SOKOINE UNIVERSITY OF AGRICULTURE

MSc Dissertation

Implementation extent and Impact of Village Land Use Planning on Tree cover Trends in Miombo Woodland Landscapes of Tanzania

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IMPLEMENTATION EXTENT AND IMPACT OF VILLAGE LAND USE PLANNING ON TREE COVER TRENDS IN MIOMBO WOODLAND LANDSCAPES OF TANZANIA

This dissertation is submitted in fulfilment of the requirements for the Master Degree of Science in Forestry to Sokoine University of Agriculture, Morogoro

By

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EXTENDED ABSTRACT

Multiple social, cultural, and economic forces are causing fast land-use changes in forests. Agriculture, logging, and other human activities cause the loss of about 6 million hectares of primary forest per year around the world. Therefore, it is important to assess the trend of tree cover across time and space and the extent to which the village land use plans have been executed. The study is in line with National land policy (1995), Village Land Act No. 5 of 1999 and National Land Use Planning Act No. 6 of 2007.

This study used the analysis of remote sensing data to assess trends in vegetation cover 10 years before and after land use planning in Ihombwe, Gole, and Kisegese villages located in various climatic areas in Miombo woodlands of Tanzania. Additionally, the study assessed the perception of local communities on the extent of implementation of land use planning through interviews administered to 30 households randomly selected in each village.

Land use planning process was carried out in Ihombwe, Gole and Kisegese villages and remote sensing data were used to reveal the forest cover before and after the planning process. The analysis of remote sensing data revealed that tree cover was declining by 33.31%, 36.75% and 46.17% before land use planning in Ihombwe, Gole and Kisegese villages respectively. After the land use planning, there were mixed results. In areas designated for village forest reserve, there was an increase in tree cover by 9.74% and 25.23% in Ihombwe and Gole respectively. However, in Kisegese, the tree cover continued to decline, but at a slower rate of 35.42%. Outside of the forest reserves, in areas allocated for settlement, agriculture, community service, and grazing, tree cover continued to decline even after land use planning. The perception of survey participants regarding the extent of implementation of the approved village land use plan was higher in areas designated as forest reserves by 57% and 65% in Ihombwe and Gole respectively but very poor in Kisegese with 20%. Also, there was poor implementation in areas designated for grazing by 15%, 24% and 0% in Ihombwe, Gole and Kisegese respectively. Poor implementation of the land use plans was mainly constrained by the resistance of certain village inhabitants who did not approve of certain specified land use classifications and exclusion of the communities during the drafting of the plans and partly due to the lack of suitability of the land use categories. The level of involvement in the planning and implementation process varies, with Ihombwe and Gole villages showing higher participation than Kisegese to which to which the respondents were only involved in implementation of the plan. Drivers that motivated the formulation of the land use plans are mainly deforestation, immigration and occurrence of the land use conflicts. There was an increase in tree cover in forest reserves and decline outside the forest in Gole and Ihombwe, also the decline in tree cover in Kisegese, before and after land use planning. Exclusion of the communities during the drafting of the plans led to poor plans implementation. Effective conservation measures are needed to reverse the trend of forest loss and promote sustainable land use in Kisegese village. Active community engagement during planning process is needed to contribute to the alignment of land use plans with local needs and fostering ownership.

Keywords: Land cover, Forests, Remote sensing, Landscapes, Deforestation

IKISIRI KUU

Nguvu nyingi za kijamii, kitamaduni, na kiuchumi zinasababisha mabadiliko ya haraka ya matumizi ya ardhi katika misitu. Kilimo, ukataji miti, na shughuli nyingine za kibinadamu husababisha upotezaji wa takriban hekta milioni 6 za msitu wa asili kila mwaka ulimwenguni kote. Kwa hiyo, ni muhimu kutathmini mwelekeo wa kifuniko cha miti kwa muda na nafasi na kwa kiasi gani mipango ya matumizi ya ardhi ya kijiji imefanywa. Utafiti huu uko katika mstari na Sera ya Ardhi ya Kitaifa (1995), Sheria ya Ardhi ya Kijiji Na. 5 ya 1999 na Sheria ya Upangaji wa Matumizi ya Ardhi ya Kitaifa Na. 6 ya 2007. Na maarifa haya ni muhimu kwa usimamizi wa maeneo ya hifadhi ya misitu.

