this time, the city proposed the idea of Day Zero, a dramatic (and apocalyptic) framing of what was to come if the city's taps were to run dry. Initially scheduled for 13 May 2018, Day Zero referred to the point at which the city's dam levels would reach 13.5%, at which point a system of citywide enforced rationing would be put in place. Day Zero clearly showed just how serious the situation was and located Cape Town's experience of scarcity in a broader planetary geography of climate change and impending climate crisis. During the weeks that followed the city's announcement of the apparent inevitability of rationing, residents were gripped by panic, a feeling heightened by the continued lack of rain and the city's unremitting demand that residents use less water (Nate Millington; Suraya Scheba 2021) It was scheduled for 13 May 2018, at which point a system of citywide enforced rationing would be put in place. Day Zero clearly showed just how serious the situation was and located Cape

Town's experience of scarcity in a broader planetary geography of climate change and impending climate crisis. During the weeks that followed the city's announcement of the apparent inevitability of rationing, residents were gripped by panic, a feeling heightened by the continued lack of rain and the city's unremitting demand that residents use less water (Millington and Scheba, ibid). Integrated efforts by multiple players prevented day zero from happening. They stopped activities that use a lot of water to preserve water by integrating various players.

On the other hand, Australia took over 12 years to achieve a similar reduction like that of Cape Town during its millennium drought (de Villiers, 2018; Government of South Australia, 2018;

Rathi, 2018). The impact of climatic change has resulted in the significant decrease in rainfall in the catchment the past decade and has adversely affected water bodies. The surge in human population in the last few decades has also contributed to increased exploitation and degradation of the water resources (Rathi, 2018). If unsustainable exploitation of water resources continues such as over damming and uncontrolled furrowing, there is no difference in reaching the Cape Town crisis and without determining actors in the Upper Lunsemfwa River Catchment to integrate their ideas, information and skills on how to save the Upper Lunsemfwa River Catchment, the future of the catchment will be very different from what exists today. In the same way, experiences from joint management of the Okavango Delta are a good example of the IWRM. When the benefiting nations realised that the Okavango delta was under threat due to climate change and over abstraction from upstream countries and that if these threats were not addressed, they may have profound impact on the river systems. Angola, Botswana and Namibian government agreed to join forces to save the Okavango Delta. They came together and shared ideas and information on how to improve joint management of the water resources (IUCN, 2015). Even though these experiences are at the national government level, lessons can be drawn on how integrating different interests can help save river systems at the catchment level. Eventually, water resources can be managed with these integrations in practice.

At national level, shared basins by multiple countries present management complexities that must be resolved by collaboration strategies towards common objectives (Imperial, 2005). The Zambezi River Basin is home to diverse, valuable natural resources for the eight countries that share the region: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, and Zimbabwe ZAMCOM,2015). Currently, more than 30 million people live in the watershed, which must satisfy their social and economic needs as well as maintaining the health of the natural environment. As any area highly dependent in water resources, water is necessary for the major economic activities in the basin, such as water supply for hydropower production, irrigation, and urban and rural consumption (Beck and Bernauer, 2011). Some countries have the capacity to invest more in infrastructure than others to assure water availability while others contribute more area to the basin, bringing up questions regarding which countries have more privileges than others to its water allocation (World Bank, 20210). Formation of the Zambezi Watercourse Commission (ZAMCOM) is an integrated mechanism that is aimed at helping to protect, conserve and promote sustainable and equitable utilization of the Zambezi basin by multiple users (Beck and Bernauer, 2011).

Zambia subscribes to the IWRM framework through the Global Water Partnership to which it is a part. Furthermore, this study sits in the IWRM Centre which partly anchors the framework. This study provides an opportunity for the Centre to add to the already accumulated knowledge through research findings which adds to the body of knowledge, policy formulation and implementation and further provides solutions to water related problems in the face of Climate change.

2.2 Agricultural Practices and Implications for Sustainable Water Resource Management

Agricultural practices have a significant impact on water resource management, with practices like irrigation scheduling, sustainable agricultural methods such as tillage type, tillage frequence as well as cropping pattern playing a key role in determining the efficiency and sustainability of water usage, potentially leading to issues like reduced water levels, water pollution, and reduced crop yields if not managed properly; therefore, implementing practices that optimize water use is crucial for sustainable agriculture and water resource management. Further, agriculture is fundamental to the survival of people, and its existence depends on water. Agriculture extends over 4.8 billion hectares (ha) of the global land surface, with Asia, Africa, and Latin America having the largest areas of agricultural land use. Small farms (< 2 ha), mostly in developing countries, account for the greatest number of agricultural producers, but increasingly total land use is dominated by larger, often corporate-based, farms (Lowder et al. 2016) that benefit from access to new technology and markets through trade agreements.

Agricultural practices and systems interact with water bodies in many ways. At catchment and river-basin scales, agriculture can have interactions through system wide changes in water use, sediment movement, changes in biodiversity and increased pollutants, leading to an overall degradation at landscape scale. Impacts also occur on natural ecosystems, directly by land conversion, water extraction, nutrient inputs, erosion and soil degradation. All these interactions can lead to changes in the ecological character of water bodies and the possible permanent loss of its benefits to people, emphasizing the need for sustainable agriculture (Wood & van Halsema, 2008).

Water pollution is caused by excessive fertilizer use, application of pesticides, salinization from agricultural drainage water and contamination by animal manure and slurries (FAO/ IWMI, 2018). Fertilizer use increased steadily around the globe in the period 1960-1990, with the largest growth rates in consumption in Asia, Latin America and Africa.

Agriculture is responsible for around 70% of global freshwater withdrawals, and despite increasing competition in demand for water, agriculture withdrawals continue to increase (FAO, 2020). Agricultural water use in different regions ranges from 28 to 76 % of total water withdrawal depending on the level of economic development. In large areas of Asia, northern Africa, Australia, and the Americas, agriculture intensification disproportionality drives high water stress affecting people and natural ecosystem (FAO, 2020).

A study done by McIntyre et al., (2008) reveals that some agricultural systems are still being promoted with unacceptably high environmental, economic and social costs, albeit with the promise of further gains in output. Consequently, business-as-usual with regards to agricultural development is increasingly considered inadequate to deliver sustainable production intensification to 3 meet future needs in terms of food security, poverty alleviation and economic growth and ecosystem services (Friedrich et al., 2009a; Kassam et al., 2009).

Food is a basic requirement for every living being. Most of the food we eat come from agriculture. Farmers use form of procedures for their management and improvement of crops they cultivate. This art of cultivation of the crop is called agriculture. In agriculture, there are parameters to be considered such as land on which to cultivate, technics to use in tillage, the type of crop to grow and cropping pattern, properties of soil, manuring climate, and water for irrigation Depending upon these parameters, farmers decide which crop is to be cultivated at what time of the year and place. Additionally, to yield a high-quality product, suitable soil, climate, and season are not sufficient. It requires a set of procedures which needed to be followed. The measures which are followed to grow crops are called agricultural practices (Ottman, and Mike, 2017).

The supply of freshwater that supports human health and enterprise is basically constant, representing only about 1% of the water available worldwide. Good quality, non-saline water is the most important global asset in satisfying the increasing demand for basic food, fiber, feed and fuels. As the major consumer of this global asset, irrigation accounts for about four fifths of the total freshwater consumed and about two thirds of the total diverted for human uses. Irrigation has shaped the economies of many semi-arid and arid areas, permanently coloring the social fabric of numerous regions around the world. It has stabilized rural communities, increased income and provided many new opportunities for economic advancement. Irrigation permits human habitation, at times quite dense populations, where it otherwise could not exist. Nevertheless, it is estimated that 60% of the global population may suffer from water scarcity by 2025 (Evans and Sadler, 2008).

Land drainage and river flow diversion for agriculture also modify natural water flow paths with often negative impacts on surface water and its functioning. The total area of drained agricultural land in the world is over 200 million ha (Schultz et al. 2005), and in many regions this supports productive farmland, including channels of major rivers (Gramlich et al. 2018).

A study done by Montgomery, (2007); UNCC, (2017) reflects how sediment is supplied to water bodies from wind or erosion through natural sediment transport processes, as well as from human induced changes in land or water management, including agriculture. Land conversion and farm practices such as tilling and harvesting can lead to a significant increase in erosion and soil degradation. In arable and intensively grazed lands rates of soil erosion is 100 to 1,000 higher than natural erosion rates, and far higher than rates of soil formation with high inputs and deposition of sediment to water bodies, nutrients and other chemical compounds are also transported, which can affect the ecological functioning of streams and rivers, floodplains, lakes and forested wetlands. Nutrient losses from soil degradation also led to increased rates of fertilizer application at high economic and environmental costs (UNCCD, 2017). Despite this study having been undertaken from main wetlands, its results mirrors agriculture practices in the Upper Lunsemfwa River Catchment and learn lessons from its findings.

Agriculture contributes to climate change through land use changes (UNCCD, 2017; IPBES, 2019) and energy use. Together, agriculture, forestry and other land uses cause between 20 and 25% of global human greenhouse gas (GHG) emissions (IPCC, 2014; 2019), with the conversion and drainage of wetlands for agriculture directly contributing to increased GHG emissions (Moomaw et al. 2018). Globally, some 50 million hectares of peat lands have been drained for agriculture and forestry since 1850 that contribute approximately 4% (2 Gt CO2 -eq/year) of anthropogenic greenhouse gas emissions (Leifeld et al. 2019).

Water scarcity is a global concern for wetlands and people (FAO 2020) that is felt locally, but needs to be dealt with at catchment, national as well as international scales. In many regions of the world, river basins, which are critical to maintain groundwater levels and the overall water cycle, are under water stress due to agricultural withdrawals. As noted in the 2020 assessment on food and agriculture "almost one-sixth of the world's population live in areas with very high severe drought frequency or very high-water stress. Water requirements will only increase owing to population and economic growth, dietary changes and climate changes" (FAO, 2020). This illustrates the tension between providing water to support agriculture, while maintaining environmental flows to water bodies.

Water pollution, including excessive amounts of nutrients and pesticides in water bodies and soils, degrades the ecological character of natural ecosystem. The synthesis report on food and water pollution (FAO/IWMI, 2018) was unequivocal, stating "population growth, changes in calorie intake and diets have increased the demand for a wider variety of foods, including more meat and dairy products. Where the resulting agricultural intensification is not well managed, its benefits for society are often accompanied by significant environmental and health costs, through water pollution. Further, the loss of organic soil and associated nutrients due to land erosion is a significant concern for agricultural production, reducing crop yields and increasing fertilizer and water use (FAO/ITPS, 2015). The study findings here suggest transformation of how the global agriculture system was needed to reverse the trends of environmental degradation, ensure the wise use of wetlands, and respond to climate change. This need for global change has been recognized for some time (FAO 2011, 2018a; CGIAR. This recommendation highlights lesson for the Upper Lunsemfwa River Catchment to implement a transformation approach that will help reverse the signs of water depletion in the area.

2.3 Water Related Conflicts

The water crisis, particularly water scarcity, is a main global risk that has adverse socio-economic and environmental impacts on society (Alexander, 2019; Biswas, 1999; Moustakbal, 2023). It is a critical challenge. Caused or intensified by various direct factors, such as limited resources, climate change, periodic droughts, hydrological conditions, environmental changes, population and consumption growth, the increased demand for water, and excessive use of resources. The crisis is also influenced by indirect factors, particularly socio-economic and cultural changes, sociopolitical and institutional challenges, inadequate knowledge, attitudes, and skills of water users, and unsustainable behaviors by society (Camargo et al., 2023; Esen et al., 2020; Gain et al., 2015; Kujinga et al., 2014). In the face of already existing conflicts associated with water scarcity as is reflected in literature, this study sought to determine water related conflicts in a catchment system and identify key actors in water resources management in the Upper Lunsemfwa River Catchment.

Climate change has intensified the scarcity of water resources around the world (DeNicola et al., 2015; El Kharraz et al., 2012; Lehane, 2014), affected ecosystems and their resources, and caused a series of adverse impacts, including droughts, floods, human health, biodiversity loss, and the incidence of other natural hazards, which can unavoidably threaten human systems activities and well-being (Brown and Berry, 2022. Rural communities, particularly small-scale farmers, are among the most vulnerable people to climate-induced water stresses, because of their livelihood's dependency on agriculture and natural resources (Alibaygi and Karamidehkordi, 2009; Karamidehkordi et al., 2023). Considering small scale farming patterns and their knowledge on climate change and its impacts is crucial to adopting sustainable actions for maintaining rural economies, improving food security, conserving and restoring biodiversity, and decreasing conflicts among resource beneficiaries (IPCC, 2023). Scholars and researchers have noted a gap between the scientific understanding of climate change and farmers' adoption of adaptive management in water crises (McDonald and Styles, 2014; Siders, 2019). Despite these profound results from scholars on water related conflicts, their studies focused largely on adaptive management to curb conflicts. This study went further in farming practices such as irrigation schedule, irrigation type and type of water sources for agriculture to add to existing knowledge.

Water-related conflicts among farmers typically arise when there is a scarcity of water sources for irrigation, leading to competition over access to limited water supplies, often resulting in disputes regarding water allocation, timing of water usage, and the maintenance of irrigation systems, particularly in regions with shared water sources like rivers or streams. The water crisis, particularly water scarcity, floods, pollution, and groundwater table decline, is a main global risk that has adverse socio-economic and environmental impacts on society (Alexander, 2019; Biswas, 1999; Moustakbal, 2023). It is a critical challenge caused or intensified by various direct factors, such as limited resources, climate change, periodic droughts, hydrological conditions, environmental changes, population and consumption growth, the increased demand for water, and excessive use of resources. The crisis is also influenced by indirect factors, particularly socioeconomic and cultural changes, socio-political and institutional challenges, inadequate knowledge, attitudes, and skills of water users, and unsustainable behaviors by society (Camargo et al., 2023; Esen et al., 2020; Gain et al., 2015; Kujinga et al., 2014). Climate change has intensified the scarcity of water resources around the world (DeNicola et al., 2015; El Kharraz et al., 2012; Lehane, 2014), affected ecosystems and their resources, and caused a series of adverse impacts, including droughts, floods, human health, biodiversity loss, and the incidence of other natural hazards, which can unavoidably threaten human systems activities and well-being (Brown and Berry, 2022; Salehyan, 2008). Rural communities, particularly small-scale farmers, are among the most vulnerable people to climate-induced water stresses, because of their livelihood's dependency on agriculture and natural resources (Alibaygi and Karamidehkordi, 2009; Karamidehkordi et al., 2023; Karimi et al., 2024). These communities' livelihoods have faced many climatic uncertainties and experienced numerous environmental challenges, particularly because of their exposure and maladaptation to climate change (Coppitters et al., 2022; Saliman and Petersen-Rockney, 2022). Rural communities and farmers are exposed to climate change-induced stressors, shifts, and shocks, e.g., rising temperatures, precipitation change, and more intense and frequent wildfires (Aggarwal et al., 2022; Coppitters et al., 2022)

Water shortage tends may escalate if water does not properly distribute among various water users (Lecler, 2004). This may be the beginning of clashes among water users (Gasteyer, 2009). These clashes among water users are results of rivalry for water resources especially in the dry season (Gichuki, 2002; Kulkarni, 2011). One of the main issues in this scenario is water conflicts. It can be described as a conflict between nations or people regarding the unequal distribution of water reserves (Tulloch, 2009; KameriMbote, 2007). Water conflicts emerge among two or more groups due to the competition in distribution or its use (OECD, 2015).

A study by Naderi et. Al (2024) identified different perspectives of farmers regarding the negative impact of climate change on intensifying demand-based water crisis which is agricultural, municipal, industrial, and environmental water scarcity, the surface water crisis which is as a result of persistent droughts, drying of streams, rivers, and springs, the water level decline of reservoir dams, torrential rain, and floods. Similar evidence is noted in other literature as well.

The conflicts over water resources are rarely single-caused and a wide range of factors, including the water crisis and climate change, usually affect (Gleick, 2014). The continuation of water consumption and management practices in the current style can likely increase water scarcity, crisis, and relevant conflicts in the future, especially in developing regions, and increase the complexity of managing their challenges (Biswas and Tortajada, 2019; Jury and Vaux Jr, 2007; Ringler et al., 2010; Sivakumar, 2011). When water is not fairly distributed among different farms based on their land size, water needs, or historical rights, it can lead to tension and conflict. Inefficient irrigation techniques, lack of water conservation measures, and water wastage can exacerbate water scarcity and lead to disputes among farmers. Farmers located downstream on a river may face water shortages if farmers upstream excessively withdraw water, leading to conflicts. Variations in water availability throughout the year can cause conflicts, as farmers may compete for water during dry seasons (Sharmina et al., 2016).

Absence of well-defined water allocation rules and enforcement mechanisms can lead to disputes over water usage. Farmers may fight over irrigation schedule and time spent on irrigating. Disputes also arise when farmers from a distant farm within a river basin compete for water resources with those located close by. Although there is no consensus on basic reasons for the future water crisis and water conflicts (Gokçekus ¨ ¸ et al., 2023; Hanjra and Qureshi, 2010), many studies have indicated water crisis as a main reason for the conflicts over water resources (Briesen, 2020; Gbandi, 2022; Mehrparvar et al., 2016). The continuation of water consumption and management practices in the current style can likely increase water scarcity, crisis, and relevant conflicts in the future, especially in developing regions, and increase the complexity of managing their challenges (Biswas and Tortajada, 2019; Jury and Vaux Jr, 2007; Ringler et al., 2010; Sivakumar, 2011). Water conflicts happen for the supply, distribution, or use of shared water resources within or between nations or communities. Managing these conflicts can lead to cooperation between/among stakeholders in a basin, depending upon the problematic situation and its management approach (El-Fadel et al., 2003; Mehsud and Khan, 2019; Renner et al., 2021; Uprety and Salman, 2011). Studies on the water crisis indicate that the world is experiencing water scarcity and insufficient freshwater will be available to maintain all lives and ecosystems (Gizelis and Wooden, 2010; Li et al., 2022; Wood, 2008), which can intensify associate conflicts (Gleick, 1993; Kloos et al., 2013). The global water crisis is not only because of actual physical water scarcity, population increase, and increased water demand (Kim and Regan, 2020; Vor¨ osmarty ¨ et al., 2010), but also the result of other factors, such as extensive and continuous mismanagement and inefficient practices and processes, including human interventions in water supply, distribution and use in different sectors, water pollution, poor water governance, inadequate planning and management of transboundary and other shared waters (Link et al., 2016; Sivakumar, 2011).

Studies done by Adger and Barnett, (2009); Chellaney, (2013) and Chris, (2012) all reveal how water resources around the world are exposed and vulnerable to climate change, which has threatened the future of the world for access to water and caused the water crisis with wide-ranging consequences for human societies and ecosystems. These studies are an indication of the current trends in different regions around the world which include smallest units such as catchments like the Upper Lunsemfwa where water bodies are increasingly becoming vulnerable and threatening the future of the people in the area who are dependent of agriculture. This justifies the significancy of study in the Upper Lunsemfwa River Catchment to determine rural agriculture and implications of water resources management. Changing climatic and local weather conditions can adversely influence water, social, and economic systems. Climatic variability, particularly drought, can negatively impact water demand.