Utafiti huu ulitumia uchanganuzi wa data za utambuzi wa mbali kutathmini mwelekeo wa uoto miaka 10 kabla na baada ya kupanga matumizi ya ardhi katika vijiji vya Ihombwe, Gole, na Kisegese vilivyoko katika maeneo mbalimbali ya hali ya hewa katika misitu ya Miombo nchini Tanzania. Zaidi ya hayo, utafiti ulitathmini mtazamo wa jamii za wenyeji juu ya kiwango cha utekelezaji wa mipango ya matumizi ya ardhi kupitia mahojiano yaliyofanywa kwa kaya 30 na zaidi zilizochaguliwa kwa nasibu katika kila kijiji.

Mchanganuo wa takwimu za vihisia mbali mbali ulibaini kuwa kiwango cha miti kilipungua kwa asilimia 33.31%, 36.75% na 46.17% kabla ya upangaji wa matumizi ya ardhi katika vijiji vya Ihombwe, Gole na Kisegese mtawalia. Baada ya upangaji wa matumizi ya ardhi eneo la miti liliongezeka kwa 9.74% na 25.23% katika matumizi ya ardhi iliyotengwa kwa ajili ya hifadhi ya msitu wa kijiji lakini ilishuka kwa kiwango cha 35.42% katika kijiji cha Kisegese. Kwa vijiji vyote, eneo la miti lilipungua kwa kiasi kikubwa nje ya hifadhi ya msitu, katika eneo lililotengwa kwa ajili ya makazi, kilimo, na huduma za jamii na malisho hata baada ya kupanga matumizi ya ardhi. Mtazamo wa washiriki wa upimaji kuhusu kiwango cha utekelezaji wa mpango wa matumizi bora ya ardhi ya kijiji ulioidhinishwa ulikuwa mkubwa zaidi katika maeneo yaliyotajwa kuwa hifadhi za misitu lakini duni sana katika maeneo yaliyotengwa kwa ajili ya malisho. Utekelezaji duni wa mipango ya matumizi ya ardhi ulichangiwa zaidi na upinzani wa baadhi ya wakazi wa kijiji ambao hawakuidhinisha uainishaji fulani wa matumizi ya ardhi na kutengwa kwa jamii wakati wa kuandaa mipango na kwa sehemu kutokana na kutokuwepo kwa matumizi ya ardhi. Kiwango cha ushirikishwaji katika mchakato wa upangaji na utekelezaji kinatofautiana, ambapo vijiji vya Ihombwe na Gole vinaonyesha ushiriki mkubwa kuliko Kisegese ambapo wahojiwa walishirikishwa tu katika utekelezaji wa mpango. Sababu zilizochochea uundaji wa mipango ya matumizi ya ardhi ni hasa ukataji miti, uhamiaji na kutokea kwa migogoro ya matumizi ya ardhi. Hatua madhubuti za uhifadhi zinahitajika ili kubadili mwelekeo wa upotevu wa misitu na kuendeleza matumizi endelevu ya ardhi katika kijiji cha Kisegese. Ushirikishwaji hai wa jamii wakati wa mchakato wa kupanga unahitajika ili kuchangia katika upatanishi wa mipango ya matumizi ya ardhi na mahitaji ya ndani na kukuza umiliki.

Maneno muhimu: Kifuniko ardhi, Misitu, Utambuzi wa mbali, Mandhari, Ukataji miti

DECLARATION

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

_____ _____

Prince Batamuzi Date
(MSc. Candidate)

The above is confirmed by;

_____ _____

Dr. Charles Joseph Kilawe Date
(Supervisor)

_____ _____

Dr. Proches Hieronimo Msigula Date
(Supervisor)

LIST OF MANUSCRIPTS

Manuscript 1: Trends in tree cover 10 years before and after Village Land Use Planning in Miombo Woodland Landscapes of Tanzania

Manuscript 2: Extent of implementation of the village land use plans in Miombo Woodland Landscapes of Tanzania.

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First and foremost, I extend my heartfelt gratitude to the Omnipotent God for the blissful blessings throughout my study period and its successful completion.

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DEDICATION

I would like to dedicate this work to my brother, Walter and in loving memory of Prof. Emmanuel Batamuzi. May your souls rest in eternal peace and am proud that all the wishes are coming true. I express my heartfelt gratitude for your love and invaluable wisdom.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

SVM	Support Vector Machine
VLUPs	Village Land Use Plans
GEE	Google Earth Engine
GIS	Geographical Information System

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background Information

Land use planning is the systematic evaluation of land and water potential, land-use alternatives, and economic and social conditions in order to select and implement the best land-use options. Its goal is to identify and implement land uses that will best meet people's needs while conserving resources for the future (URT, 2017). Land cover relies on effective land use planning. In Tanzania, rapid changes in land cover, driven by agriculture, logging, and urbanization, underscore the critical need for proactive planning.