2.4 Theoretical Framework

2.4.1 Resource Based Theory

Resource-Based Theory (RBT) was first put forward by who proposed a model on the effective management of firms' resources, diversification strategy, and productive opportunities Penrose (2009). To understand water resource management, the study applied the Resource-Based Theory which is a management framework that emphasizes the role of resources, capabilities, and competencies in achieving competitive advantage in business (Barney, 1991), (Armstrong & Shiminzu, 2007). A critical defining feature of RBT is that it is an efficiency-based explanation of performance differences, rather than one relying purely on market power, collusion, or 'strategic' behaviors (Barney, 1991; Conner, 1991). Kraaijenbrink et al. (2010) conclude from their recent review that there is a need for analysis within firm boundaries of the internal processes of managing resources. A key aspect is the recognition that heterogeneous human capital is a critical underlying mechanism for capabilities. In the context of water resource management in the Upper Lunsemfwa River Catchment, key actors in the area possess different skills, knowledge, competences and capabilities can be utilized to tailor management strategies of the water resources according to the demand, resource availability and accessibility. Resource-based management can lead to economic opportunities by leveraging a region's water advantages, like developing water-intensive industries in areas with abundant water supplies. The Lunsemfwa River Catchment has abundant water bodies. Construction of dams is a common agriculture practice among farmers, which is utilized for agricultures purposes in times of low rainfall yields or droughts. Excess water in dams can be sold to areas with water shortages. These management practices allow more efficient allocation of available water resources and can prevent water related conflicts and lead to abundant crop yield. In the context of water users' competitive advantage is a term that is generally used to describe the relative performance of rivals (multiple water users) of water (as a product) on the market environment (Margaret A. Peterafa, and Jay B. Barney 2003.

Similarly, by focusing on resource availability, the RBT promotes practices that ensure long-term water security, preventing overexploitation and protects biodiversity. Resource-based management can lead to economic opportunities by leveraging a region's water advantages, like developing water-intensive industries in the areas with abundant water supplies. Dams can be water intensive industries which can store abundant water for agriculture and be utilized in drought seasons and guarantee sustainability (Kraaijenbrink, Spencer and Groen, 2010) The competitive advantage approach in the context of water resources and capabilities, the theory encourages irrigation practices that are specific to available water in the Lunsemfwa, including using drought-resistant crops to maximise the resource.

Unlike the one-size-fits-all approach, this theory encourages a deep understanding of a region's specific water sources, including surface water (rivers, lakes), groundwater, rainfall patterns, and water quality to tailor management strategies accordingly. The Lunsemfwa is well positioned with various water bodies that benefit different users such as farmers, mining activities, housing units. Identifying and prioritizing prudent management of the most valuable water resources within the catchment will result in maximizing their benefits to the users. Furthermore, RBT highlights the significance of capabilities and competencies in resource utilization. The ability to efficiently manage and deploy resources is crucial for success in rural agriculture. This includes skills in sustainable farming practices, effective water management, and adept decision-making. For instance, farmers with the capability to adopt precision agriculture techniques may utilize resources more efficiently, reducing input costs and environmental impact (Barney, 1991).

However, the Resource-Based Theory is not without its critiques, especially in the context of rural agriculture. Critics argue that the theory tends to overlook the external environment and the role of institutions, policies, and market dynamics. In the agricultural sector, external factors such as government policies, climate change, and global market trends can significantly impact resource availability and utilization (Helfat et al., 2007). The Lunsemfwa River Catchment has been impacted by effects of climate change which has resulted in water bodies drying up, further impacting availability and utilization of water resources. Thus, a comprehensive understanding of rural agriculture requires a balanced consideration of both internal resources and external influences.

2.4.2 Scarcity Theory

Scarcity theories state that social unrest and violent conflict can occur when local demand exceeds supply (Homer-Dixon, 1994; UNEP,2019). This can be due to a decrease in supplies, for example by overexploitation, pollution, or droughts, or due to an increase in demand, for example by population growth, immigration, and urbanization. The economic deprivation following natural resource scarcity has been shown to cause migration, disrupt important social institutions, and aggravate social unrest. Many studies have followed since Homer-Dixon's pioneering work, showing the relation between different types of natural resource scarcities and social instability (Homer-Dixon, 1994). Currently, the study of natural resource scarcities and conflicts can mainly be found in the environmental justice literature (Temper et al., 2018). Applying the water scarcity in The Lunsemfwa River Catchment, revealed that, the available water resources cannot meet demand of the people in the area. The study showed that water scarcity is increasingly becoming phenomenal in the area. The study further reveals that population growth, climate change, and lack of key actor's involvement in water resource management, agriculture practices and unequal sharing of water amongst different users, has resulted in conflicts due to increased competition for the now limited water resources.

These internal stresses locally can grow to security threats on a national scale or even lead to international repercussions, as shown by the contested example of the Syrian Civil War (Ide, 2018).

The Lunsefwa River Catchment houses the Lunsemfwa River which takes its water to the Luangwa River and the Luangwa River takes it Water to the Zambezi River which is shared by multiple nations. This scarcity can affect water bodies that are shared by multiple nations and can result in tensions. Resource scarcity theories of violent conflict have often been received with much criticism. The problems brought up include the choice of case-studies, failure to engage with existing conflict theories, lack of robust statistical evidence, and difficulties in generalizing findings (Mildner, Lauster, and Wodni, 2011). However, more and more statistical evidence of climate change's impact on natural resources, livelihoods and violent conflict is countering parts of this criticism and supporting resource scarcity theories (Ide 2018). Therefore, climate change is now generally accepted as a threat multiplier for violent conflicts. This theory is more applicable to water scarcity in the Lunsemfwa River where the population is fast growing hence, huge consumption of water to irrigate their crops. This is resulting in conflict by the farmers to secure a part of the share for irrigation water.

2.4.3. Abundant theories

Abundance theories of natural resource conflict have identified four mechanisms explaining how natural resources trigger, intensify, and extend conflicts. The resource curse thesis was built on statistical evidence that natural resource-rich countries experienced lower economic growth rates than countries without such natural wealth, as well as higher risks for violent conflict (Sachs and Warner, 2001). The first mechanism is that the exploitation and trade of natural resources makes violent conflicts feasible by financing armed forces, often also driven by greed for personal enrichment from those resources (Collier, Hoeffler, and Rohner 2009; Mildner, Lauster, and Wodni, 2011). Areas with high-value resources become strategically interesting as targets to capture, access, and control, especially in disputed transboundary areas. Secondly, a domestic economy dependent on a narrow set of resource exports is conducive to rent seeking behavior, corruption, and struggles for power (Sala-i-Martin and Subramanian, 2003; Ross, 2015).

Revenues from resource exports rather than from a broad set of tax incomes alienates governments from their population's needs (Le Billon 2001; Sala-i-Martin and Subramanian, 2003; Mildner, Lauster, and Wodni, 2011). This leads to under-investments in public institutions, regulations, infrastructure such as transport systems and telecommunication, and monetary systems. Deprived of functioning institutions ensuring basic needs, such as food security, education, and health care, the neglected needs of population groups in combination with natural resources exploitation by elites can trigger grievances, insurgency and violence (Sala-i-Martin and Subramanian, 2003; Mildner, Lauster, and Wodni, 2011). The third mechanism can be difficult for countries with weak governments and state institutions to create employment and added value from the primary commodities, resulting in similar grievances (Ross, 2015). Therefore, fragile country contexts, including poverty, low human development, ongoing political transformations and large populations are particularly vulnerable to political instability and insurgencies (Scheffran et al., 2012; Abel et al., 2019). The fourth mechanism presents that the growth of a national economy from natural resource extraction has been shown to increase the cost of living for citizens and to undermine the competitiveness of other economic sectors such as manufacturing or agriculture. This process, the so-called Dutch Disease, makes a country even more dependent on its resource sector. Subsequently, a government, whose revenues depend on exports of raw materials, is highly vulnerable to the fluctuations of global commodity prices (van der Ploeg and Poelhekke, 2009).

Empirical findings on abundance conflicts, like scarcity conflicts, do "not support a deterministic cause-and effect relationship between resources and conflict", but indicate the importance of the socio-economic and political intervening context (Schilling, Saulich, and Engwicht 2018). Under certain conditions, resource wealth makes violent conflicts less likely. For example, peace can be bought-off with resource-derived revenues through patronage (political distribution of resource rents, making deals with political challengers), manipulating election results, effective repression of public opposition through large investments in the state's security apparatus, and ensuring protection from powerful importing countries (Ross, 2015). Countries where resource revenues pay for the oppression or appeasement of political opposition are called 'rentier states. Therefore, direct cause-effect relations between natural resource abundance and violent conflict are hard to identify, and researchers argue for a further study of the causal relation (ibid.). In reference to the Upper Lunsemfwa River Catchment, there has been a perception that water was readily available in the area. This led to less/no stringent water conservation practices and as well as lack of focus on water management mechanisms despite the area presenting challenges such as reduced water levels due to severe droughts, people in the area still treat water as though it was abundant.

2.5 Research Gap

The review of related literature has provided insights on the key actors in water resource management, the rural agricultural practices and related conflicts among the water consumers in the area. The global and African studies that have been reviewed delved into the implications of rural agriculture on water resource managements and the causes of water related conflicts amongst small scale farmers in rural systems, where agriculture is the main source of livelihood. However, there was a gap in managing the water resources which was a main input in agriculture. In addition, the international and African studies have also shown the implications of rural agriculture on water resource management. Regionally, literature has shown the implications of agriculture on water resource management. Back home in Zambia, literature does not show how rural agriculture affect the water resource management. Additionally, majority of literature is mainly focused on mechanized agriculture and the implications it has on water resource management with little or no focus on rural agriculture. This study was different because it provided insight on how rural agriculture affected water resources and its management. Finally, at the time of the study, there was no literature that had looked at rural agricultural and their effect on water resource management in the Upper Lunsemfwa River Catchment in Central Zambia in Mkushi District.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the methods that were used and the data collection techniques that were followed in the study to gather, analyze and present both quantitative and qualitative data. It describes the research design, study site, population, sample frame, sampling techniques, sample size, data gathering instruments, sources of data, data analysis, validity and reliability and ethical considerations.

3.2 Research Design

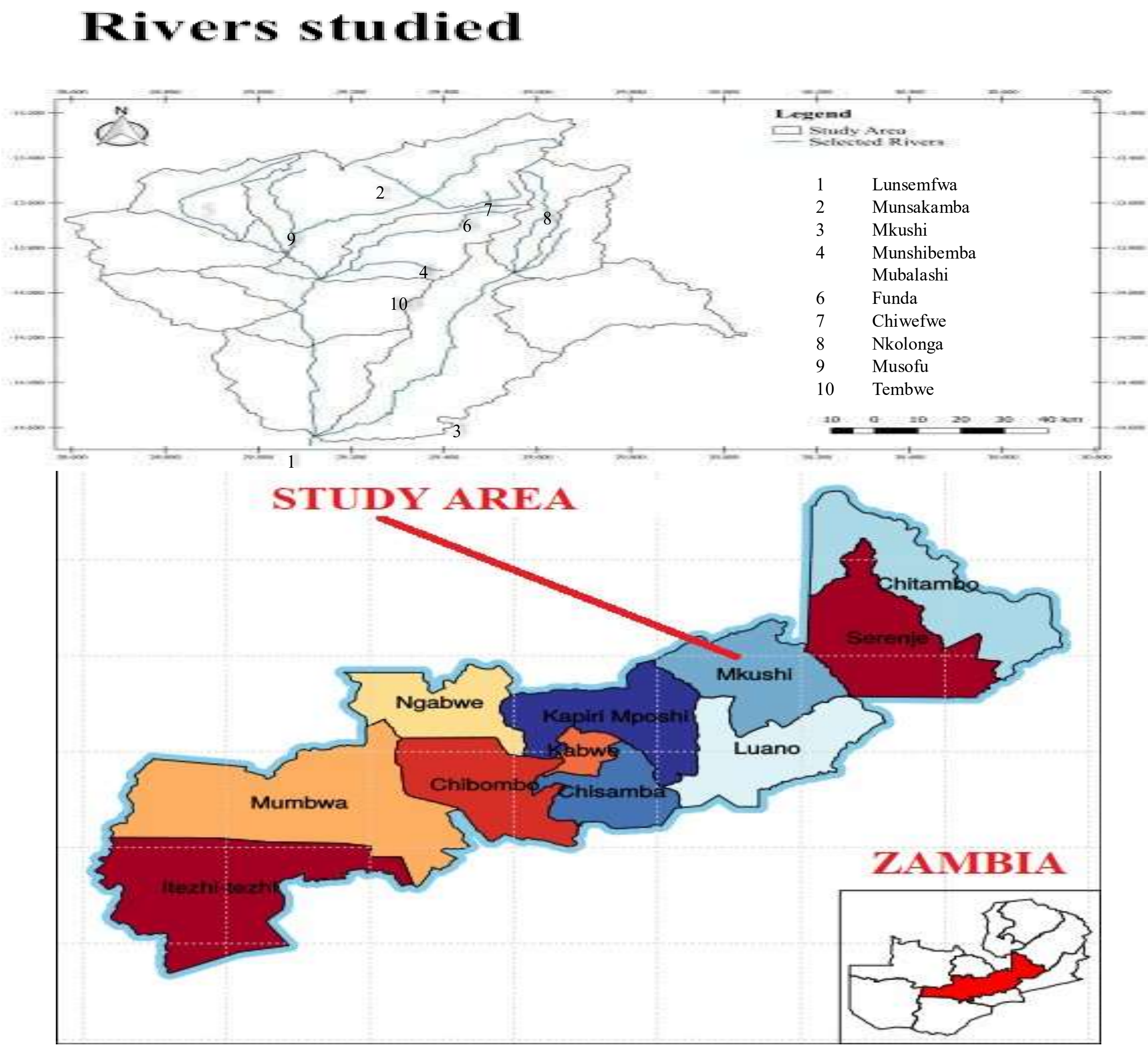
The study employed a mixed-methods approach. Specifically, the study adopted triangulation Design. Creswell (2003) argues that the triangulation design is used when a researcher wants to directly compare quantitative statistical results with qualitative findings or to validate or expand quantitative results with qualitative data. This study intentionally combined quantitative and qualitative data rather than keeping them separate to ensure the maximization of the strengths while also minimizing the weaknesses of each type of research approach.

The mixed methods approach was particularly helpful for this research because the study used multiple sources of inquiry on key actors on water resource management, the forms agriculture practices associated in the area and the types of conflicts amongst competing water users. This research relied on pragmatism which uses what works to achieve desired objectives of the study Creswell, (2014), Biddle and Schafft, (2015).

3.3 Study Site

This study was conducted in Mkushi District among small scale farmers in the Upper Lunsemfwa River Catchment. The catchment is endowed with various water bodies that support agriculture. The Lunsemfwa River is a significant tributary of the Luangwa River, and the Luangwa River takes its water to the Zambezi River, one of Zambia's longest waterways which is shared by multiple nations. The catchment's precise location within Mkushi is pivotal for local ecosystems, supporting agriculture and serving as a vital water source for irrigation and domestic use. The sustainable management of the Lunsemfwa River Catchment water bodies is crucial for the success of agricultural endeavors. The Mkushi District stresses the interdependence between water resources and the district's socio-economic activities (Zambia Environmental Management Agency, 2018). This study was accrued among farmers who practice crop agriculture and utilize water bodies in the area to irrigate their crops. The Lunsemfwa River Catchment holds huge importance for both commercial and small-scale farmers in Chitina, Shaibila, Mulungwe chiefdoms and surrounding areas of Mkushi District. The Chibefwe River, a tributary of the Lunsemfwa River, whose headwaters start in the Forest Reserve, is the only source of water for the people of Mkushi Town for domestic uses. The Lunsemfwa River also goes on to provide water for Mita Hills Dam, which is used to generate Hydro Electric power for the nation (Mkushi District Agricultural Coordinating Office, 2020).

Figure 3.1: Mkushi District Map (Source Google maps, 2022)



3.4 Population of the study

The target population for the study was all rural farmers that operate around the upper Lunsemfwa catchment area of Mkushi District in Central province district of Zambia., This population was vital for generating a comprehensive picture and understanding of the rural agriculture and its implication on water resource management.

3.5 Sampling Frame

The sample size was determined using Roscoe, (1975) who provides the "Rule of Thumb". According to him the appropriate sample size for a study ranged from 30-500 for un-known population sizes. Therefore, the selection of 227 respondents in total was adopted after the researcher applied the principle of saturation as the responses were recurring, 217 respondents came from small-scale farmers on a proportional basis and 10 from the key informants were identified through snowballing. Amongst these were The District Commissioner, 1 Representative from the council, 1 from the Forestry Department, 1 from the Ministry of agriculture, 1 Chief, 1 from Lukanga Water and Sewerage, 1 from Lunsemfwa Hydropower Station, 2 Commercial farmers and 1 from Water Resources Management Authority (WARMA).

3.6 Sampling techniques

This study used mixed methods. Particularly it adopted the triangulation design. The population of the study was **150** respondents. For the quantitative sample, the study used systematic random sampling technique. This technique is where elements are randomly selected using a sampling interval. To determine the sampling interval for this study, a Slovin formular (n = N/ (1+Ne2) was used to ensure representative of the sample. As regards the participants for the qualitative data, the study took on a purposive sampling technique because it focuses on characteristics of a population that are of interest and enabled them to answer the research questions. While utilising purposive sampling, the study ensured that only rural farmers in Upper Lunsemfwa River Catchment that fall within the age range of 19-65 were selected. This helped to provide informed data because the researcher collected information only from participants that have the relevant characteristics and information that was useful for the study. formula: k = N ÷n was used. Where k is systematic sampling interval.

3.8 Data-gathering instruments

To collect data, the study used an interview guide, focus group discussion and structured questionnaire. Both primary and secondary data were collected so as to complement each other. Secondary data were collected from district scholarly articles, reports and publications. Primary data were collected from small scale farmers, FGDs and key informants from government departments and farming stakeholders. The questionnaires collected data from small scale farmers related with demographic and socio-economic characteristics of all respondents' while interview guides collected data from FGD and key informants. This helped with the acquisition of an indepth understanding of associated conflicts and farming patterns in the area

3.9 Data Processing and Analysis

3.9.1 Qualitative data analysis

Qualitative data collected through the KIIs and FGDs were analysed through content analysis by synthesizing various arguments, and the arguments were compared with information gathered through the questionnaire. The qualitative data were used to triangulate and complement information collected through the questionnaire. To analyze the qualitative data, the study utilized thematic analysis. This involves systematic identification, organizing, and offering insight into patterns of meaning (themes) across a dataset. The data analysis process involved transcribing data and cleaning up the data by finding important aspects that were necessary for answering the research questions. Thereafter, themes were generated while identifying those that are similar or peculiar to the other themes. Themes were reviewed and a meaning was attached to each theme. Finally, reporting was done, which included the interpretation of the different aspects of the analysed data in the form of narrations without distortion of the responses from the study participants.

3.9.2 Quantitative data analysis

Data collected using the structured questionnaire were analysed using the Statistical Package for Social Sciences (SPSS) software. The data were first coded before being analysed. The analysis included computing descriptive statistics such as frequencies, percentages, means. Thereafter, postcoding of open-ended questions on the questionnaire and cleaning entries was done. Basic computations were also done to show regularities and patterns emerging on various aspects in line with research questions. Frequency distribution tables and cross-tabulations were done, and results were presented in the form of tables, graphs and pie charts.

3.10 Validity and reliability

To ensure validity the study used triangulation of data. According to Creswell (2014) triangulation refers to the process of bringing together multiple sources of data, including interviews, observations and previous publications to analyze a phenomenon from different viewpoints. In this study validity was ensured through the collection of data through both qualitative and quantitative data collection methods. Similarly, multiple data collection tools and procedures were adopted using in-depth interviews, focus group discussions and semi- structured questionnaires interviews. Furthermore, the researcher collected data from secondary sources like books, articles, research papers and policy documents. Additionally, data was collected from key informants from various institutions that deal with farming and water resource management and from farmers in Lunsemfwa river upper catchment. To further validate the data, the researcher also used non-participant observation method while collecting data. Another way that the researcher used to validate the data was through the conceptualization and operationalization the concepts of interests qualitatively. Operationalization is the process by which researchers conducting quantitative research spell out precisely how a concept will be measured. It involves identifying the specific research procedures to use to gather data about concepts. In order to ensure reliability, the researcher conducted a pilot study on 10 farmers to check for any inconsistences or problems on the questionnaires. This also ensured that the data collection instruments address the research objectives and answers research questions.