Multiple social, cultural, and economic forces are causing fast land-use changes in forests. Agriculture, logging, and other human activities cause the loss of about 6 million hectares of primary forest per year around the world. Several articles on land use and land cover change have addressed the issue of tropical forest loss (Käyhkö *et al.,* 2011). Tanzania's rural area, the Village Land Use Planning (VLUP) is gradually becoming a tool for land resource management (Huggins, 2018). Tanzania's high population growth rate, combined with concerns about climate change, places additional strain on land use sustainability. Land use planning has been prioritized on the country's agenda as a means of reconciling socioeconomic development, land justice, and nature conservation. However, less than 15% of Tanzania's 12,000 villages currently have land use plans, and technological advancement is needed to speed up the planning process without jeopardizing the quality of the plans (URT,2017).

A village land use plan (VLUP) has the opportunity to lower landscape fragmentation and land use disputes, as well as formalize settlement, modernize agriculture, improve natural resource conservation, secure tenure, and reduce land grabbing. Land-use planning can be done at national, zonal, regional, district, and village levels (Kilawe *et al.,* 2011). Village land use planning aims to make the best use of limited land resources which can be attained through strengthened institutions and coordinating mechanisms for facilitating active involvement and participation of people at the local level. Coordination among sectors with a stake in land is necessary due to the increasing demand to regulate the use of land resources (URT, 2017).

1.2 Problem Statement and Study Justification

The current population growth in Kilombero has hastened the creation of settlements in the area, as well as disputes over land scarcity. Land usage disputes have erupted between farmers and pastoralists, as well as between major agricultural farms and villagers. The problem has worsened due to a lack of implementation of local land management that improves land productivity and land administration which improves tenure security (Huggins, 2016). For example, in Kilosa district there is a fewer there are 164 villages in the Kilosa district, but only 14 have begun the village land use planning process, with just 7 villages having finished it including Ulaya-Mbuyuni village which lies 25km from Kilosa town. Pastoralists and indigenous farmers have had severe land use issues in the Kilombero district in recent years. When pastoralists relocate from one location to another in search of water and pastures, such conflicts arise.

This is especially true in Mofu Village, where the encroached Namwai Forest Reserve is located (Land N, 2017). Due to agricultural expansion, significant immigration and

urbanization, forest cutting for diverse uses, and overgrazing, the Kilosa district's forest area is being degraded and deforested (Nduwamungu, 2001). The village land use plan is believed to alleviate these issues (Kauzeni *et al.,* 1993). The MKURABITA Programme Management Unit chose Handeni as the pilot area to test advances in land use planning and registration that could help enhance and speed up the implementation of the Village Land Act No. 5 of 1999. Handeni district had created some capability in this area of work as a result of the program, having formed a GIS unit with suitable gear and software. Despite financial and human resource constraints, the district intended to continue this procedure in other interesting villages. The district found it extremely difficult to extend this vital service to the remaining villages in the area (Kosyando, 2007). Effective land-use planning is predicted to lower the rate of deforestation and forest degradation, conflicts and poverty and increase forest conservation since the pressure on the designated forests is reduced (URT, 2017) (Mugasha and Katani, 2016). Despite the positive prospects for land use plans, However, the implementation extent of village land use plans has rarely been assessed (Naiposha *et al.*, 2021; Calbick, 2003).

It was found that communities perceived that land use planning was only implemented by 48% and 42% in Ibingu and Chabima villages, respectively (Kilawe *et al.,* 2011). Additionally, several studies have shown that deforestation, and forest degradation have increased despite land use plans being in place (Benjaminsen *et al.,* 2009; Kilawe *et al.,* 2018). However, there are few cases, where the implementation of land use plans has resulted to the improvements in forest management (Uisso *et al.*, 2019) (Mndeme *et al.,* 2012). The majority of past studies were carried out within a timeframe of less than 5 years after the implementation of land use plans; hence the impact of the plans might not be evident.

The study is in line with National land policy (1995), Village Land Act No. 5 of 1999 and National Land Use Planning Act No. 6 of 2007. The study also aims at providing more information on village land use planning, enhancing efforts to increase village land use planning preparations, and more research on its contribution to forest conservation and can be replicated to other areas.

1.3 Objectives

1.3.1 Main objective

The overall objective of this research was to assess the effects of village land use planning on tree cover in and outside forest reserves in Miombo woodlands of Tanzania.

1.3.2 Specific objectives

The specific objectives during this research were to;

i. To determine trends in tree cover before and after village land use planning.
ii. To determine the extent of implementation of village land use plans.

1.4 Limitations of the Study

After accomplishing the assessment on how the land use plan can contribute to the conservation of the forest using remote sensing data, several limitations remain. Here, suggestions for follow-up research are presented.

1. The first manuscript shows that the village land use plans contributed to the increase in tree cover in the area designated as the forest reserve and the

decrease in areas outside the forest reserve. Forest disturbances and structure in terms of basal area, volume, carbon, tree density and regeneration were not assessed in the study villages. To address this issue, future studies can focus on assessing the effect of village land use planning on forest conservation in terms of structure and disturbances.

2. After the implementation of the land use plans it was observed that tree cover in other land use categories decreased in 10 years after the planning. It's crucial to observe if the trend is still persisting since the continued decrease in tree cover in areas outside the forest reserve has an implication to the forest since there will be a shortage of products such as firewood, charcoal, medicine, timber which will attract people to encroach the forest to obtain the needed products for their wellbeing.

1.5 Dissertation Structure

This dissertation is divided into five chapters and is structured as a series of publishable manuscripts. The first chapter provides an introduction to the study, including background information, the problem statement, study objectives, and limitations. Chapter two presents the trends in tree cover 10 years before and after Village Land Use Planning in Miombo Woodland Landscapes of Tanzania. Chapter three presents the results on extent of implementation of the village land use plans in Miombo Woodland Landscapes of Tanzania. Chapter four is a general discussion of the study's findings, and Chapter five provides a summary of the key contributions, conclusions, and recommendations for future research.

CHAPTER TWO

Manuscript One

Trends in tree cover 10 years before and after Village Land Use Planning in Miombo Woodland Landscapes of Tanzania

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Keywords: Forest cover change; Degradation; Deforestation; Reforestation; Land use patterns

Abstract

This study addresses the crucial understanding of the impact of land use planning on vegetation cover in Tanzanian villages within Miombo woodlands. Rapid changes in land use patterns and increasing pressure on natural resources in Miombo woodlands of Tanzania have caused shifts in vegetation cover across the landscape in most rural areas. This study used the analysis of remote sensing data to assess trends in vegetation cover 10 years before and after land use planning in Ihombwe, Gole, and Kisegese villages located in various climatic areas in Miombo woodlands of Tanzania. The perception of local communities on the extent of implementation of land use planning was also investigated through interviews administered to 30 households randomly selected in each village. The analysis of remote sensing data revealed that tree cover was declining by 33.31%, 36.75% and 46.17% before land use planning in Ihombwe, Gole and Kisegese villages respectively. After land use planning the tree cover increased by 9.74% and 25.23% in land use category designated for village forest reserve but declined at rate of 35.42% in Kisegese village. For all villages, tree cover declined substantially outside forest reserve, in land area designated for settlement, agriculture, and community service and grazing even after land use planning. The perception of survey participants regarding the extent of implementation of the approved village land use plan was higher in areas designated as forest reserves but very poor in areas designated for grazing.

2.1 Introduction

Land use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options (Metternicht, 2017). In Tanzania, land use planning involves allocation of land to diverse purposes in a participatory way by incorporating the community who are the land users (Kalenzi 2016, URT 2007). Land use planning is essential in order to address worldwide sustainability issues like climate change, biodiversity loss, and food security (Winkler *et al.,* 2021). Due to a changing economy and a growing population, land usage in the tropics has altered dramatically during the last century (Nzunda and Monjare, 2013). Human actions are transforming the world's landscapes in pervasive ways, whether they are cutting tropical forests, practicing subsistence agriculture, intensifying farmland productivity, or expanding urban centres (Foley *et al.,* 2005). Changing land-use patterns have resulted in fast degradation, which has decreased biodiversity in several protected areas and destroyed natural habitats (Kileo and Mbije, 2021). Furthermore, unforeseen consequences such as increased forest clearing and intensification have damaged both conservation and agricultural sustainability (Lardon, 2011).