3.11 Ethical Considerations

The study ensured adherence to research ethics at each stage of the research. In so doing the researcher ensured that participants consent to participate in the research in a way that is voluntary, free of any coercion or promises unlikely to result from participation. In addition, the researcher ensured full disclosure of the nature of the study, expected benefits to the participants and society with an extended opportunity to ask questions. The researcher also ensured that participants were aware that they can choose to withdraw their participation at any given time in the study if they so wish.

In as far as the identities and information obtained was concerned, the researcher kept all the participant's identities anonymous, and all the information obtained was kept confidential. In addition, the respondents were assured that their identities would be anonymous and the information that was be obtained would be kept confidential. Confidentiality potentially helped to build trust and allow for the free flow of information between the respondent and researcher while protecting the privacy of the respondents' personal life. Furthermore, the researcher also ensured fairness in the selection of participations and kept the focus on the purpose of the study without changing statements during the course of the research. Finally, before going into the field for data collection the researcher ensured that permission to undertake the study was obtained from the University of Zambia, Humanities, Mkushi District council and traditional leaders before conducting the interviews and discussions with the farmers.

CHAPTER FOUR: PRESENTATION OF FINDINGS

4.0 Introduction

This chapter presents the results of this study according to the specific objectives. The sample size considered for this study was 150 respondents.

4.1 Background characteristics of respondents

The following results present the background characteristics of respondents. Majority of respondents were in the age group 26-35 (27 percent), while the minority were in the age group 18-25 (13 percent). By sex, males had the highest proportion of respondents (60 percent), while females had the lowest (40 percent). Majority of the respondents were married (90 percent), whereas the minority were divorced and widowed (3 percent). Slightly above half (51 percent) of the respondents had attained secondary education, whereas only 7 percent never went to school at all. White farmers were about 7 percent.

4.2 Key actors in water resource management in the Upper Lunsemfwa River Catchment

The following results present the key actors in water resource management in Upper Lunsemfwa River Catchment. Traditional leadership was the main key actor involved in water resource management (25 percent), followed by WARMA, Forestry, and Mkushi District Council at 11 percent each, while the lowest actor's involvement in water resource management were the Lukanga Water and Sewerage and Agro dealers at 3 percent each.

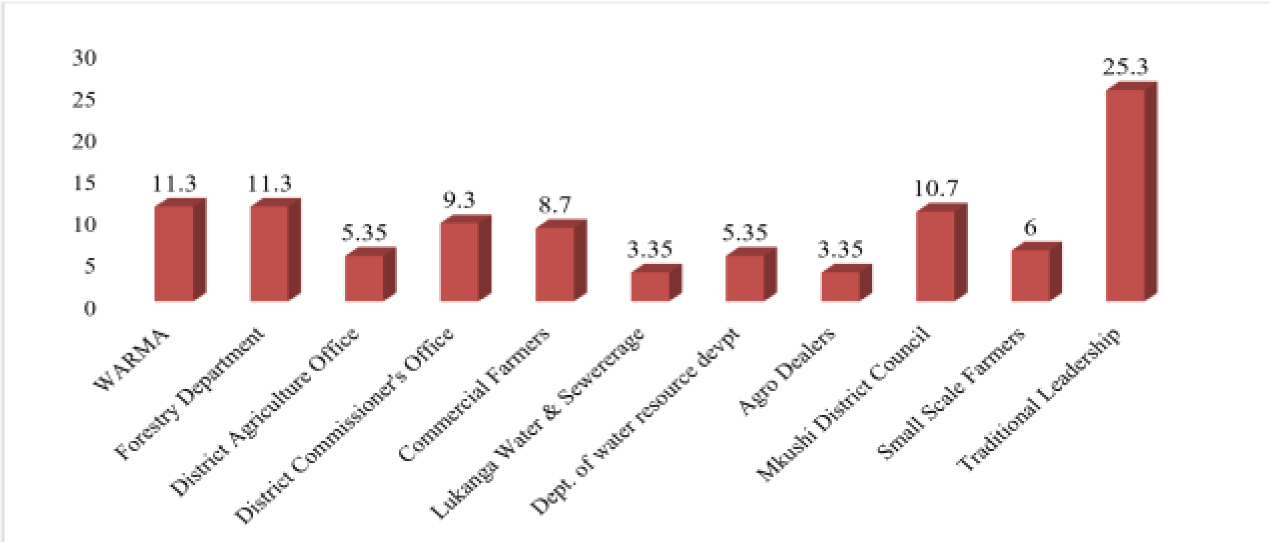


Figure 4.1: Key actors in water resource management in Upper Lunsemfwa River Catchment

4.2.1 Women's involvement in water resource management in Upper Lunsemfwa River Catchment

Majority of the respondents confirmed that women were not involved in water resource management (60 percent), while the rest indicated that women were involved in water resource management (40 percent).

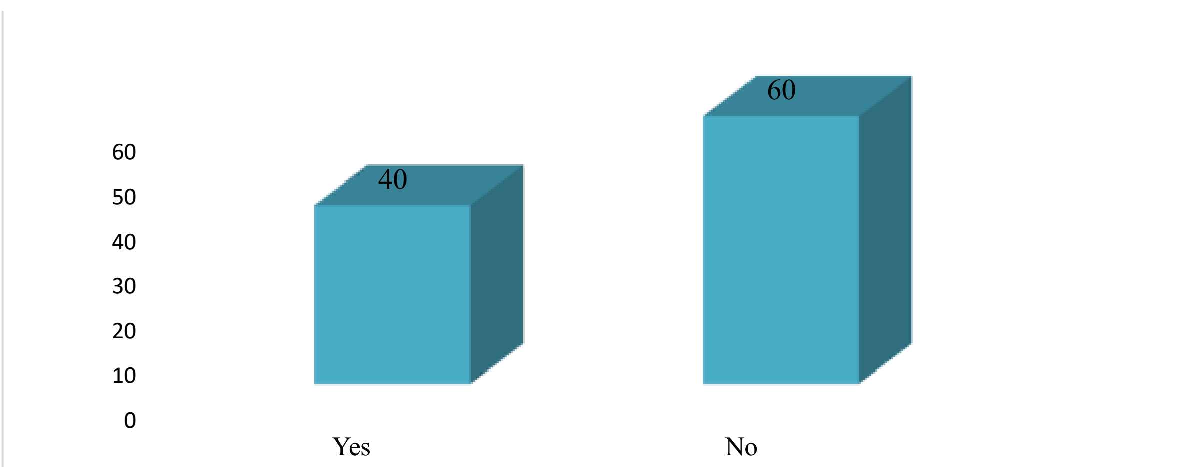


Figure 4.2: Women's involvement in water resource management in Upper Lunsemfwa River Catchment

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4.2.2 Presence of Community Traditional Structures Established to help Manage Water Resource

The results present presence of community traditional structures established in the Upper Lunsemfwa River Catchment to help manage water resource. The majority (60 percent) respondents indicated that there were no community traditional structures (traditional councils) established to help manage water resources, whereas the rest (40 percent) indicated that community traditional structures established to help manage water resource were present.

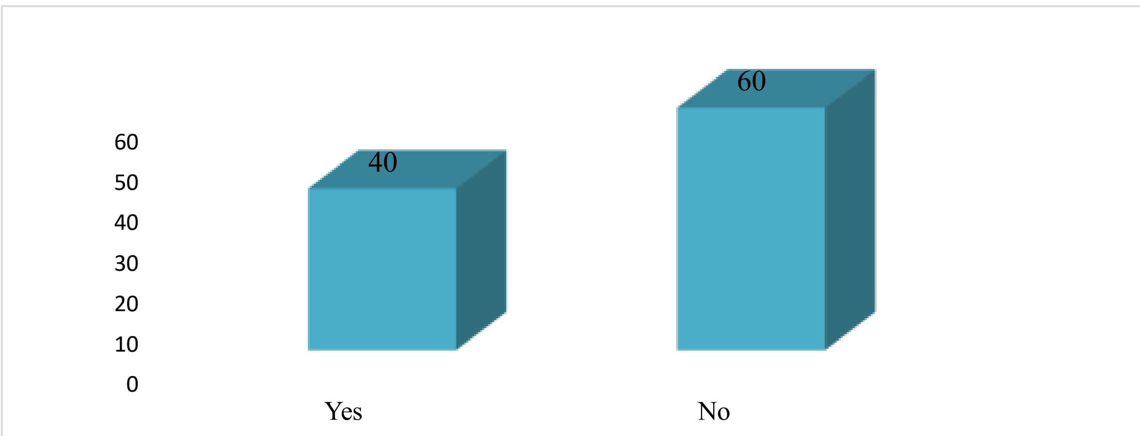


Figure 4.3: Presence of community traditional structures established to help manage water resource in Lunsemfwa River Catchment

4.3.1 Land ownership in the Upper Lunsemfwa River Catchment

The results present land ownership in the Upper Lunsemfwa River Catchment. Majority of the respondents owned the land (58.7 percent), followed by the land owned by their relatives (34.7 percent), whereas (2 percent) were rented and the rest (4.7) belonged to the category of others

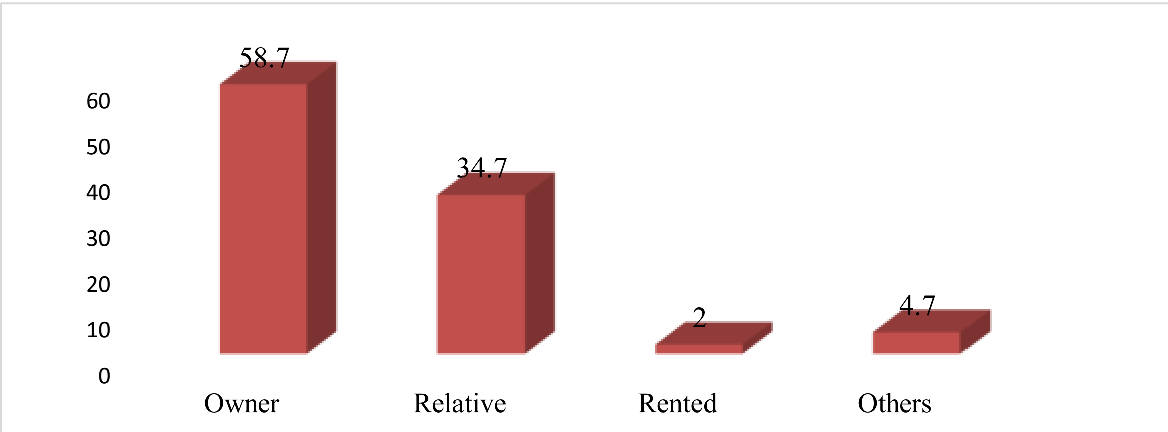


Figure 4.4: Land ownership in the Upper Lunsemfwa River Catchment

4.3.2 Land size owned

The results present the land size owned. Respondents (26 percent) owned about 10 to 12 hectares of land, followed by those who owned about 1 to 3 and 4 to 6 hectares (19 percent), respondents (16 percent) owned land more than 16 hectares. Others (11.3 percent) owned land between 7 to 9 hectares. The lowest distribution (8 percent) owned 8 hectares of land.

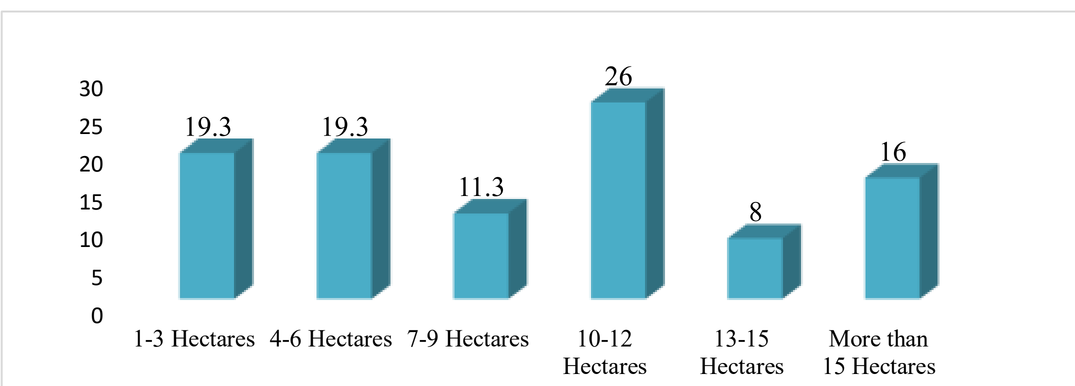


Figure 4.5: Land size owned

4.3.3 Land size under cultivation

The findings present the land size under cultivation in Upper Lunsemfwa River Catchment. More than half (55.3%) of the respondents were cultivating 1 to 3 hectares of land, whereas (26 percent) cultivated between 4 to 6 hectares. Respondents (6.7 percent) cultivated 10 to 12 hectares. Respondents (4.7 percent) cultivated 13 to 15 hectares and 7 to 9 hectares. The lowest distribution (2.7 percent) cultivated more than 15 hectares of land. The bigger the land the more water and chemicals are used.

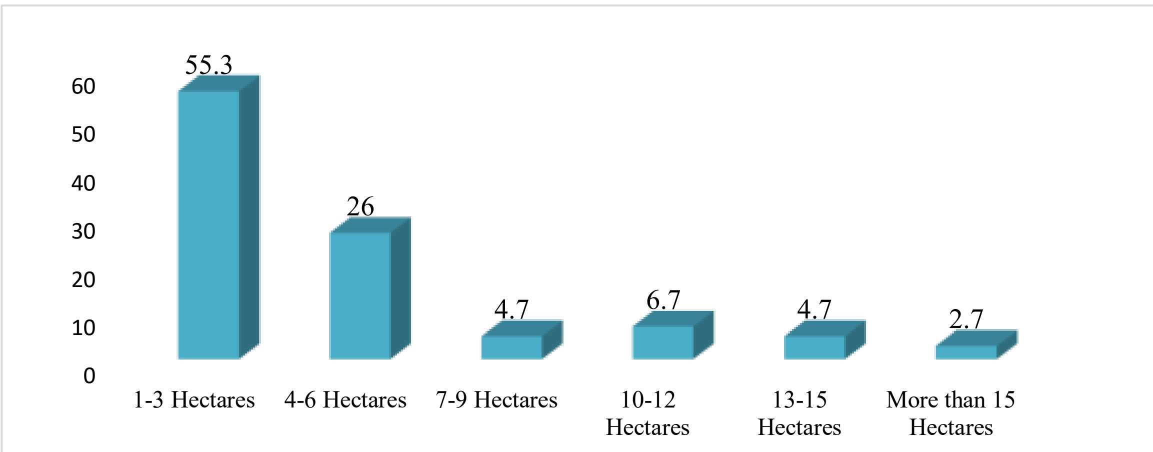


Figure 4.6: Land size under cultivation in the Upper Lunsemfwa River Catchment

4.3.4 Time when respondents started farming in the Upper Lunsemfwa River Catchment

The results present period when respondents started farming in the Upper Lunsemfwa River Catchment. The majority (33.3 percent) respondents indicated that they started farming between 1 to 5 years ago. Respondents (21.3 percent) indicated that they started more than 20 years ago. Respondents (16.7 percent) indicated that they started farming between 6 and 10 years agon. Respondents (14.7 percent) indicated that they started farming 16 to 20 years ago. The rest (14 percent) indicated that they started farming between 11 to 15 years ago

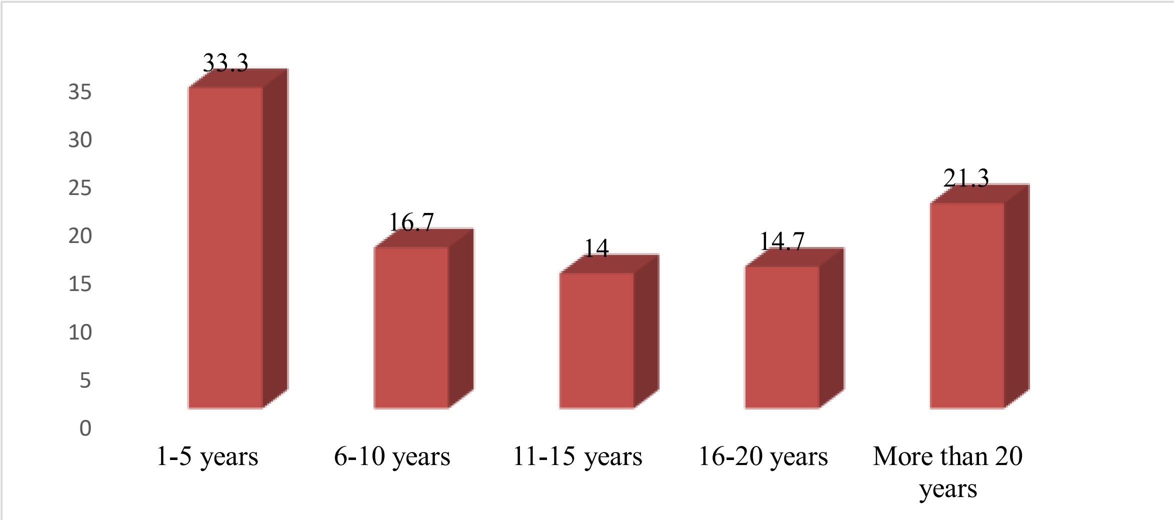


Figure 4.7: Time when respondents started farming in theUpper Lunsemfwa River Catchment

4.3.5 Source of water for farming

The majority of respondents (74.7percent) indicated that their main source of water for farming was Chibefwe, Nkolonga, Mubalashi, Msofu, Munsakamba, Funda, Kafwa streams. Respondents (22.7 percent indicated that their source of water were Mkushi and Lunsemfwa rivers. Respondents (2 percent) indicated boreholes as a source of water. The rest (0.7 percent) indicated other sources such as hand dug wells.

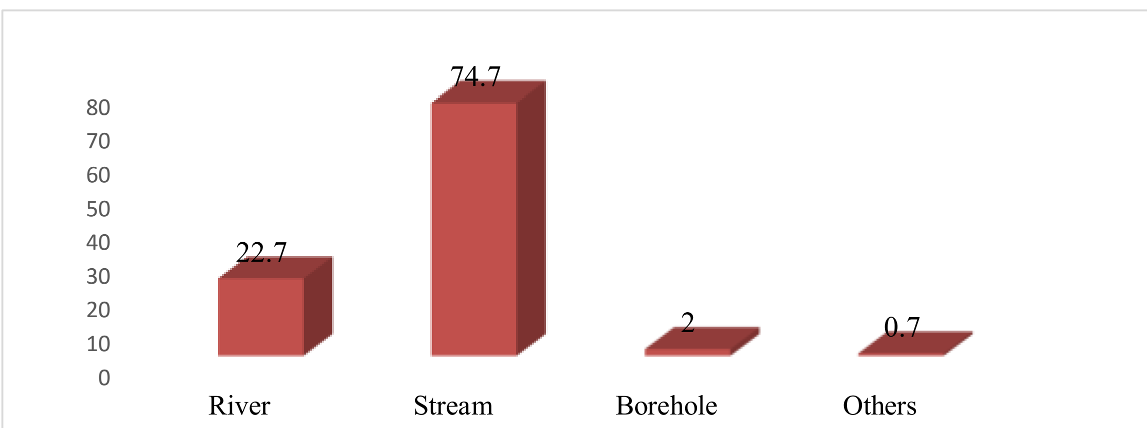


Figure 4.8: Source of water for farming in Upper Lunsemfwa River Catchment

4.3.6 Method of abstracting water

The results show methods of irrigation in Lunsemfwa River Catchment. The majority (62.7 percent) of the respondents indicated that their main method of abstracting water for farming was furrowing from Chibefwe, Nkolonga, Mubalashi, Msofu, Munsakamba, Funda, Kafwa streams. Respondents (18.7 percent) indicated others means such as bucket irrigation, respondents (13.3 percent) direct pumping using engine pumps. The rest (5.3 percent) indicated reservoir/dam.