The Tanzania Village Land Act Cap 114 (Land and Planning, 2007) has made it mandatory for all villages to have land use plans. Throughout the country, a grand total of 2,556 village land use plans have been developed (URT, 2022) representing 20.75% of the total 12,317 villages. The small number may be attributed to the involved costs and expertise because land use planning process requires data collection, community engagement, infrastructure development, and monitoring and evaluation (Tanzania National Land Use Planning Commission, 2011). Village land use planning adheres to governmental directives as outlined in the National Land Use Planning Commission's 2011 document (Tanzania National Land Use Planning Commission, 2011). This process includes the identification of natural-resource and related problems, analyse how they developed and how they might be solved, select the best options for solving them, implement solutions, getting needed technical information from both within and outside the community, move from planning and immediate problem solving, to long-term land management and the delineation of village borders and creating land-use maps that delineate various land-use zones within the village (URT, 1998). Village land use planning process is a participatory activity and it involves the following processes, preparation (District level), PRA for land use management, supplementary surveys, participatory land use planning and administration, implementation of appropriate land management measures and consolidation (URT, 2017). Subsequently, the village has the authority to issue Certificates of Customary Right of Occupation, a type of land tenure, to individual residents in accordance with Section 7 of the Village Land Act from 1999 (Huggins, 2018).

The land-use planning is predicted to lower the rate of deforestation, conflicts and poverty (URT, 2017) (Mugasha and Katani, 2016). However, the implementation extent of village land use plans has rarely been assessed (Naiposha *et al.,* 2021; Calbick, 2003). A study by Kilawe *et al.* (2011) found that communities perceived that land use planning was only implemented by 48% and 42% in Ibingu and Chabima villages, respectively. Additionally, several studies have shown that deforestation, and forest degradation have increased despite land use plans being in place (Benjaminsen *et al.,*

2009; Kilawe *et al.,* 2018). There are few cases however, where the implementation of land use plans has resulted to the improvements in forest management (Uisso *et al.,* 2019) (Mndeme *et al.,* 2012). Most of the previous studies were conducted in less than 5 years after the implementation of land use plans, thus the impact of the plans might not be evident.

This study aims to assess trends in vegetation cover 10 years before and after village land use planning and assess the extent of implementation of the village land use plans. The study utilized remote sensing and Geographic Information System (GIS) techniques to gather and analyse spatial data related to vegetation cover and land use patterns and household survey to understand the perceptions of local communities on the extent of implementation of plans and the associated challenges.

2.2 Material and Methods

2.2.1 Study area

The study was conducted in three villages located in various climatic zones of Miombo woodlands of Tanzania. The villages in districts were chosen due to the existence of village land use plans and knowledge of land use planning. The villages are Ihombwe village in Kilosa District, Kisegese village in Kilombero District, Morogoro region and Gole village in Handeni District, Tanga region (Fig. 2.1).

Ihombwe village, situated in the Kilosa District of the Morogoro Region in Tanzania, is located approximately 15 km from Mikumi and 65 km from urban Kilosa along a rough road. Positioned at an altitude of around 400 meters above mean sea level, the village spans from 7° 10' S to 7° 30' S and 36° 40' E to 37° 0' E, nestled within the miombo woodlands of Kilosa district, adjacent to Mikumi National Park. The village experiences variable annual precipitation levels ranging from 800 mm to 1600 mm, influenced by its altitude. Ihombwe is home to a relatively small population, estimated at 3450 people residing in approximately 750 households (URT, 2022). The native tribes of Ihombwe village are the *Wavidunda* and *Wasagara* people. However, the village has been receiving migrants from other tribes such as *Wagogo, Wasukuma, Wanyakyusa, Maasai, Iraqi, Wakurya, Waha* and *Wanyakyusa.* It's essential to note that some individuals who don't live in the village still own cultivated land (Strömquist and Backéus, 2009). The soils are leached reddish soils developed under a moister climate. The village is known for pastoralism, agriculture, and charcoal production. The temperature fluctuates with elevation. The yearly average temperature stands at 25°C, with July being the coldest month and March the warmest. Temperature fluctuations throughout the year span from 19°C to 30°C (URT, 2020). The village possesses a 10-year land use plan which was developed in 2013. The land use categories included in the land use plans are agriculture, settlements, forest reserve, grazing, and community services. The village landscape is dominated by tree species of the genera Brachystegia, Julbernardia and Isoberlinia.

Gole, the second village under study, is situated approximately 57 km from Handeni Urban in the Kang'ata ward, near Madebe village, within Handeni District, Tanga Region, Tanzania. Positioned between latitudes 5°40' S to 5°45' S and longitudes 37°55' E to 38°05' E, at an elevation of around 600 m above sea level, Gole experiences an average annual rainfall ranging from 800 to 1,400 mm. Its topography consists of undulating