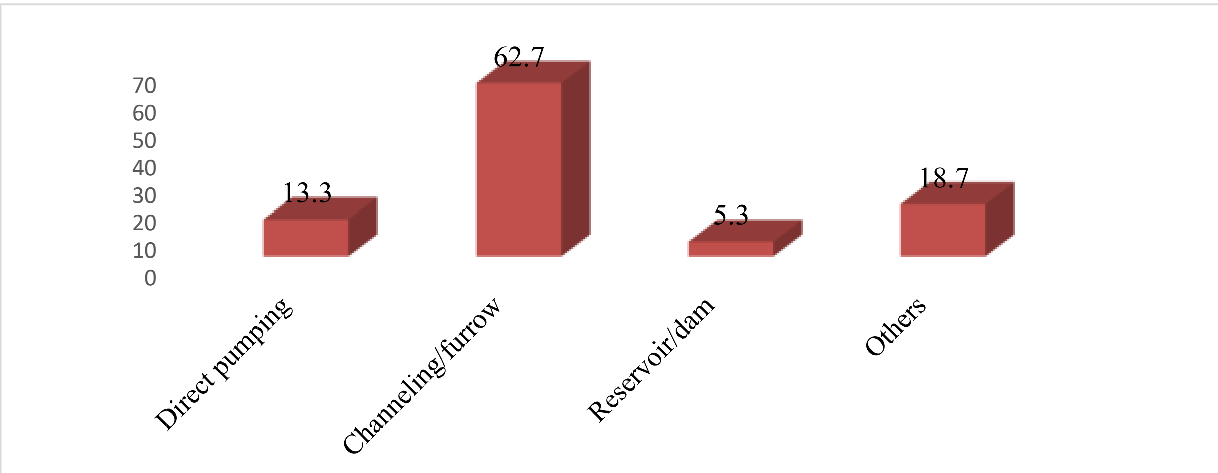


Figure 4.9: Abstraction of water in Upper Lunsemfwa River Catchment

4.3.7 Type of irrigation used

The type of irrigation used among Famers in Upper Lunsemfwa River Catchment. The majority of respondents (62.7 percent) used a furrow method. Respondents (21.3 percent) used the bucket method. Respondents (3.3 percent) indicated that they used drip irrigation. The rest (12.7 percent) indicated that they used methods other than the ones mentioned such as direct pumping.

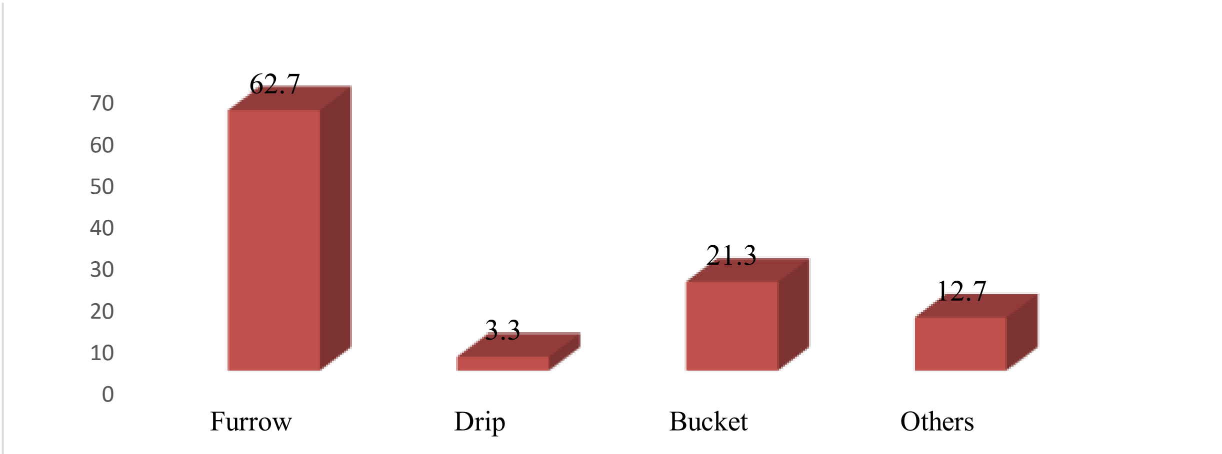


Figure 4.10: Type of irrigation used in Lunsemfwa River Catchment

4.3.8 Irrigation schedule

The study results show the irrigation schedule in the Upper Lunsemfwa River Catchment with majority (55.3 percent) who indicated that they irrigated once per day. Respondents (13.3 percent) indicated that they irrigated twice per day. Respondents (3.3 percent) indicated that they were irrigated three times per day. Respondents (28 percent) indicated others such as irrigation by chance, irrigation by direct fetching water from the source.

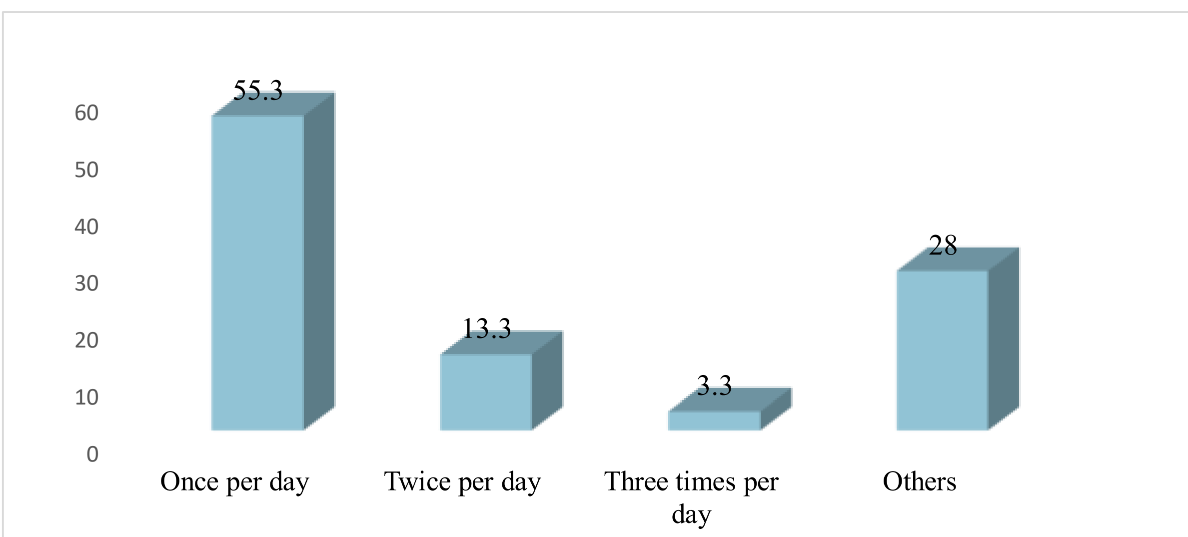


Figure 4.11: Irrigation schedule in Upper Lunsemfwa River Catchment

4.3.9 Tillage equipment used in Upper Lunsemfwa River Catchment

The following results presents tillage equipment practiced. The majority (72 percent) indicated that they used hoe. Respondents (26 percent) indicated that they used plough. The rest (2 percent) indicated that they used other methods such as no tillage at all.

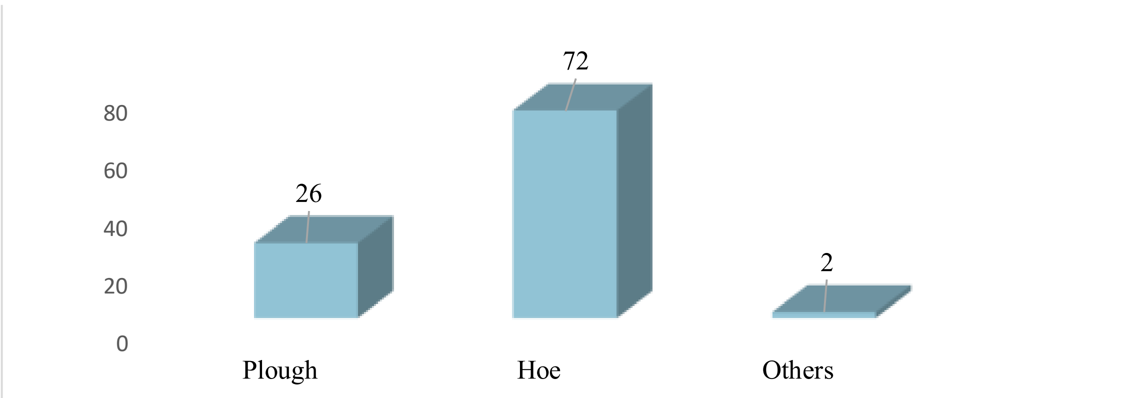


Figure 4.12: Tillage equipment used at the farm in Upper Lunsemfwa River Catchment.

4.3.10 Farming type practiced in the Lunsemfwa River Catchment

The results show that majority respondents (86 percent) indicated that they practiced intensive tillage, whereas the rest (14 percent) indicated that they practiced extensive.

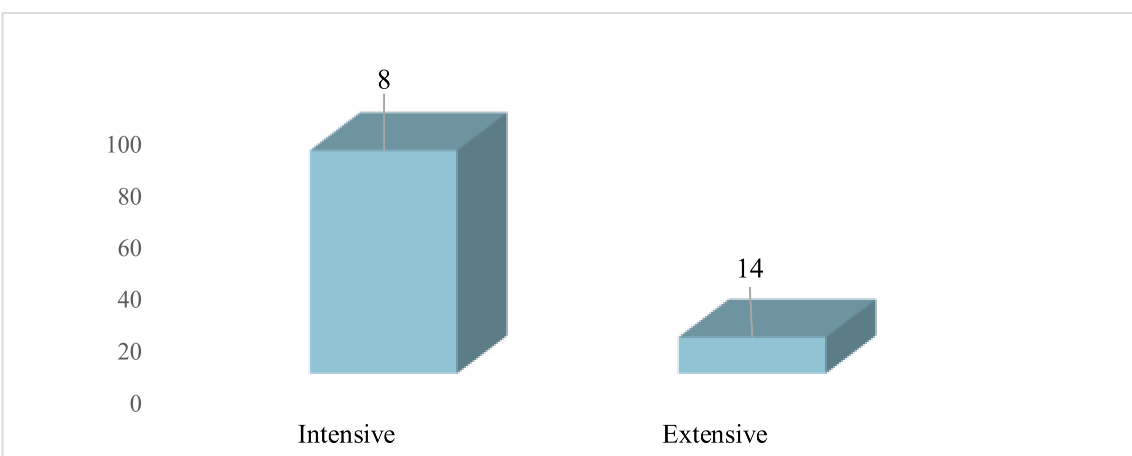


Figure 4.13: Farming type practiced in Lunsemfwa River Catchment

4.3.11 Farming frequency practiced in the Lunsemfwa River Catchment

The results show respondents (49.3 percent) farmed twice a year. Respondents (45.3 percent farmed once a year. Whereas respondents (4.7 percent farmed 3 times in a year. The rest (0.7 percent) fell on others such as whenever land was available/

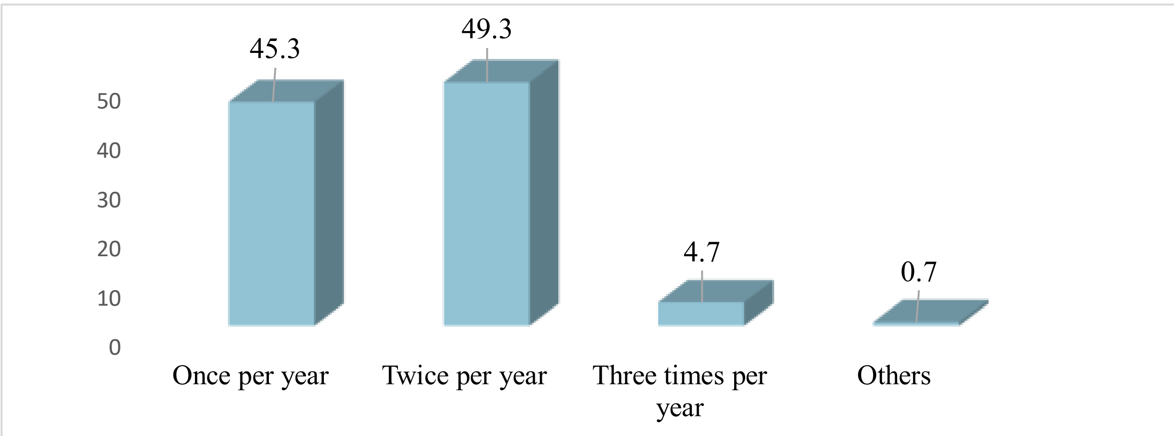


Figure 4.14: Tillage frequency practiced at the farm in Lunsemfwa River Catchment

4.3.12 Farming methods practiced in the Lunsemfwa River Catchment

The results show respondents (68 percent) indicated they practiced convention method. Respondents (18.7) indicated that they practiced conservation methods. The rest (13.3) indicated that they practiced organic farming.

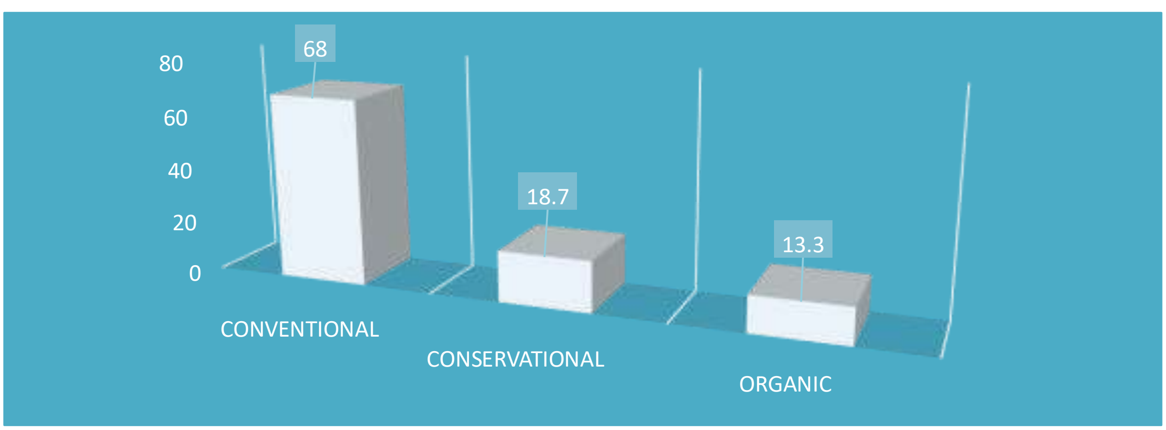


Figure 4.15: Farming methods practiced in Lunsemfwa River Catchment

4.3.13 Crops grown in the Lunsemfwa River Catchment

The type of crops grown in the area are presented. The main crops grown in the area were maize, wheat, soyabeans, tomatoes (13 percent), while the least crop grown was rape (1 percent).

Table 4.1: Crops grown in the Lunsemfwa River Catchment area

Crop	Freq.	Percent
Maize	20	13.3
Wheat	20	13.3
Soyabeans	20	13.3
Tomatoes	20	13.3
Tobacco	10	6.7
Sunflower	10	6.7
Macadamia	8	5.3
Millet	8	5.3
Sorghum	6	4
Cotton	6	4
Granadillas	5	3.3
Groundnuts	7	4.7
Cabbage	4	2.7
Onion	4	2.7
Rape	2	1.3

4.3.14: Cropping pattern practiced in the Lunsemfwa River Catchment

The results reveal respondents (56 percent) indicated that they practiced mixed cropping. Respondents (41.3 percent) indicated that they practiced monocropping. The rest (2.7 percent) practiced inter-cropping.

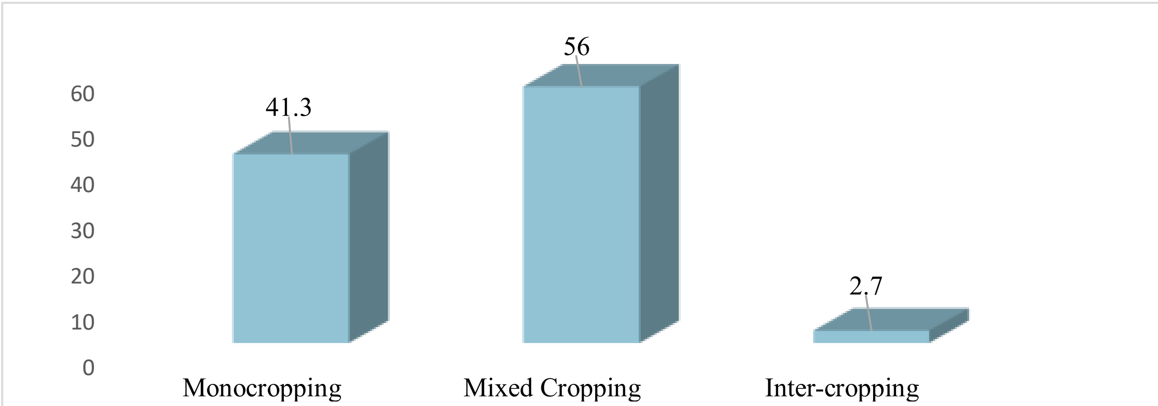


Figure 4.16: cropping pattern in Lunsemfwa River Catchment

4.3.15: Crop rotation type practiced in the Lunsemfwa River Catchment

The majority respondents (79.3 percent) indicate they practiced crop rotation every one year. Respondents (16 percent) indicated that they practiced crop rotation every two years. Respondents (3.3 percent) indicated that they practiced crop ration every six months. The rest (1.3 percent) indicated others.

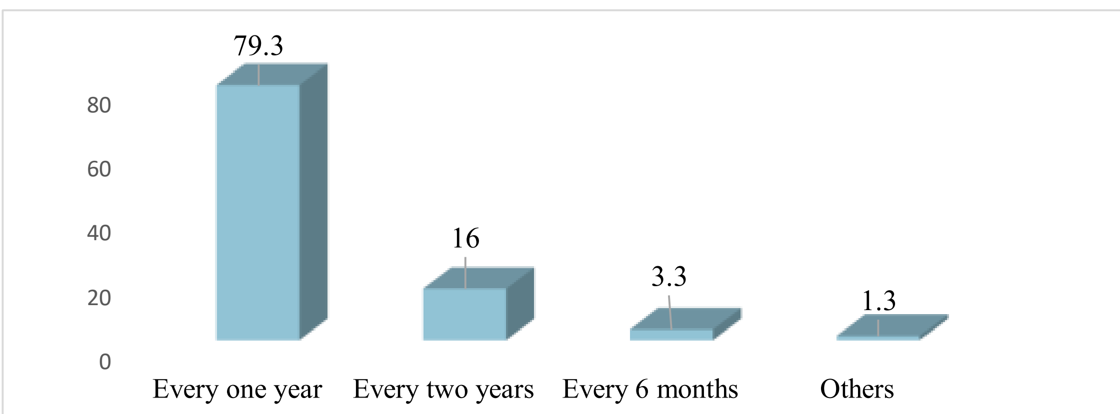


Figure 4.17: Crop rotation type in Lunsemfwa River Catchment

4.3.16: Usage of pesticides in Agriculture in the Lunsemfwa River Catchment

The majority of respondents (91 percent used chemicals on crops. The rest (9 percent) indicated they did not use chemicals.

Table 4.2: Chemical in Agriculture in the Lunsemfwa River Catchment

Chemical usage	Frequency	Percentage
Yes	136	91
No	14	9

4.3.17: Training offered on chemical usage in Agriculture in the Lunsemfwa River Catchment

The majority respondents (56 percent) indicated that they did not undergo any training on chemical usage. The rest (44 percent) indicated that they received training on chemical usage.

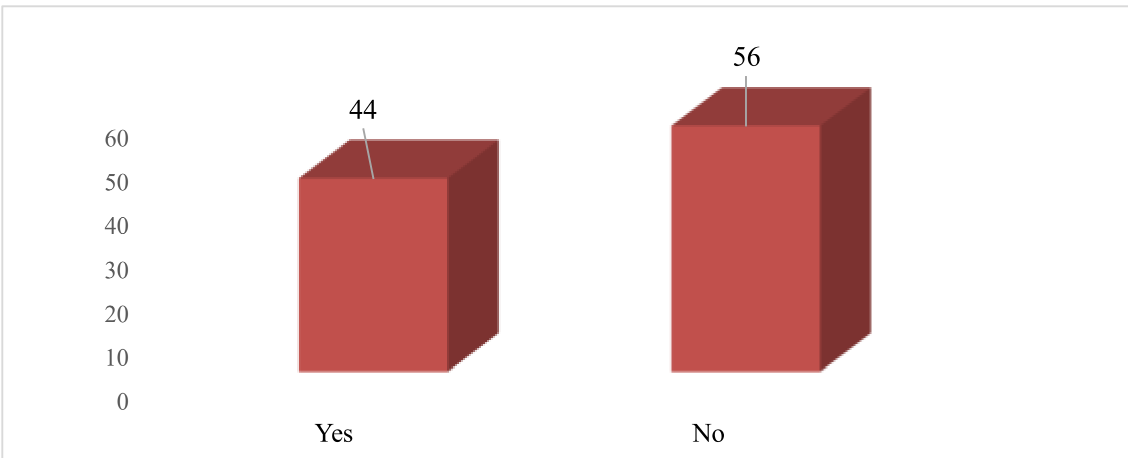


Figure 4.18: Training on chemical usage Agriculture in Lunsemfwa River Catchment

4.3.17: Trainers on chemical usage on crops

The majority respondents (40 percent) were trained by the Ministry of Agriculture. Respondents (12 percent) indicated by neighboring farm owners and agro-dealers. Other respondents (8 percent) indicated that they were trained by commercial farmers. The rest (28 percent) indicated others such as by reading on containers of chemicals.

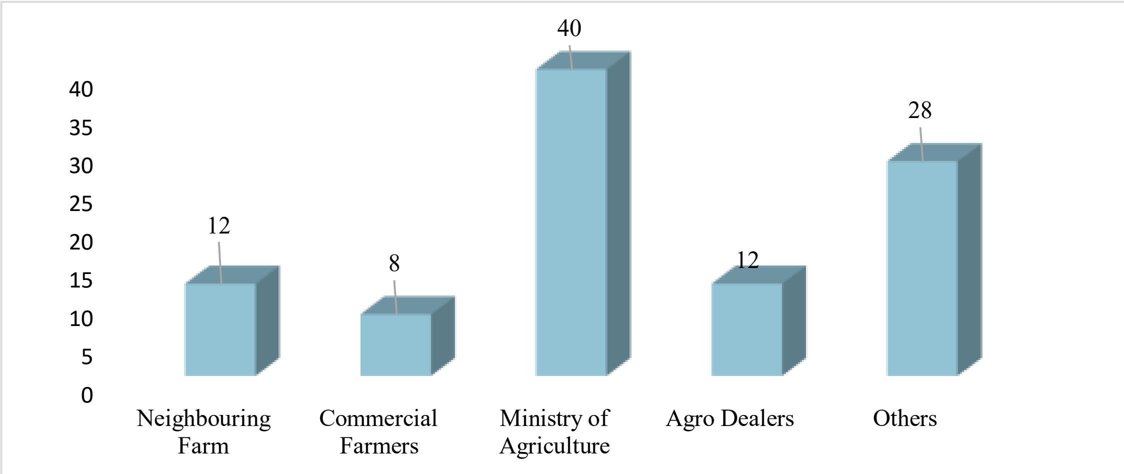


Figure 4.19: Trainers on Chemical Usage in Agriculture in Upper Lunsemfwa River Catchment

4.3.18: Disposal methods of chemical storage materials in the Lunsemfwa River Catchment

The majority respondents (40.7 percent) used the burning method of disposal. Respondents (38.7) indicated that they washed and recycled chemical storage materials. The rest (20.7) indicated that they method of disposal used was burying.

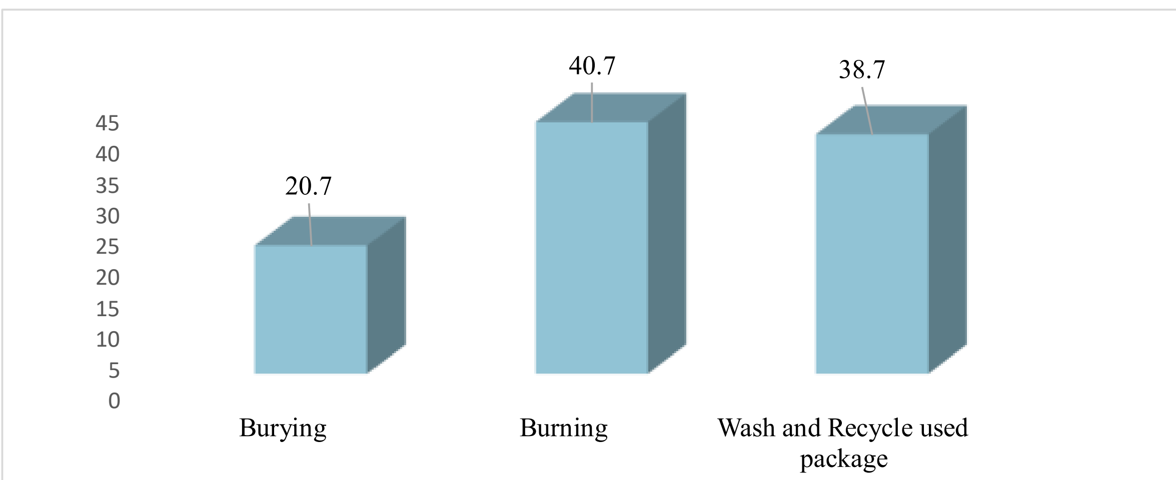


Figure 4.20: Disposal methods of chemical storage materials in the Lunsemfwa River Catchment

4.3.19: Abuse of chemicals among farmers in the Lunsemfwa River Catchment

The majority respondents (60 percent) confirmed that they did not abuse chemicals, whereas the rest (40 percent) indicated cases of abuse of chemicals.

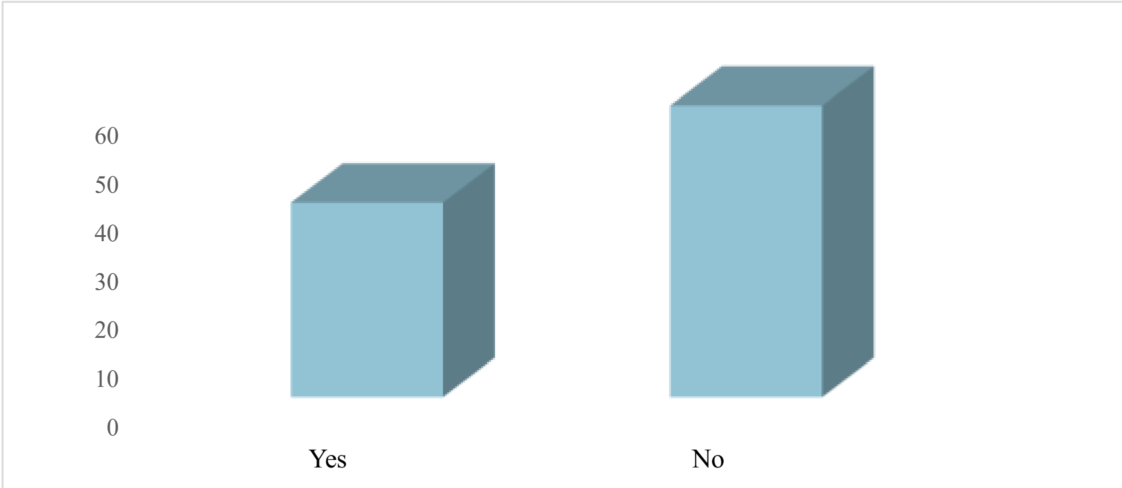


Figure 4.21: Abuse of chemicals among farmers in Lunsemfwa River Catchment

4.3.20: History of people who have been reported sick because of handling chemicals.

Majority of respondents (60.7 percent) indicated that there has been no history of people who have been reported sick because of handling chemicals. Other respondents (39.3 percent) indicated there has been history of people who have been reported sick because of handling chemicals.

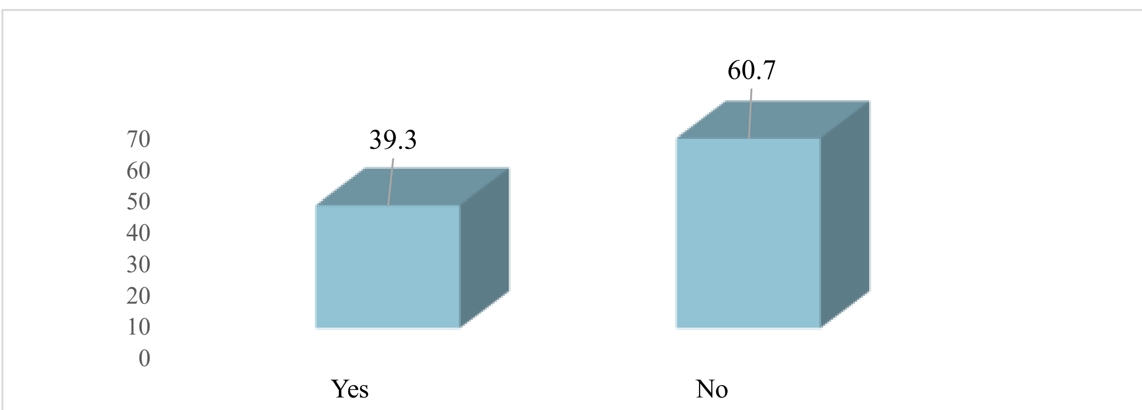


Figure 4.22: History of people who have been sick because of handling chemicals

4.4 Water Associated Conflicts by different users in the Lunsemfwa River Catchment.

4.4.1 Presence of Water Related Conflicts among farmers in the Lunsemfwa River Catchment

Water related conflicts experienced among farmers in Upper Lunsemfwa River Catchment. The majority respondents (58.7 percent) indicated the presence of water-related conflicts in the area.

The rest (41.3 percent) indicated that there were no water-related conflicts in the area.

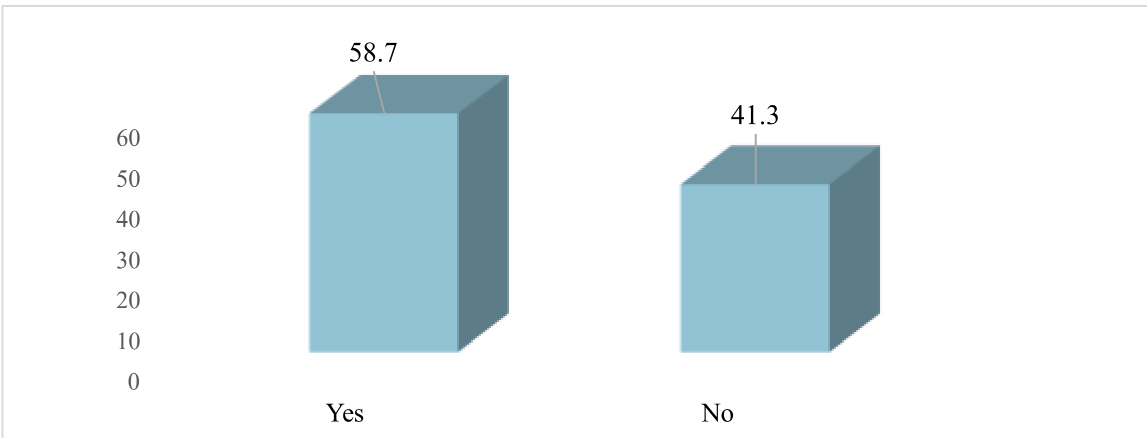


Figure 4.23: Presence of water related conflicts among farmers in Lunsemfwa River Catchment

4.4.2: Causes of water related conflicts in the Lunsemwa River Catchment

The majority (33.3 percent) indicated boundary disputes. Respondents (26.7 percent) indicated geographical location (upstream versus downstream). Respondents (20 percent) indicated irrigation schedule wrangles and size of the field respectively. The rest (28 percent) indicated others.

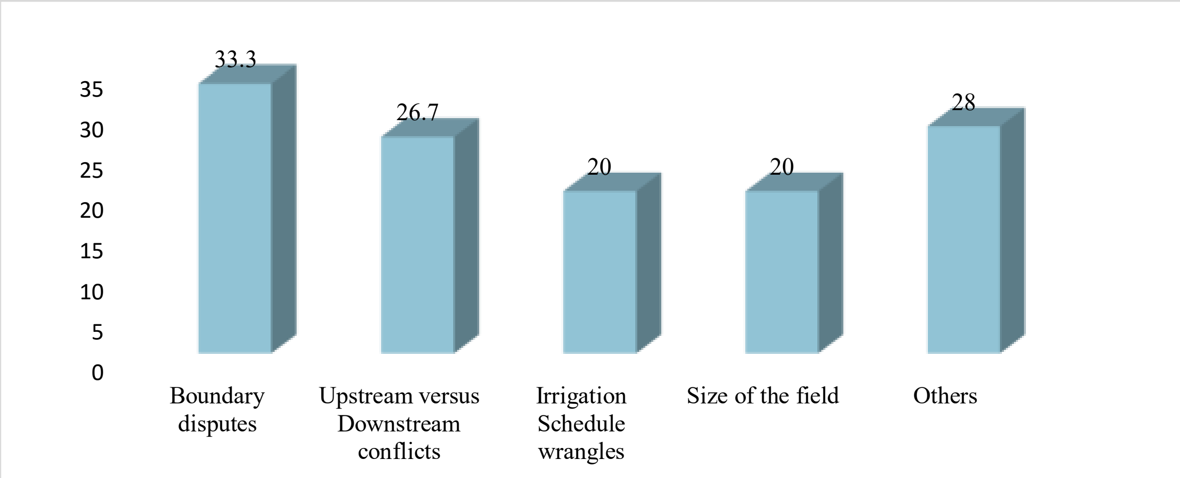


Figure 4.24: Cause of water related conflicts in Lunsemfwa River Catchment

4.4.3: Parties involved in resolving water-related conflicts

The majority respondents (80 percent) indicated tradition leaders as parties involved in resolving water related conflicts. Respondents (10 percent) indicated Ministry of Agriculture. Others (6.7 percent) indicated the District Commissioner. Whereas (1.3 percent) indicated Water Resources Management Authority (WARMA). The rest (2 percent) indicated others such as the police.

Table 4.3: Parties involved in resolving the water related conflicts in Lunsemfwa River Catchment

Party	Freq.	Percent
WARMA	2	1.3
Ministry of Agriculture	15	10
Chiefs-Traditional Leadership	120	80
District Commissioner	10	6.7
Others	3	2

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.0 Introduction

This chapter discusses the findings of the study that according to the specific objectives. The discussion is presented herein on water actors, agriculture related practices and any conflicts that arise due to water management.

5.1 Key actors in Water Resource Management

These findings reveal that the youthful age group were dominant in the area. These findings are not surprising because for example, the ones that irrigate more than once per day are falling in the age group between 18 - 35 years which is perceived to be a more productive age group who may still have the strength (Adesida et al., 2021). Similarly, this age group is considered the younger generation and one of the principles of IWRM is sustainability, and when the younger generation are taught the principles of IWRM, it means that you are teaching them sustainability. This will have positive influence in attaining the Sustainable Development Goals (SDGs) and Sustainable Development is guaranteed, which is development that takes care of the needs of the current generation without compromising the capacity of the future generations to meet their own needs. These findings are consistent with AAVV OECD, (2009) report which indicates that the entry into agriculture of young farmers can provide some indication of the potential long-term viability of water agriculture, given that a younger workforce is more likely to be able to respond rapidly to changing economic and environmental conditions and the sustainability of agriculture.

Findings revealed a different perception from the older generation. It showed that the fact that one is old was a symbol of cultural authority in the area. This showed from the focus group discussion with respondents, where older farmers registered their presence and contributed to the discussions on mechanisms for water resource management with so much authority. The older age groups confirmed that water was once abundant in the area, and they have observed that the quantity of water in rivers and streams keeps on going down. This, therefore, shows that age will play a critical role in passing on knowledge on water conservation. This is in line with the findings of Gima (2017) that older farmers with long years of experience adopted innovation better than the younger ones. In this study age it is linked to people who consume a lot of water in their agriculture field.

The flip side of order generation in this study was the perception that water was a gift from God, and therefore, they can use it in whichever way they feel like. The perception of water as a free resource makes the older generation feel that water should be available for them for free and there should be no interference from outsiders such as the government and its policies. This perception can hamper efforts to integrate competing users and could perpetuate conflicts and prevent the implementation of effective water management mechanisms. The furthest point of the revelations in this study is the behavior patterns of different age groups which show how categories of people are required to be integrated in water resources management mechanisms to influence change of perception at different stages of life. The (AAVV OECD, 2009) report show that age of the farmer is hypothesized to have a negative influence on the land management. The older generation, for example, are perceived to be less equipped and less motivated. The report perceives older farmers to be less knowledgeable about the causes and occurrence of soil erosion and its impact on productivity. Rural viability relates to issues such as farmer age structures, besides educational and managerial skills, and access to key services. The findings of this study reveal a different scenario.

It reveals that different age groups play different and specific roles and at different levels.

5.1.1 Women Involvement in Water Resources Management in Lunsenfwa River Catchment

As earlier observed in the result section, gender plays a prominent role in water management matters. This reveals that there were more male than female respondents. Overall, literature has shown that in customary establishments the norm is that men in rural areas are less involved in water collection. Based on literature men are engaged in water collection only when the distance to a water source is long and the technological requirement to collect water is high (van Zyl et al., 2007). The findings in this study are different from other studies. It shows that men were more involved in water related activities simply because they have an authoritative voice over water for agriculture. For example a study conducted by van Zyl et al., (2007) show that females are perceived as high-water consumers than males because they carry out more water-related activities than their male counterparts at household level. While a study by Jordán-Cuebas et al., (2018) shows that females take long showers than their male counterparts. All these studies are pointing to roles of women in water consumption and conservation at household level. In the Lunsemfwa river catchment access to water for agriculture by women revealed low levels. However, analysis show that if women were allowed to have equal access to water for agriculture the same as their male counterpart, they can apply the similar principles of water conservation like they do at household level. This is justified by the findings of Fink on gender roles whose study revealed that women have a high level of knowledge on water conservation than men who are less frequently engaged in water conservation programmes. Analysis shows that access to water resources is key in its preservation. It shows that the gender differences distort access and right to water. These have fundamental implications on integrated water resources management. The study revealed that while women were a key custodian of domestic water such as water for drinking and food production, their lack of access to water for agriculture reduces their influence on water management mechanisms. This is likely to make them shun getting involved in water management. Women are a significant factor in water management because they represent a large part of stakeholders involved in everyday water use and management (Manase et al., 2003). The study reveals that women are not recognized as key in all water affairs. When water bodies are not protected it's the women who will suffer because they are the custodians of water at household level. Women carry and spread the message quickly, this makes them critical actors. In the Lunsemfwa

Women especially in developing countries are often responsible for fetching water and cleaning, cooking, and washing. The men are often away from home, while women are the ones actually using and managing water day-to-day (Global Resources Institute, 2022). This makes them primary water decision-makers at the household level. According to the results in the study 67% show women did not have a role water resource management whereas 33% of participants showed women who had a role in water resource management. A study in South Asia investigated the role of women and found that a greater involvement of women can also strengthen the effectiveness of the organization of water resources as they were identified as a the major factors in resources transformation (Meinzen-Dick and Zwarteveen, 2016). In Africa the picture is similar in that women were found not contributing to the water sector because of cultural practices, low selfconfidence, low levels of capacity, and high workloads (Elias, 2016). The present study has revealed low participation in water sector by women in Lunsemfwa catchment and should be overcome to provide water resources management a balanced outlook and overcome the impact of culture on women in water management raises concerns regarding gender issues in rural area.