plains intersected by valleys and isolated hills. The approximate population of the village is assessed to be 11,332 total population with 2850 households (URT, 2022). The indigenous *Zigua* tribe is prevalent, though various other tribes such as *Wakurya, Wasukuma, Wahehe, Waha, Wagogo,* Barbaigs, and Iraqis have migrated to the village, with Iraqis, Kurya, and Zigua currently forming the majority. The acidic-clay soils characterize Gole, and socio-economic activities predominantly revolve around pastoralism (53.1%), farming (44.9%), and mining (2%). Pastoralists in the region depend on livestock husbandry for income, deriving revenue from the sale of livestock-related products such as meat, skin, hide, and milk (Mwakalonge and Chingonikaya, 2023). The village initiated the implementation of a land use plan in 2014, encompassing categories such as agriculture, forest, settlements, grazing areas, and community services (Fig. 2.1). The natural vegetation primarily comprises dense miombo woodland dominated by *Brachystegia spp., Julbernardia spp., Pterocarpus angolensis, Brachystegia huillensis*, and *Afzelia quanzensis*. Gole also boasts a village forest reserve, the Gole Forest Reserve, managed locally by the village.

The third village investigated, Kisegese, is located in the Kilombero District of the Morogoro Region in Tanzania. The Kilombero valley is particularly valuable for agricultural purposes, particularly rice and sugar cane farming. Over the past few decades, the local human population has rapidly increased, resulting in extensive conversion of wildlife habitats into farmland. Additionally, there has been a notable influx of pastoralists and their cattle in recent years (Jones *et al.,* 2012). The village, with an estimated total population of 12,167 and 4,736 households (URT, 2022), spans an area between 7° 9' 34" S to 9° 9' 34" S and 34° 20' 28" E to 38° 20' 28". Nestled at an altitude of approximately 200 meters above sea level, the landscape of Kisegese is predominantly flat, offering a vast expanse of level terrain. The climate in Kisegese is classified as tropical, characterized by consistently high temperatures and abundant rainfall. The area experiences regular and substantial precipitation patterns, contributing to the overall lushness of the surroundings. The wet and humid conditions are conducive to diverse flora and fauna, fostering rich biodiversity in the region. Dominated by woodlands and grasslands, often featuring sandy and clay soils, Kisegese is known for its agricultural productivity, particularly in rice farming. The natural vegetation consists of the miombo woodland dominated by *Diplorhynchus condylocarpon* followed by *Antidesma venosum, Stereospermum kunthianum, Julbernardia globiflora* and *Combretum molle.* The village is home to diverse tribes, including the Sukuma, Nyakyusa, Hehe, Waha, and Maasai. The population density is notable, with livelihood strategies primarily centered on agriculture. The village formulated a land use planning process in 2011, aiming to organize and manage its resources effectively. However, despite these efforts, the Ruipa corridor, a vital migration route for large mammals, has lost its effectiveness and faces threats to its existence due to rapid destruction and overexploitation of the Namwai forest situated in Kisegese village (Jones *et al.,* 2007). Restoring the corridor's functionality would require significant resources and investment.