The implication here, is that respondents who had higher level of training and education were in the category of adopters of water conservation practice. This finding is supported by the study of Hoang, G.H. (2020), found that educated farmers appreciate and adopt the use of mobile phone in marketing cereals than the uneducated farmers. Furthermore, result shows that 33% of respondents were married while 50% were single. Also, 22% were divorced and 17% were widow. Household demographics play an important role in understanding diversity inherent in agricultural activities. This result is in consonance with the study of Pienaar and Traub (2015), found that social relations such as gender, marital status, class differences are central to agricultural production. Likewise, the study of Agholor (2019) found that almost 43% of the labour force in Sub-Saharan Africa's agricultural sector are made up of women, but their activities in farming are reduced to unpaid family labour, and as a consequence, they are in many cases excluded from agricultural statistics.

5.1.2 Married couples in Water Resources Management

The study considered the marital status of respondents because society deals with different social statuses differently. Couples were considered to have access to knowledge on both agriculture and water than those who were single. For example, in village meetings, the husband or wife will represent the family while the other one will have gone to the field to attend to their crops. This implies that the family would not miss out on important information that would have been passed on by a third party when they miss out on key information. Analysis also showed that couples cultivated big portions of land because they help each other and used a lot of water for irrigation and irrigated the crops withing the required time allocated than those who were single. These findings were similar to (Van Aelst and Holvoet, 2016) whose findings show that when married women are not irrigating, their agriculture fields are being irrigated by their husband. Further analysis has shown that married couples are likely to take on relatively agricultural water management roles because of irrigation activities. However, the position of wives in water management was unclear because their relationship with their husband mainly determined their access to agricultural water management through for example irrigation. Most women in the area lacked independent access and control over water.

5.1.3 Level of Education in Water Resources Management

Respondents who constituted 46.7% attained primary education. Those who attained secondary education constituted 42%. Only respondents constituting 4% attained tertiary education and respondents representing 7.3% never went to school.

People in rural areas have limited opportunities for education. It is said education is the key to achieving economic development and the lack of it, therefore, has potential to present sustainable development challenges. The level of education is crucial in water resource management. The study observed that those who attained tertiary education were comfortable discussing the topic around water management. Analysis further revealed that those who have gained some levels of education are likely to find it easy participating in water resource management. For example, those who have attained secondary and tertiary education were able to explain laws and policies on water management. Farmers who have attained primary education showed potential to stimulate communication and cooperation among their communities. Further analysis shows that even those with minimum literacy can apply basic knowledge on water, communicate in public meetings and judge decision based on integrated water resources management. The topic on education was noted to be very important as its affect their sources of livelihood such as water management. In rigid rural communities where people's behavior is shrouded in cultural norms, education plays a role of preparing and inspiring rural communities to be agents of change. This can be a catalyst for practicing Integrated Water Resources Management Resources (IWRM) principle and could play a role in preventing water related disasters such as the South Africa's day zero. Several studies have stipulated the importance of education on water, for example Mosley et al. (2004) in their study reveals the importance of water literacy in connection with natural disaster response and recovery. Further, more cases have been documented in which the lack of knowledge about the danger of water-quality deterioration following a water-related disaster led to infectious diseases and other negative health effects. One noteworthy example of the contribution of education to disaster response comes from the Japanese coastal town of Kamaishi, in the prefecture of Iwate, where 99.8% of secondary-school students survived the tsunami and flooding caused by the 2011 Great East Japan Earthquake (Sato, 2012). This was, in part, due to local school and communityled education for Disaster Risk Reduction (DRR) which had been regularly conducted prior to the events. This example demonstrates that one key to reducing the scale of damage triggered by waterrelated disasters is water related DRR education. These forms of education will only become more important, as global warming and other environmental factors are likely to increase the frequency and scale of water-related disasters around the world. The Hyogo Framework for Action 20052015 points to the importance of ensuring access to appropriate training and educational opportunities for those populations considered “socially vulnerable”, including women. Moreover, to reinforce coastal hazard risk management and local community safety and resilience, various studies demonstrate the importance of improving all shareholders’ knowledge about water issues (Dewi, 2007; Marfai and King, 2008; Marfai et al., 2008; Ristic et al., 2012)

5.2.1 Key Actors in Water Resource Management Determined in Upper Lunsemfwa River

Water is a finite source, and its existence can not only be controlled by nature but also humans. People can help manage its aspects such as to access, to preserve it and to allocate between different users. However, human influence at the same time can significantly decrease water levels through ineffective mechanisms of land management and use, weak agricultural knowledge and practices, including lack of effective irrigation systems.

The findings of this study revealed that, traditional leadership including the chief, village headmen and local indunas were the main key actor involved in water resource management by organizing the community through village committees, followed by WARMA, Forestry, and Mkushi District Council at 11 percent each, while the lowest actors were the Lukanga Water and Sanitation and Agro-dealers at 3 percent each. White farmers play a huge role too in water reservation by making dams, furrows from the Kafwa and Funda streams to the farms for easy irrigation, as well as water tanks at the farms. In the Upper Lunsemfwa River Catchment the rural population indicated that traditional leaders were key in water management. Despite traditional leaders being ranked as a very key actor, WARMA is the mandated government institution by law to oversee the use of water resources and management. Traditional leaders hold traditional powers over customary land and their subjects, administering their affairs as per tradition and customs.

Small scale farmers sit on traditional land and submit to the authority of traditional leaders. Commercial farmers on the other hand sit on land converted from customary land (traditional) to private, which was bought by traditional leaders and have since acquired title deeds. There are no known traditional practices and customs of water resource management. Traditional authority is known for dispute mediation that occurs in villages which includes unequal access to water for agriculture in chiefdoms and yet with no system for traditional water resource management. There are no known rural structures that shape water use in Upper Lunsemfwa River Catchment. Traditional hierarchy comprise of the chief being the top, headmen (Induna) and community heads.

One key informant said:

> *"There have been no known attempts to introduce IWRM in rural communities particularly among small scale farmers who are major users of water in chiefdoms. The biggest chiefdom in the area is chief Shaibila, He is also believed to be the strictest traditional leader where land allocation and development are concerned".*

The chief is known to be educating his subjects on the importance of preserving trees to prevent land degradation. People that reside near streams and rivers in Upper Lunsemfwa River Catchment have a perception that they are self-reliant when it comes to water provision.

One Chief said:

> *"Our role as chiefs is to ensure that there are no activities along the banks of rivers and streams. People think land near rivers and stream is very fertile, so they opt to cultivate along the banks of the rivers. We also ensure that people don't cut trees along the banks of streams and rivers to prevent disruption of natural ecosystem. Water resource management is the role of the headman together with traditional councilors. They are the ones who help chiefdoms in conflict resolutions."*

The study reveals that other governments and prospective mine owners make decisions without involving chiefs. Mining licenses are issued without the knowledge of traditional leaders, yet the government expects chiefdoms to welcome their investor. Mining activities take place in chiefdoms and have increased competition over water. Apart from agriculture, mining activities have seen massive migration of people to the area. Some farmlands have been taken over by mine investors and threaten food security. There is lack of understanding different mandates by different institutions. The Ministry of agriculture has no role in water resource management in the area. The interest of the ministry is to do with crop production because water is an essential input in crop production. Regardless of what chemicals famers are using so long the crop is doing fine and high yield is guaranteed.

One key informant said:

> *"We as a ministry only concerned about water scarcity arising from increased competition because lack of adequate water is linked to poverty in the area due to water shortages for agriculture".*

The study revealed that the interest of the utility company are water bodies such as the Chibefwe stream, because it is used to supply water to households. The farming community are key in water resource management because they are the main water users, and their activities affect the state of the water bodies. All the water is abstracted in the Mkushi farm block. This is a challenge for other users such as the Lunsemfwa Hydro Power station who have no water. The water utility company tries to protect the source of the Chibefwe by ensuring there is no tree cutting and any other activity on the banks of the stream that can compromise the flow of the streams. More force was required, particularly from the forestry department, to help and protect the watershed. Safeguarding water bodies is a challenge because of lack of basic resources including transport which is used in monitoring forest reserves. The biggest problem noted in the study is lack of identifying key actors in water resource management. Many issues arise such as political influence. The local authority doesn't come in so much because it is partially controlled by political offices. The small-scale farmers are culprits in over abstraction of water and cutting of trees. There is also a lack of traditional monitoring mechanisms at the customary level.

The area has recorded influx in mining, adding to large and small-scale farming. The sectors such as mining and agriculture have presented opportunities for employment creation. Due to these economic activities, there is an increased population that has come with water-related challenges with people resorting to cutting down trees for charcoal production. This practice distorts the forestry natural state and disrupts the headwaters which is a source of water for many streams in the Upper Lunsemfwa River Catchment. The role of forestry is to manage safeguards. The role can be fulfilled with support from other stakeholders such as WARMA. Effective management of water can come about when players in water management take up their roles. The term integrated implies that different users coordinate with one another with due regard for individual institution and their joint effect on water resource. There are no stakeholder meetings to discuss water management. Different institutions have different mandates and objectives which make it difficult for institutions to have a unified plan. There is also no support from key institutions to coordinate and collaborate in order to reduce competition and provide a pathway for sustainable water resource management at catchment level.

One of the functions of the Local authority is land use planning. This function is affected particularly by how water is managed. Mkushi being an agriculture town means water is a key feature in the area. This makes the district council key in water resource management. There are no routine programs amongst key actors in the area to manage water resource.

Lack of understanding how much water resource is available in the catchment. There are no quantitative figures in terms of how much water is available against what is abstracted. Similarly, there is no information on what is abstracted by small scale farmers. The extent of encroachment on recharge area. Lack of coordination amongst water users. There is no legal water user's association. The SI on water users' association hasn't yet been passed into law. There is a need to meet frequently to understand problems the catchment is facing. Adding to all this, climate change effects are increasingly becoming visible. Charcoal banners are also a problem because the practice is distorting the ecosystem. Water users are the number one stakeholder in the area, with a promising water management mechanism. Lukanga Water and Sanitation company spearheading the issues. There are no NGOs or civil society organizations to champion water issues in the catchment.

One key informant said:

> *"We facilitated water resource assessment. We are also looking at the extent of water resource encroachment through use of sate light images. We have engaged the Local Authority in Kapiri Mposhi to see how best we can work together. We are also spearheading the formation of WUAs. We want to be integrated by the WUAs in the Lunsemfwa River Catchment".*

A similar study conducted in Malawi revealed that traditional leaders play a vital role and had a high percent distribution involvement in water resource management (Kuruk, 2004 and Sarpong, 2005). Further, a study conducted in Tanzania by Dungumaro and Madulu (2003) justified the need for an Integrated Water Resource Management approach and explained the rationale for community participation, that involvement of the community members in water resource management by making dams, furrows from the rivers and streams. This community involvement helps in water resource management. This is like the Zambian practice, where farmers do make dams and furrows at their respective farms. For a rural community this practice is important because their livelihood is dependent on farming and water supplements farming. This is because many rural communities in sub-Sahara Africa are dependent on agriculture. The study further revealed that Tanzanian Ministry of Water is heavily involved in water resource management together with community engagement (Dungumaro and Madulu, 2003).

Contrary, a study conducted in Zimbabwe revealed that that water management institutions lacked effective regular interaction and cooperation at the River Basin level. Communities do not get involved in water resources management in the Upper Pungwe River Basin Zimbabwe, this results in water scarcity for effective farming among farmers at the Upper Pungwe River Basin (Chitakira and Nyikadzino, 2020).

5.2 Agricultural Practices in the Upper Lunsemfwa River Catchment Area and Implications for Sustainable Water Resource Management.

5.2.1 Policies for water resources management

Zambia has several policy and legal frameworks to support its effective management and utilization of the natural resources. The constitution of Zambia (2016) is the highest supreme law of the land. The Act No. 2 of 2016 provides for sustainable utilization, management and use of natural resources and its environment and has accorded a high priority to protect and conserve the environment (GRZ, 2016).

The Government of the Republic of Zambia recognizes the key role improved access to clean and safe water supply and sanitation services play, in the socioeconomic development of the country. The water sector in Zambia consists of three sub-sectors namely Water Resources Management

(WRM), Water Resources Development (WRD), and Water Supply and Sanitation (WSS) under the Ministry of Water Development and Sanitation which is the ministry responsible for water development. The 2010 National Water Policy refers to WRM as the practice of making decisions relating to river basin planning, development of water harnessing infrastructure, controlling of reservoir releases, regulating flood plains, and developing new laws and regulations as well as taking actions on how water should be managed (Government of the Republic of Zambia, 2020).

The policy further defines WRM as the promotion of rational and optimal utilization, protection, conservation and control of water resources; and improving access to water of sufficient quality and quantity of water; and the distribution of water for various uses. On the other hand, the 1994 National Water Policy was revised considering principles of Integrated Water Resources Management (IWRM). This culminated into enactment of the WRM Act No. 21 of 2011 to provide the legal framework for the revised policy given the IWRM principles and the need to realign mandates following the creation of the Ministry for Water Development and Sanitation in 2016. In addition, Zambia has been implementing the 7th National Development Plan (7NDP) which was anchored on the policy of leaving no one behind. This implies that the nation took an integrated approach to empower and enact change by carrying along categories of people who are unable to gain influence or participate meaningfully in the decisions that impact them. To achieve the SDGs, people must be equal agents of sustainable utilization of water and empower them, by integrating their meaningful participation in decision making and establishing safe and inclusive mechanisms for their involvement in water resources management.

Despite the laws of Zambia and policies containing prudent use and management of water resources, analysis reveal lack of enforcement of laws among the rural populations. Water is the main input in agriculture. The Agriculture sector constitute 22 percent of GDP in the Zambia (Vision 2030). Therefore, there should be a link between agricultural intensification, land use and water resources management revealing the need for clear key policy integration.

Several studies have been done on how policies are relevant in managing water. Grey and Sadoff, (2007), Ngene et al., (2021) stipulates how developed nations have a shared history of heavy investment in water infrastructure, institutions and the capacity to manage water resources adequately and how less developed nations are usually characterized by inadequate water infrastructure, weak institutions, and poor water governance. Given that the demand for finite water resources is increasing, it is important to examine how water resources can be managed to facilitate continued national development. The Sustainable Development Goals (SDGs) offer an opportunity for policy makers and stakeholders to mobilize integrative efforts, create shared global understanding and commit to action to improve the lives of people and the environment by shifting the previous paradigm focused on solving individual situations and beginning to connect the dots between actors, policy fields and scales to address development challenges in a systemic way.

As in any policy field, water resource governance strongly depends on the institutional arrangements in place. Recognizing the IWRM principles in the National Water and Sanitation Policy for 2020 reveals that the IWRM approach is still the effective mechanism in water resources management. Water institutions include, among others, water laws, water sharing rules, irrigation procedures and beliefs linked to rivers, lakes and other water bodies. According to this definition, institutions shape the choices made in managing water; they impose constraints on water policy; and they drive behaviors related to water sharing and use (Hassenforder and Barone, 2019). Institutionally.

Findings reveal that despite the water policy being in existence the policy has not fully integrated climate change to address the management of water resources in Zambia. Analysis show that the current water related policy is almost ineffective in dealing with issues such as climate change as policies have not been able to consider the changing context of national climate related problems affecting water resources. Sustainable management of the water bodies in Zambia, specifically the water resources in the Lunsemfwa, should be proactively addressed by identifying and addressing policy gaps and governance issues. This is in line with the studies by Ringler, Bhaduri, & Lawford (2013) whose findings reveal that the development of a national water policy receives support from various stakeholders on to address adaptive change, considering new information arising on the topic of water such as climate change and its challenges, will facilitate sustainable development.

A water policy that incorporates the principle of managing water across sectors will promote sustainable use of the resources in the various sectors. Thus, economic development will be allowed that will not negatively impact the ecological functions of the natural resource or the social wellbeing of water users (Ringler et al., 2013). Some of Zambia’s agriculture production comes from the Upper Lunsemfwa River Catchment, thus, any water challenge that reduces agriculture productivity will affect sustainable development and food security in the community and at national level. Similarly, any unsustainable agriculture practices such as careless usage of water, pipe leakages, that affect the water resource reservoir in the catchment, will have ripple effects on farming due to water scarcity.

5.2.2 Land ownership

The results for landowners by local community in the study area revealed that majority of respondents constituted 58.7% owned the land they cultivated on. The other 34.7% cultivated on land that was owned by relatives. The rest, 6.7% rented the land they cultivated on.

Land ownership systems determine who can access and exploit resources in a particular area, and who can expect to inherit those resources over the long term. As such, land ownership is a cultural trait that plays a critical role in shaping natural resource management practices and influences the resilience of social-ecological systems (Adesida et al., 2021). The study revealed land owned is all traditional land without control from the state and ownership of land is associated with land uses. Most respondents talked revealed that there have been changes in the land use. In the past land would lie fallow but this time it is rarely practiced. The following is a method of agriculture land management that has been used for a period in order to let the land rest and regenerate.

> *One respondent said agriculture was not as common as it is presently. People cultivated just what they could manage, The rest of the land would remain unutilized.*

Once agriculture started booming land was becoming more and more scarce; crop fields were becoming small. Agriculture chemicals also became available to farmers to enhance soil nutrients, the practice of fallowing was beginning to be abandoned because a field left unutilized doesn't bring in any benefits.

The provision of agriculture chemicals have potential to make farmers not appreciate sustainable agriculture activities. This in turn is likely to impact water resources negatively. The findings are consistent with study done by Adesida et al., (2021). Their findings revealed that the support to farmers mostly encouraged them to increase their production through intensification or expansion of the land under cultivation, which may endanger agricultural sustainability and the environment, if they are poorly designed and implemented.

Land ownership was relevant to understand where intensive agriculture was being practiced. Majority of farmers who owned land practiced intensive agriculture and use furrowing as a means of irrigation. Analysis shows that majority of farmers used land for crop agriculture. This also implies that the more land the more water is used. Abstraction of water to the fields has a direct link to land ownership. For example, migrant farmers who go to rent fields don't find it easy to have access to water since fields located near water bodies are strictly owned by the local people. The study observed that land and water were in sync for farmers. However, a controversy was also observed since water management was vested in the state, but land rights were under customary authority unless in instances where people have bought customary land and converted it to state. The study also observed most farmers had some form of planning for land yet nothing for water resources. The activities from land use may have a ripple effect on water resources. This makes small scale farmers, who practice subsistence farming accounting for 65% of rural farmers (Akinyemi and Mushunje, 2019) not to have account for water they use. The results are similar to results found in South Africa (Akinyemi and Mushunje, 2019; Siphesihle and Lelethu, 2020) and Uganda (Ainembabazi and Mugisha, 2014) that reviewed small portions being cultivated.