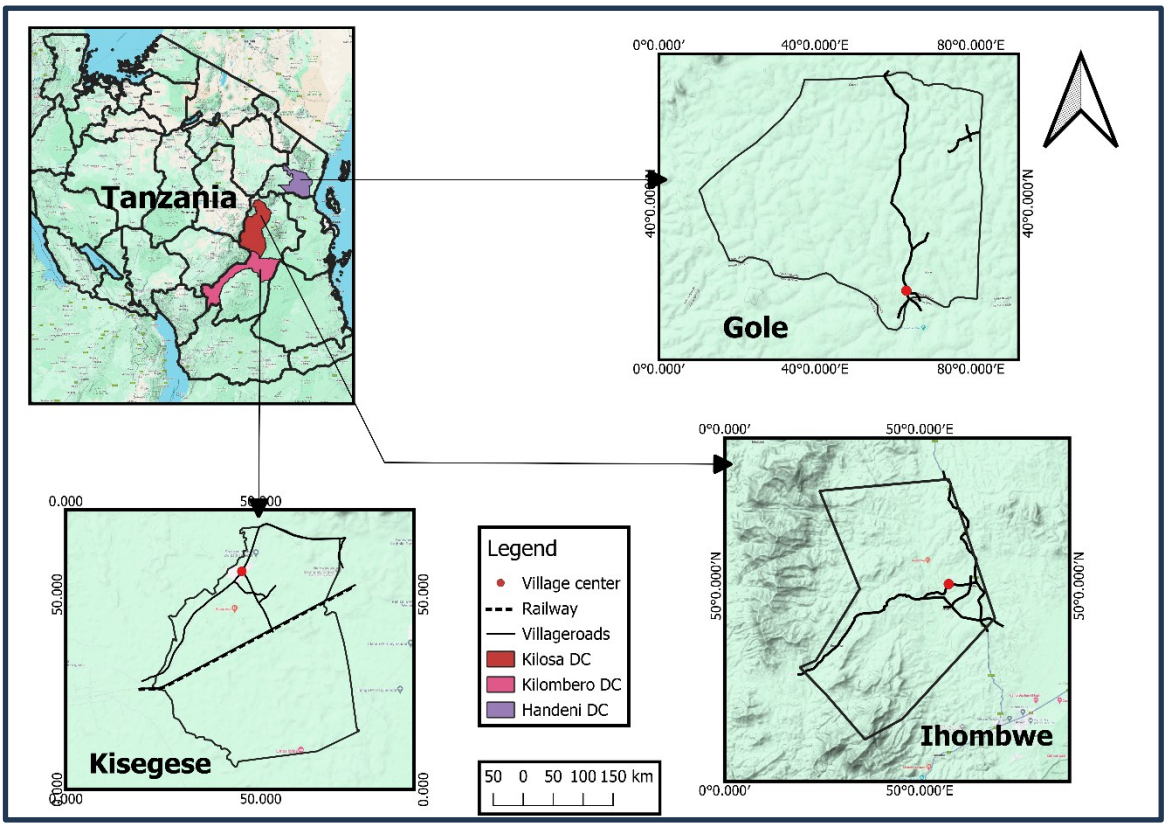


Figure 2.1: A map showing the study areas.

2.2.2 Data collection and analysis

2.2.2.1 Remote sensing data

Landsat 5 TM and Landsat 8 ETM images were used as study materials (Table 2.1). Landsat satellite images of the study area were obtained from Google Earth Engine's extensive image collection (https://code.earthengine.google.com/). The Google Earth Engine (GEE) provides a cloud platform to access and process large amount of freely available satellite imagery, including those acquired by the Landsat-8 remote sensing satellite (Shelestov *et al.,* 2017). Landsat images were chosen because of their relatively fine detail (30 meters by 30 meters) and their spectral bands specifically designed for the analysis of vegetation and contains a much broader range spectral information (Goldblatt *et al.,* 2017). Landsat images resolution allows detailed and accurate monitoring of land cover and land use changes over large areas. Additionally, Landsat images offer a long-term and consistent dataset, enabling temporal analysis of land dynamics spanning several decades. The Landsat images were filtered and retrieved from Earth Engine's image collection using the relevant time frames (dry season months) for each year. The imageries were taken during dry seasons to avoid clouds obstacles and season disparities, whereas the selected imageries were those with a cloud percent of less than 10. Images containing more than 10% cloud cover were avoided and excluded from the analysis as recommended by (Romero-sanchez, 2017).

Table 2.1: The characteristics of images selected for land cover classification

Village	Image	Image acquisition date	Cloud cover	Path/Row
Ihombwe	Landsat 5 TM	July 02, 1995	1%	167/65
	Landsat 5 TM	July 20, 2005		
	Landsat 5 TM	July 10, 2010		
	Landsat 8 ETM	October 18, 2015		
	Landsat 8 ETM	August 26, 2020		
Gole	Landsat 5 TM	June 13, 1995	2%	167/64
	Landsat 5 TM	July 19, 2005		
	Landsat 5 TM	June 19, 2010		
	Landsat 8 ETM	September 01, 2015		
	Landsat 8 ETM	August 03, 2020		
Kisegese	Landsat 5 TM	June 23, 1995	1%	168/66
	Landsat 5 TM	July 20, 2005		
	Landsat 5 TM	July 1, 2010		
	Landsat 8 ETM	June 14, 2015		
	Landsat 8 ETM	August 04, 2020		

2.2.2.2 Land use classification

We performed Pixel Based Image analysis in Google Earth Engine as a cloud-based geospatial platform developed by Google. Pixel-based analysis can achieve high accuracy when used with appropriate algorithms and training data and the analysis can be performed quickly and efficiently, making it suitable for large-scale image analysis (Suzuki, 2012). Google Earth Engine was used to visualize and classify all collected images through supervised classification. Subsequently, 50 training sample polygons were selected manually from each image (Horning *et al.,* 2010). These training samples were classified into respective pixels by using the support vector machine (SVM) algorithm using Google Earth Engine. The Support SVM demonstrates favourable outcomes even when the quantity of available training data is minimal (Rudrapal, 2015). This approach allowed for the efficient and reliable identification of forested and non-forested areas to observe the vegetation cover dynamics basing on the land use categories and zones within the land use plans.