The crops grown are related to the culture of the rural farmers. Maize crop was the most grown in the study area because Zambia's main staple food is maize, and it was mostly rain fed. In addition, the results showed that the rural farmers also grew wheat, soybeans and tomatoes, tobacco, sunflower macadamia, millet, sorghum, cotton, granadilla, groundnuts, cabbage, onion, and rape. The growing of such variety shows that farmers grow for sale and some for consumption. When added together portions of land, the cumulative hectarage that is farmed can have a significant impact on water resources. The study also found that land ownership shaped involvement in management of natural resources.

Analysis revealed that agriculture expansion has necessitated the growing demand for water in the area. As this growing trend is expected to continue, more pressure will be exerted on water availability and access to water. There are no known traditional practices and customs of water resource management. With vast investment made into the agriculture sector in the district, there are also challenges especially to do with land and water scarcity. The growth and expansion of Mkushi town through housing infrastructure development has put pressure on water supply. Irrigation is also becoming more and more challenging for farmers. Trees are being cut everywhere to pave the way for agriculture expansion and mining. Land under the council is not big enough for infrastructure development. Influx of Chinese mining is a development concern. Investment in manganese mining has become a key source of employment in the Lunsemfwa River Catchment. The ongoing agriculture expansion has offered a smooth pathway for commercialized agriculture. Agriculture has contributed to employment creation in the area. There are about 717 commercial farmers, out of this number only 7 were Zambians at the time of this study. Some commercial farmers own land stretching the distance of 42 kilometers. This means that there is no equal opportunity in land acquisition. One of the roles of traditional leaders during meetings is to sensitize the people on preservation of forests.

5.2.3 Land Use

Improving water resources management mechanisms was critical if the future water disasters were to be evaded. Land use was an important variable in understanding agricultural practices and water management mechanisms. The study found that there has been an increase in cultivated land and a decrease in grassland areas particularly in areas near rivers and streams.

From the analysis, some land cover classes, such as water bodies, forest lands, bare land, grass lands, crop lands, rural and urban settlements and built-up areas were identified. The historical expansion of cultivated land has largely been at the expense of natural forests and bare land and grasslands. Land degradation due to agricultural practices was becoming widespread. Analysis shows that while majority of the populations are engaged in agriculture as the major livelihood, sustainable land use and protection of soils played a key role in integrated water resources management. The study revealed that crop lands and rural settlements had increased. This conversion occurred because of rapid population growth and at the expense of natural forests, bare land and grassland. Consequently, farmers in the area are encroaching and cultivating along riverbanks, which exacerbate land degradation and soil erosion, which in turn results in reduced river flows. Further analysis suggests that traditional land expansion has made the council fail to plan the city properly. This is because traditional land allocation and town planning were not done collaboratively.

5.2.4 Size of land under cultivation

Increasing crop production to meet economic needs and food requirements has continued to put excessive pressure on the water resources. The Upper Lunsemfwa River Catchement is known for agriculture production and increasing demand for water is becoming a major constraint for production. Agriculture is the largest user of land and agriculture is the largest use of water in the area. Expansion of agriculture land, particularly irrigated land, is crucial in understanding agriculture expansion and prudent water management mechanisms. Farmers indicated that increasing cultivated land also increased water usage. The amount of water for agriculture also increases when the size of land being cultivated becomes big. The impact of the changing structure of agriculture on the environment is an issue of increasing interest given that agriculture is believed to be expanding in the area. In general, research suggests that the trend toward increasing farm size usually entails the intensification of operations, which enables farmers to produce a higher output from the land.

5.2.5 Farming practices in Lunsemfwa River catchment

Various agricultural practices were identified in the Upper Lunsemfwa River Catchment. These agricultural practices may also have negative impacts on water quality and quantity as improper agricultural methods may elevate concentrations of nutrients, fecal coliforms, and sediment loads. Increased nutrient loading from animal waste can lead to eutrophication of water bodies which may eventually damage aquatic ecosystems (OECD, 1998). Thus, agricultural practices have a great impact on water resources.

Firstly, the study revealed that 68% indicated that conventional farming was the main farming method that was used with only 18.7% showed that the main method was conservation farming and 13.3% indicated that it was organic farming method. Conventional farming uses chemical fertilizers to promote plant growth and sprays pesticides to get rid of pests. This is the most practices in the study area but a recent investigation in Zambia showed that small-scale adopters of conservation agriculture are less ‘climate smart’ than conventional farmers in terms of water infiltration and soil moisture (Esser, 2017). Additionally, about 86% indicated that the tillage practice was intensive. The practice causes soil degradation and leads to the expansion of new lands which has an impact on impact on natural habitats leading to water pollution and ultimately climate change (Adomako and Ampadu, 2015; Davari et al., 2010). Similar results on intensive farming has been reported in South Africa (Siphesihle and Lelethu, 2020), Ghana (Adomako and Ampadu, 2015), and Zimbabwe (Chitakira and Nyikadzino, 2020) in Sub-Sahara Africa as these areas have similar economic challenges. Additionally, 56% indicated that they practiced mixed cropping pattern 41.3% showed that they practiced monocropping with remaining 4 denoting 2.7% indicated that they used inter-cropping pattern. With only 45.3% indicated that the growing cycle of cropping pattern was once per year 40.7% showed that cycle was twice per year and 19 representing 12.7% indicated that it was done every three times per year. The remaining 2 representing 1.3% was for others who indicated irregular growing cycle of cropping pattern. Despite these challenges 95% indicated that they practiced crop rotation, and this could be possibly due to many years of training of farmers. This is required so that good farming practices are adopted.

Secondly, the type of water usage in the study area was investigated and reviewed that 62.7% indicated that they obtained water through channeling/furrow. About 94 representing 62.7% indicated that they used buckets to irrigate their crops. Furrow irrigation causes imbalance in distribution of canal water, a situation of scarcity somewhere and water logging in other areas is caused due to collection of water there and lead to excessive soil erosion (Kandpal and Henry, 2016). Another study reported that many diseases are caused due to spread of mosquitoes, worms and insects on account of stationary water in canals (Fahong et al., 2004).

Thirdly, chemical usage was investigated the most mentioned frequency was three to four times per week (74%). Some farmers sprayed more frequently than once a week on a routine basis. Only a small number of farmers (0.7%) sprayed once per month and waited for signs of infestation before they could spray. The impacts of these agro-chemicals are a function of their degree of accumulation in environmental sinks in the soil, air, water, plants and animals (Adomako et al., 2015). This is because Pesticides have the potential to contaminate drinking water supplies (WHO, 2017). As stated above, the rural farmers practice intensive and conventional farming, this practice leads to overuse of chemicals are diseases will easily spread without control. The results on water usage reviewed that furrow irrigation is used which acts as a conduit to spreading diseases. Thus, when the agrochemicals are applied to farmlands, gardens and lawns and can make their way into ground water or surface water systems which have great impact on water resources and human health (WHO, 2017). A large proportion of the farmers (61%) reported burning containers for chemicals. While farmers representing (58%) washed the containers and recycled them. Some farmers representing (31%) reported burying them in their fields. There was no mention of taking containers to Agro shops for safe disposal. A large proportion of farmers (90.60%) had no heard of anyone abusing chemicals, while farmers representing (60.40%) had heard of people abusing chemicals. Such waste management practices are common in Africa which does not have proper waste management practices including Zambia as revealed in this study The challenge of waste management is wide spread in SADC region (SADC, 2022). Majority of farmers (96%) indicated abuse of chemicals by some farmers and farmers dependents having abused chemicals. 3.3% represented accidents that occurred during chemical applications.

Most farmers confirmed that their main abstraction of water for farming was furrowing (63 percent), whereas reservoir dams were the least (5 percent). This practice of abstraction of water from the main source should be done with the highest order to make sure that water is not depleted from the main source. Similarly, a study conducted in Zimbabwe found that farmers along the banks of Upper Pungwe River Basin used furrows as their main source of water abstraction, and this was done with the guide from the traditional leaders (Chitakira and Nyikadzino, 2020). The use of furrowing as a means of irrigation (abstraction of water) implies that the more land used for farming the more water is used. Abstraction of water to the fields is as a direct link to land ownership. The activities from land use may have a ripple effect on water resources. Similarly, a study was conducted in Uganda found that majority of the farmers used furrows to abstract water, and this reduced the water content from the main source, due to the high consumption to water the crops (Akinyemi and Mushunje, 2019).

The study also found that farmers used chemicals to protect their crops from insects, fungal among others. The provision of agriculture chemicals has a high potential to make farmers not appreciate sustainable agriculture activities. This in turn impacts water resources negatively. The findings are consistent with the study done by Adesida et al., (2021) who revealed that farmers used a lot of chemicals to their crops and the disposal of the expired and packaging chemicals impacted water management negatively, through contamination by the chemicals of water bodies. The agricultural practices evidenced among farmers in the Lunsemfwa River Catchment are likely to discharge large quantities of agrochemicals, organic matter, drug residues and sediments that drains into water bodies. These practices have implications as the water resources could be affected by erosion hence siltation of water bodies due to intensive farming practices, water usage activities like leaving water pouring from the pipe or tap even after use and bad waste management practices by rural farmers.

The crops grown are related to the culture of the rural farmers. Maize crop was the most grown in the study area because Zambia's main staple food is maize, and it was mostly rain fed. In addition, the results showed that the rural farmers also grew wheat, soybeans and tomatoes, tobacco, sunflower, macadamia, millet, sorghum, cotton, granadilla, groundnuts, cabbage, onion and rape.

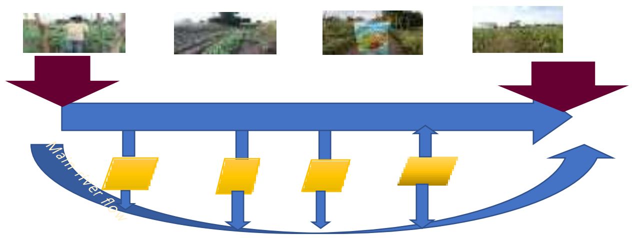
The growing of such variety show that the farmers not only grow for consumption but for sale too. When added together portions of land, the cumulative hectarage that is farmed can have a significant impact on water resources. This study found that the main crops grown in the Lunsemfwa River Catchment area were maize, wheat, soya beans and tomatoes. These crops are widely grown due to their consumption demand in the community.

5.3 Water related conflicts in the Lunsemfwa River Catchment

5.3.1 Boundary disputes

Boundary disputes were a common occurrence. The study showed some new farmers diverting water away from the boundaries of old neighbors. Affluent use their wealth to illicit favors from village leaders and grab water access opportunities from the poor. Land near water is prime land for cultivation of crops particularly in dry season. Those whose fields are located far from rivers and streams find it difficult to maneuver their furrows in private fields, hence making access to streams and rivers very difficult.

Case Study: 1 Isolated small-scale farms of varying locations and sizes without water sharing mechanisms, a source of conflict.



Farm plot sizes were noted to be another source of conflict because farmers with big fields take very long to irrigate and often get into the time allocated to other farmers. The bigger the farm plot the more water is consumed on crops and the more time is taken to irrigate. Most farmers with smaller farm plots desired a uniform application of water to crops regardless of variability of farm sizes. Apart from furrowing there were limited water distribution networks options. Farm plots sizes were noted to be a key factor over the conflicts happening among small scale farmers because some farmers use water in ways which negatively affects the opportunities of other farmers.

5.3.2 Upstream versus downstream conflicts

Water is in the Lunsemfwa is largely surface gravity driven as a result, upstream farmers and users have access to more water and on a timely basis, while downstream users often do not get sufficient or any water. Focus group discussions showed that if upstream farmers can grow maize, tomatoes, onions, rape, cabbage and other cash crops for market, downstream farmers due to shortage of water, resort to growing mostly cassava for own consumption. Such disparity leads to tension between upstream and downstream users, which often escalates into open conflict. Water for crops is not provided on an appropriate time scale. Farmers upstream have more influence on controlling water allocation. Water is used up by the upstream beneficiaries, leaving little or no water for downstream farmers. The flow of water in the furrows is dependent on the release of water from upstream farms.

5.3.3 Irrigation schedule

The different types of conflicts in the study area and the most frequent cause of dispute is boundary disputes with 33% followed by upstream versus downstream conflicts that account for 26.7% and irrigation schedule wrangles and size of the field accounting for 20% each. This results are similar literature the major underlying reasons for these conflicts include; low rainfall, inadequate water supply, and dependency on one major water source; high population growth and rapid urbanization; (3) modernization and industrialization; and a history of armed combat and poor relations between countries and among groups (Atef et al., 2019; Jury and Vaux, 2007; Sokile and van Koppen, 2004). However, the results in this study are different in that the Lunsemfwa River Catchment is not trans boundary as it is it is wholly in Zambia. Despite being within Zambia, decision support conflict resolution should aim for transforming conflict into cooperation, sharing benefits, enabling the aggrieved to negotiate a win-win process as in riparian state (Atef et al., 2019). The results 80% indicated that traditional leaders were involved in resolving water related conflicts due to the rural nature of the catchment. Des. Others were the ministry of agriculture 15 representing (6.7%) (10%). The rest WARMA 2 representing (1.3%) and the District Commissioner 10, representing (6.7%). The study revealed that some influential individuals and elderly people in the area have in the past helped in resolving conflicts (Edossa et al., 2007). This is one mechanism that is being applied in countries like Ethiopia and can be adopted in other catchment in Zambia and other places. Despite this finding the major decision makers in Zambia on water resources management is WARMA and they need to show visibility at the local community level as opposed to be make decisions for other actors in water sectors not recognized by local community. The bottom-up approach is required, therefore.

The study further revealed one of these challenges that has caused heightened conflicts between Lunsemfwa Hydro Power Station and some Commercial farmers is that all water in the river remains in Mkushi Farming Block. This becomes a challenge for the Lunsemfwa Hydropower Station located in the Lower Lunsemfwa River. When farmers' cultivating land is proximity to each other, conflict is always present between the two parties due to the need to acquire a lot of land and water proportion for health growth of crops. Majority of the respondents experienced farm boundary disputes concerning water resources where everyone wants to own a certain water resource such as furrow abstracted from the Kafwa stream as the cause of water related conflict

(33 percent), whereas the minority experienced irrigation schedule wrangles and size of the field (20 percent). Land near water is prime land for cultivation of crops particularly in dry season. Those whose fields are located far from rivers (Lunsemfwa River and Mkushi river) and streams (Funda and Kafwa streams) find it difficult to manoeuvre their furrows in private fields. Therefore, they enter in those whose land is near the water bodies, eventually dispute about farm boundaries elapses. The results are inconsistent with the study conducted in Ghana with the major underlying reasons for these conflicts included; low rainfall, inadequate water supply, and dependency on one major water source; high population growth and rapid urbanization (Atef et al., 2019; Jury and Vaux, 2007; Sokile and van Koppen, 2004).

Further, the results of the study found that 80% indicated that Chiefs-traditional leaders were involved in resolving water related conflicts due to the rural nature of the catchment, where all the farmers with disputes over land or water resource reports to the traditional leaders for counsel and judgment. Similarly, in Ethiopia traditional leader resolved conflicts over water, land disputes, whe ever farmers had conflict over land or water usage the traditional leaders were available to resolve the conflict (Edossa et al., 2007).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter highlights the conclusions and recommendations of the study in line with the results attained. The recommendations made may help stakeholders formulate interventions that can help to strengthen the water management amidst of high demand among rural agricultural farmers. In addition, the recommendations may also improve on the planning, development and implementation of rural agricultural and its implication of water resource management.

6.1 Conclusion

In conclusion, the study found that key actors involved in water resource management in the Upper Lunsemfwa River Catchment were traditional leadership, even though their authority to superintend over traditional matters is only recognized during land wrangles and other conflicts other than water. The major agricultural practices in the catchment area included conventional methods of farming, traditional tillage using hoes were common practices and furrowing was main type of water abstraction practiced. Maize was the most grown crop in the catchment area, and farmers had training on chemical usage on crops and the Ministry of Agriculture Extension officers was the main trainer involved. The most frequent cause of dispute was farm boundary disputes on water resources followed by upstream versus downstream conflicts. These conflicts were resolved mainly by traditional leaders. The interventions to improve mechanisms for managing water resources in the Upper Lunsemfwa River Catchment are inevitable, given the current threats to water bodies in the area that is threatening both the natural ecosystems and agriculture due to unsustainable agriculture practices, the impact of climate change adding to the increasing population which has a direct correlation with increased demand for water resources. The study has further concluded that agriculture practices that meet sustainable standards of conservation are needed to guarantee food security and economic well-being of the farmers in the area. The conflicts over water resources are rarely single-caused and a wide range of factors, including the water crisis and climate change, usually affect them. The continuation of water consumption and lack of management practices in the current style is likely to increase water crisis, and relevant conflicts in the future, and further increase the complexity of managing their challenges. The lack of policies that enhance farmers' knowledge on water resources management will continue to increase misunderstandings and perception gaps regarding climate change and its impact on the water crisis, and conflict management among farmers in the Upper Lunsemfwa River Catchment.

6.2 Recommendations

The following are recommendations:

1. Establish Water Use Agreements and Allocation Mechanisms: Develop transparent and equitable water allocation mechanisms, including water use agreements and permits, to mitigate conflicts and ensure fair and efficient water distribution among different user groups in the Upper Lunsemfwa River Catchment. These agreements should consider environmental sustainability, social equity, and economic viability while addressing competing water demands.

2. Development of interventions to improve mechanisms for managing water resources in the Upper Lunsemfwa River Catchment

3. Given the inevitable nature of climate change and its current threats to water bodies, there is need to enhance training programs for farmers that address topics on the effects of unsustainable farming practices and its implications on water resources

4. The impact of climate change and the increasing population which has a direct correlation with increased demand for water resources, therefore formulation of water users' association as a first step to monitoring water usage and equal distribution is needed among small scale farmers.

5. Agriculture practices that meet sustainable standards of conservation should be encouraged and incentivized among small scale farmers in the area as a motivation to implement sustainable farming and water conservation.

6. Water related conflict resolution mechanisms should be developed alongside water resources management mechanisms.

7. Develop policies that enhances farmers' knowledge on agriculture and water resources management in order to reduce misunderstandings and perception gaps regarding climate change and its impact on the water resources in the Upper Lunsemfwa River Catchment.

8. Enhance Stakeholder Collaboration: Foster multi-stakeholder collaboration among governmental agencies, local communities, non-governmental organizations, and other key actors involved in water resource management in the Lunsemfwa River Catchment. This collaboration aims at improving communication, coordination, and decision-making processes to address water challenges effectively.

9. Implement Integrated Water Management Approaches: Develop and implement integrated water management approaches that consider the interdependencies between agricultural practices and water resources in the Upper Lunsemfwa River Catchment. This includes promoting sustainable land-use planning, water-efficient agricultural techniques, and ecosystem-based approaches to enhance water availability and quality while supporting agricultural productivity.

10. Promote Stakeholder Engagement and Capacity Building: Engage stakeholders in participatory decision-making processes and capacity-building initiatives to enhance their understanding of water issues, rights, and responsibilities. Empowering local communities and user groups through education, training, and awareness-raising programs can help build consensus, improve water governance, and foster sustainable practices.

11. Invest in Water Infrastructure and Technology: Invest in water infrastructure, such as irrigation systems, water storage facilities, and wastewater treatment plants, to improve water efficiency, reduce losses, and enhance agricultural productivity in the Upper Lunsemfwa River Catchment. Additionally, promote the adoption of innovative watersaving technologies and practices among farmers to optimize water use and minimize environmental impacts.

REFERENCES

AAVV_OECD, (2009). Environmental Indicators for Agriculture, Methods and Results (Vol.4).

Achankeng, F., 2013. Conflict and conflict resolution in africa: engaging the colonial factor. Afr. J. Confl. Resolut. 13 (2), 11–37

Adano, W.R., Dietz, T., Witsenburg, K., Zaal, F., 2012. Climate change, violent conflict and local institutions in Kenya's drylands. J. Peace Res. 49 (1), 6 –80

Adesida, I.E., Nkomoki, W., Bavorova, M., Madaki, M.Y., 2021. Effects of agricultural programmes and land ownership he adoption of sustainable agricultural practiceNigeria.

Adger, W.N., Barnett, J., 2009. Four reasons for concern about adaptation to climate change. Environ. Plan. A 41 (12), 2800–2805

Adomako, T., Ampadu, B., 2015. the Impact of Agricultural Practices on Environmental Sustainability in Ghana: a Review. J. Sustain. Dev. 8, 70–85

Adomako, T., Ampadu, B., Ampadu, I.B., (2015). The Impact of Agricultural Practices on Environmental Sustainability in Ghana: A Review. J. Sustain. Dev. 8. https://doi.org/10.5539/jsd.v8n8p70.

Aggarwal, A., Frey, H., McDowell, G., Drenkhan, F., Nüsser, M., Racoviteanu, A., Hoelzle, M., 2022. Adaptation to climate change induced water stress in major glacierized mountain regions. Clim. Dev. 14 (7), 665–677

AghaKouchak, A., Feldman, D., Hoerling, M., Huxman, T., Lund, J., 2015. Water and climate: recognize anthropogenic drought. Nature 524 (7566), 409–411.

Agutu, N. O. et al. (2020). Consistency of agricultural drought characterization over Upper

Ainembabazi, J.H., Mugisha, J., (2014). The Role of Farming Experience on the Adoption of Agricultural Technologies: Evidence from Smallholder Farmers in Uganda.

Akinyemi, B.E., Mushunje, A., (2019). Land ownership and usage for agriculture: Empirical evidence from South African Living Conditions Survey. Cogent Soc. Sci. 5. https://doi.org/10.1080/23311886.2019.1663691.

Alexander, S., 2019. What climate-smart agriculture means to members of the global alliance for climate-smart agriculture. Future Food: J. Food, Agric. Soc. 7 (1), 21–30

Alibaygi, A., Karamidehkordi, E., 2009. Iranian Rural Youths' Intention to Migrate to Urban Areas. Asian Pac. Migr. J. 18 (2), 303–314.

Allan, R.P., Barlow, M., Byrne, M.P., Cherchi, A., Douville, H., Fowler, H.J., Gan, T.Y., Pendergrass, A.G., Rosenfeld, D., Swann, A.L., 2020. Advances in understanding large-scale responses of the water cycle to climate change. Ann. N. Y. Acad. Sci. 1472 (1), 49–75.

Allen R.G., Pereira L.S., Raes D., Smith M., 1998. Crop Evapotranspiration. Guidelines for Computing Crop Water Requirements. FAO Irrig. and Drain. Paper 56, FAO, Rome, 300p.

Allen R.G., Wright J.L., Pruitt W.O., Pereira L.S., Jensen M.E., 2007. Water Requirements. In:

Anderson P.K., Cunningham A.A., Patel N.G., Morales F.J., Epstein P.R., Daszak P., 2004. Emerging infectious diseases of plants: pathogen pollution, climate change and agrotechnology drivers. Trends in Ecology and Evolution 19, 535-544

Atef, S.S., Sadeqinazhad, F., Farjaad, F., Amatya, D.M., (2019). Water conflict management and cooperation between Afghanistan and Pakistan. J. Hydrol. 570, 875–892. https://doi.org/10.1016/J.JHYDROL.2018.12.075.

Battaglini A., Barbeau G., Bindi M, Badeck F., 2009. European winegrowers' perceptions of climate change impact and options for adaptation. Regional Environment Change, 9, 61-73

Beniston M., Stephenson D.B., Christensen O.B., Ferro C.A.T., Frei C., Goyette S., Halsnaes K., Holt T., Jylhä K., Koffi B.. Palutikof J., Schöll R., Semmler T., Woth K.,

2007. Future extreme events in European climate: an exploration of regional climate model projections. Climatic Change 81, 71–95

Bordi I., Fraedrich K., Sutera A., 2009. Observed drought and wetness trends in Europe: an update. Hydrol. Earth Syst. Sci., 13, 1519-1530

Brisson N., Gate P., Gouache D., Charmet G., Oury F.-X., Huard F., 2010. Why are wheat yields stagnating in Europe? A comprehensive data analysis for France. Field Crops Research 119, 201–212

Chitakira, M., Nyikadzino, B., (2020). Effectiveness of environmental management institutions in sustainable water resources management in the upper Pungwe River basin, Zimbabwe. Phys. Chem. Earth, Parts A/B/C 118–119, 102885. https://doi.org/10.1016/J.PCE.2020.102885.

Climate Change Adaptation: Evidence from Rural Tanzania. World Dev. 79, 40–50. https://doi.org/10.1016/j.worlddev.2015.11.003.

Conner K. 1991. A historical comparison of resourcebased theory and five schools of thought within industrial organization economics: do we have a new theory of the firm? Journal of Management 17: 121–154.

Conway, D., Van Garderen, E.A., Deryng, D., Dorling, S., Krueger, T., Landman, W., Lankford, B., Lebek, K., Osborn, T., Ringler, C., Thurlow, J., Zhu, T., Dalin, C.,(2015). Climate and southern Africa's water-energy-food nexus. Nat. Clim. Chang. 5, 837–846. https://doi.org/10.1038/nclimate2735

Davari, M.R., Ram, M., Tewari, J.C., Kaushish, S., (2010). Impact of agricultural practice on ecosystem services. Int. J. Agron. Plant Prod. 1, 11–23.

Diehl, P., Gleditsch, N.P., (2018). Environmental Conflict : an Anthology. 352.

Doll P., 2002. Impact of climate change and variability on irrigation requirements: A global perspective. Climatic Change 54, 269– 293

Dominick E. Ringo et. al (2022) Agricultural practices for rural development and environmental conservation: International Journal of Development and Sustainability ISSN: 2186-8662 – www.isdsnet.com/ijds Volume 11 Number 11 (2022): Pages 367-382 ISDS Article ID: IJDS22090901.

Dungumaro, E.W., Madulu, N.F., (2003). Public participation in integrated water resources management: the case of Tanzania. Phys. Chem. Earth, Parts A/B/C 28, 1009–1014. https://doi.org/10.1016/J.PCE.2003.08.042.

Edossa, D.C., Awulachew, S.B., Namara, R.E., Babel, M.S., Gupta, A. Das, (2007). Indigenous systems of conflict resolution in Oromia, Ethiopia. Community-based Water Law Water Resour. Manag. Reform Dev. Ctries. 146–157. https://doi.org/10.1079/9781845933265.0146.

Elias, F., (2016). The practice of Integrated Water Resources Management in South Africa: challenges of women in water user associations. GeoJournal 82, 1165–1177. https://doi.org/10.1007/S10708-016-9736-9.

Elsawah, S., Guillaume, H. A., and Mitchell, M.. (2011). Using participatory rapid appraisal and DPSIR approaches for participatory modeling: a case study for groundwater management in South Australia. The International Congress on Modeling and Simulation (MODSIM), 12–16 December 2011, Perth.

Esser, K.B., (2017). Water Infiltration and Moisture in Soils under Conservation and Conventional Agriculture in Agro-Ecological Zone IIa, Zambia. Agronomy 7, 40. https://doi.org/10.3390/AGRONOMY7020040.

Evans, R.G., Sadler, E.J., (2008). Methods and technologies to improve efficiency of water use. Water Resour. Res. 44, 1–15. https://doi.org/10.1029/2007WR006200.

Fahong, W., Xuqing, W., Sayre, K.,(2004). Comparison of conventional, flood irrigated, flat planting with furrow irrigated, raised bed planting for winter wheat in China. F. Crop. Res. 87, 35–42. https://doi.org/10.1016/J.FCR.2003.09.003.

Falkenmark, M., (1989). The massive water scarcity now threatening Africa - why isn't it being addressed? Ambio 18, 112–118. https://doi.org/10.2307/4313541. FAO, 2022. Chapter 9: Who are water stakeholders? [WWW Document].

Favretto, N., Stringer, L.C., Dougill, A.J., (2015). Towards improved policy and institutional coherence in the promotion of sustainable biofuels in Mali. Environ. Policy Gov. 25, 36–54. https://doi.org/10.1002/eet.1663

Fiodor, A., Singh, S., Pranaw, K., (2021). The contrivance of plant growth promoting microbes to mitigate climate change impact in agriculture. Microorganisms 9, 1–36. https://doi.org/10.3390/microorganisms9091841.

G.J. Hoffman, R.G. Evans, M.E. Jensen, D.L. Martin, R.L. Elliot (eds.) Design and Operation of Farm Irrigation Systems (2nd Edition), ASABE, St. Joseph, MI, pp. 208-288.

Gallego-Ayala, J., (2013). Trends in integrated water resources management research:A literature review. Water Policy 15, 628–647. https://doi.org/10.2166/WP.2013.149.

Gleick, P.H., (1993). Water and Conflict: Fresh Water Resources and International Security. Int. Secur. 18, 79. https://doi.org/10.2307/2539033.

Global Resources Institute, (2022). Women Are the Secret Weapon for Better Water Management | World Resources Institute [WWW Document].

Goldstone, J.A., (2018). Demography, Environment, and Security. Environ. Confl. 84–108. https://doi.org/10.4324/9780429500794-5/DEMOGRAPHY-ENVIRONMENTSECURITY-JACK-GOLDSTONE.

Government of the Republic of Zambia, (2020). National Water Supply and Sanitation Policy. Minist. Water Dev. Sanit. Environ. Prot.

Greater Horn of Africa (1982–2013): Topographical, gauge density, and model forcing influence Science of the Total Environment. 709:135149.

Grey, D., Sadoff, C.W., (2007). Sink or Swim? Water security for growth and development. Water Policy 9, 545–571. https://doi.org/10.2166/wp.2007.021.

Grigg, N.S., 2008. Integrated water resources management: Balancing views and improving practice. Water Int. 33, 279–292. https://doi.org/10.1080/02508060802272820

GRZ, G. of the R. of Z., 2016. Constitution of Zambia (Amendment) No. 2 of 2016. Natl. Assem. Zambia.

Hassenforder, E., Barone, S., (2019). Institutional arrangements for water governance. Int. J. Water Resour. Dev. 35, 778–802. https://doi.org/10.1080/07900627.2018.1431526.

Jiang, Y.F., Wang, X.T., Jia, Y., Wang, F., Wu, M.H., Sheng, G.Y., Fu, J.M., (2009). Occurrence, distribution and possible sources of organochlorine pesticides in agricultural soil of Shanghai, China. J. Hazard. Mater. 170, 989–997. https://doi.org/10.1016/j.jhazmat.2009.05.082.

Jordán-Cuebas, F., Krogmann, U., Andrews, C.J., Senick, J.A., Hewitt, E.L., Wener, R.E., Sorensen Allacci, M., Plotnik, D., (2018). Understanding Apartment End-Use Water Consumption in Two Green Residential Multistory Buildings. J. Water Resour. Plan. Manag. 144, 04018009. https://doi.org/10.1061/(asce)wr.1943-5452.0000911.

Jury, W.A., Vaux, H.J., (2007). The Emerging Global Water Crisis: Managing Scarcity and Conflict Between Water Users. Adv. Agron. 95, 1–76. https://doi.org/10.1016/S00652113(07)95001-4.

Kandpal, V., Henry, C., (2016). A Review of Improving Efficiencies in Furrow Irrigation, in: ASABE Annual International Meeting. American Society of Agricultural and Biological Engineers. https://doi.org/10.13031/AIM.20162462974.

Kraaijenbrink, J., Spencer, J.C., Groen, A.J. (2010). The Resource Based View: A Review and Assessment of its critiques. Journal of Management, Vol. 36 No. 1, January 2010 pp 349 – 372.

Kramer, A., Pahl-Wostl, C., 2014. The global policy network behind integrated water resourcesmanagement: Is it an effective norm diffusor? Ecol. Soc. 19.

L. S. Pereira (2011) Challenges on Water Resources Management when Searching for Sustainable Adaptation to Climate Change focusing on Agriculture European Water pp. 34: 41-54.

Liersch, S., Cools, J., Kone, B., Koch, H., Diallo, M., Reinhardt, J., Fournet, S., Aich, V., Hattermann, F.F., (2013). Vulnerability of rice production in the Inner Niger Delta to water resources management under climate variability and change. Environ. Sci. Policy 34, 18–33. https://doi.org/10.1016/J.ENVSCI.2012.10.014.

Lonergan, S.C., (2018). Water and Conflict: Rhetoric and Reality. Environ. Confl. 109–124. https://doi.org/10.4324/9780429500794-6.

Management of Water Infrastructures among the Chagga, Kilimanjaro, Tanzania. Land 2023, 12, 570. https://doi.org/ 10.3390/land12030570

Manase, G., Ndamba, J., Makoni, F., (2003). Mainstreaming gender in integrated water resources management: the case of Zimbabwe. Phys. Chem. Earth, Parts A/B/C 28, 967–971. https://doi.org/10.1016/J.PCE.2003.08.023.

Manda, S., Tallontire, A., Dougill, A.J., (2019). Large-scale land acquisitions and institutions:

Margaret A. Peterafa, and Jay B. Barney., (2003). Managerial and decision economics Manage. Decis, Unraveling The Resource-Based Tangle Econ. 24: 309–323 Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/mde.1126

Meigh, J.R., McKenzie, A.A., Sene, K.J., (1999). A grid-based approach to water scarcity estimates for eastern and southern Africa. Water Resour. Manag. 13, 85–115. https://doi.org/10.1023/A:1008025703712.

Meinzen-Dick, R., Zwarteveen, M., (2016). Gendered participation in water management: Issues and illustrations from water users' associations in South Asia. Agric. Hum. Value 15, 337– 345. https://doi.org/10.1023/A:1007533018254.

Millington, N., Scheba, S., (2021). Day Zero and The Infrastructures of Climate Change: Water Governance, Inequality, and Infrastructural Politics in Cape Town's Water Crisis. Int. J. Urban Reg. Res. 45, 116–132. https://doi.org/10.1111/1468-2427.12899.

Montazar, A., (2021). Irrigation tools and strategies to conserve water and ensure a balance of sustainability and profitability. Agronomy 11. https://doi.org/10.3390/agronomy11102037.

Nate Millington And Suraya Scheba (2020) Day Zero and the Infrastructures of Climate Change: Water Governance, Inequality, and Infrastructural Politics in Cape Town's Water Crisis

Ngene, B.U., Nwafor, C.O., Bamigboye, G.O., Ogbiye, A.S., Ogundare, J.O., Akpan, V.E., (2021). Assessment of water resources development and exploitation in Nigeria: A review of integrated water resources management approach. Heliyon 7, e05955. https://doi.org/10.1016/j.heliyon.2021.e05955.

OECD, (1998). Sustainable Management of Water in Agriculture, Sustainable Management of Water in Agriculture. https://doi.org/10.1787/9789264163225-en.

Ottman, M., (2017). Irrigation Cutoffs With Alfalfa – What Are the Implications? 53, 1689–1699.

Patterns, influence and barriers in Zambia. Geogr. J. 185, 194–208. https://doi.org/10.1111/geoj.12291.

Penrose, E.T. (2009). The theory of the growth of the firm. Oxford University Press

Rebelo, L.M., Johnston, R., Hein, T., Weigelhofer, G., D'Haeyer, T., Kone, B., Cools, J.,(2013). Challenges to the integration of wetlands into IWRM: The case of the Inner Niger Delta (Mali) and the Lobau Floodplain (Austria). Environ. Sci. Policy 34, 58–68. https://doi.org/10.1016/J.ENVSCI.2012.11.002.

SADC, (2022). Southern African Development Community :: Waste Management [WWW Document].

Silayo, V.M.; Pikirayi, I (2023) Community-Based Approaches in the Construction and

Siphesihle, Q., Lelethu, M., (2020). Factors affecting subsistence farming in rural areas of nyandeni local municipality in the Eastern Cape Province. South African J. Agric. Ext. 48, 92–105. https://doi.org/10.17159/2413-3221/2020/V48N2A540.

Sokile, C.S., van Koppen, B., (2004). Local water rights and local water user entities: the unsung heroines of water resource management in Tanzania. Phys. Chem. Earth, Parts A/B/C 29, 1349–1356. https://doi.org/10.1016/J.PCE.2004.09.010.

Suhardiman, D., Clement, F., Bharati, L., (2015). Integrated water resources management in Nepal: key stakeholders' perceptions and lessons learned. https://doi.org/10.1080/07900627.2015.1020999 31, 284–300.

Van Aelst, K., Holvoet, N., (2016). Intersections of Gender and Marital Status in Accessing

Van Zyl, H., van Zyl, J., Geustyn, L., Ilemobade, A., Buckle, J., (2007). Water Consumption Levels in Selected African Cities, Water Research Commission.

WHO, (2017). Guidelines for drinking-water quality. https://doi.org/10.1016/S14620758(00)00006-6.

WHO, (2022). Protecting Surface Water for Health. Identifying, Assessing and Managing Drinking-water Quality Risks in Surface-Water Catchments [WWW Document].

Zhang, W., Jiang, F., Ou, J., (2011). Global pesticide consumption and pollution: with China as a focus WenJun, in: Proceedings of the International Academy of Ecology and Environmental Sciences. pp. 125–144.

Zwolsman, J.J.G.; van Bokhoven, A.J., (2007). Impact of summer droughts on water quality of the Rhine River—A preview of climate change? Water Sci. Technol. pp. 56, 45-55.

APPENDICES

Appendix 1: the upper lunsemfwa river catchment study photo







ZAMBIA NATIONAL SERVICE
MUNSAKAMBA IRRIGATION PROJECT
UNDER THE MINISTRY OF AGRICULTURE
MKUSHI DISTRICT
FIBA
PRIMARY
PO BOX

Appendix 2: Ethical Approval Letter

THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH INNOVATION AND DEVELOPMENT

Great East Road Campus | P.O. Box 32379 | Lusaka10101 | Tel: +260-211-290 258/291 777
Fax: (+260)-211-290 258/253 952 | **E-mail:** director.drgs@unza.zm | Website: www.unza.zm

APPROVAL OF STUDY

IORG No. 0005376
NASRECREC IRB No. 00006465
REF NO. NASREC: 2025-MAR-007

31st March, 2025

Ms Annie Kalusa
The University of Zambia
P.O. Box 32379
LUSAKA

Dear Ms Kalusa

RE: "RURAL AGRICULTURE AND IMPLICATIONS FOR WATER RESOURCES MANAGEMENT IN THE LUNSEMFWA RIVER CATCHMENT, MKUSHI ZAMBIA"

Reference is made to your protocol captioned above. The NASREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

REVIEW TYPE	ORDINARY REVIEW	APPROVAL NO. NASREC-2025-MAR-007
Approval and Expiry Date	Approval Date: 31st March, 2025	Expiry Date: 30th March, 2026
Protocol Version and Date	Version - Nil.	30th March, 2026
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

CONDITIONS OF APPROVAL

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to NASREC within 5 days.
- All protocol modifications must be approved by NASREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to NASREC within 5 working days.
- All recruitment materials must be approved by NASREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. NASREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to NASREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by NASREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penalty fee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Natural and Applied Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO), both NASREC and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists NASREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.

- A reprint of this letter shall be done at a fee.
- All protocol modifications must be approved by NASREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by NASREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of NASREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,

Dr. Mususu Kaonda

CHAIRPERSON
THE UNIVERSITY OF ZAMBIA NATURAL AND APPLIED SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Research and Development
Assistant Director, Research Support and Grants
Manager, Research Administration and Support
Ethics and Affiliation Officer