The produced land cover maps were used as a base map for ground truthing to verify all land cover categories generated using remotely sensed data. A field work to verify the produced land use classification of the recent images (2020). GPS was used to record ground coordinates for different land cover types on the map to have accurate reference points. At least 30 reference points were selected on the land cover categories showing changes and transitions from one cover to another (Congalton, 1991). The recorded coordinates were then used to transform former land use and vegetation cover types before performing land use vegetation cover change detection. Land cover for previous years (1995, 2005 and 2015) were verified using time-lapse feature in Google Earth Pro which enables users observe images dating back up to 30 years, making it well-suited for validating maps depicting land use and land cover (Venkatappa *et al.,* 2020). The final

land cover maps for 1995, 2005, 2015 and 2020 of the forest were produced after incorporation of the land cover and land use information captured during ground truthing and using other reference materials like Google earth images (Electronic Supplementary Materials, ESM).

Post classification change detection was performed in ENVI 5.3 and IDL 8 for the purpose of performing change detection, producing change maps and change statistics. The statistics were further analysed to obtain changes in land area occupied by transitions in various land uses. Trend line for vegetation changes over time in all villages was established using the JMP 4 statistical software package (JMP, 2019).

2.2.2.3 Accuracy assessment

The accuracy assessment of the Google Earth Engine classification using the Support Vector Machine (SVM) algorithm was conducted to evaluate the reliability of the land cover classification results. To verify the indicated land use types, field ground truthing was done in all three villages in September-October, 2023 during the dry season. In order to have accurate reference points and to accurately capture the ground coordinates for the two types of land cover on the map, GPS was employed to collect validation points. The classified image from 2020 was used as the reference. The procedures developed by (Congalton, 1991) were followed whereby at least 30 validation points for each class were then compared with the classified land cover pixels obtained from the SVM algorithm. The accuracy assessment involved calculating various metrics, such as overall accuracy and user's and producer's accuracy for each land cover class. The assessment revealed high overall accuracy, indicating the robustness of the SVM classification for distinguishing between forest and non-forest land covers. The study had an overall classification accuracy of 86.7% and kappa coefficient of 0.72 (Table 2.2). The kappa coefficient is considered to be significant, indicating that the classified image is suitable for further research (Rwanga and Ndambuki, 2017).

Table 2.2: Accuracy assessment of classified land use maps

Village	Ihombwe	Gole	Kisegese
Producer Accuracy [%]	76.2282	71.3596	92.2843
User Accuracy [%]	92.3077	80	85
Kappa hat	0.8176	0.6828	0.9345
Overall accuracy [%]	82.5785	82.8225	94.7259
Kappa hat classification	0.654	0.6229	0.8833
Overall accuracy average = 86.7089667			
Overall, Kappa hat classification=0.720066667			

2.2.2.4 Socio-economic data collection and analysis

The household survey was used to determine the perception of local communities on the current extent of implementation of the village land use plans. A structured questionnaire was administered to 30 household heads selected randomly from the list of total number of households in each village. The respondents were asked various information related to the implementation of the village land use plan. Focus groups and key informant interviews were done to gain deeper insights into the findings, allowing for a

comprehensive understanding of land use implementation. The focus group consisted of seven individuals representing diverse cultural groups, including pastoralists, agro-pastoralists, and farmers. Additionally, five key informants were included, comprising the Village Executive Officer (VEO), village chairperson, male village elder, female village elder, and youth leader. Focus group discussion and key informants gave information on population density, characteristics, and ethnicity, services and information access and implementation of the land use plan. Data from the questionnaires were analysed using descriptive statistics in the Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp., 2011). The focus groups and key informants' findings were summarized using content analysis.

2.3 Results

2.3.1 Classification results

The land cover classification for the years 1995, 2005, 2010, 2015, and 2020 in Ihombwe, Gole, and Kisegese villages within the Miombo woodlands of Tanzania reveals significant changes in vegetation cover across different land use categories. In Ihombwe, forest cover within the forest reserve decreased from 69.20% in 1995 to 46.15% in 2010 and 50.64% in 2020, while settlement areas increased from 12.05% in 1995 to 8.16% in 2010 and increased to 17.64% over the same period. Similarly, in Gole, forest cover within the reserve decreased from 40.39% in 1995 to 32.88% in 2010 and increased to 38.34% in 2020, while areas designated for agriculture and settlements increased from 41.81% to 29.14%. In Kisegese, forest cover within the reserve declined from 21.69% in 1995 to 14.90% in 2020 to 12.62% in 2020, with settlements increasing from 29.40% to 21.55%. These highlight the dynamic nature of land cover changes influenced by various land use activities over time (Fig. 2.2a-c & 2.3a-c).

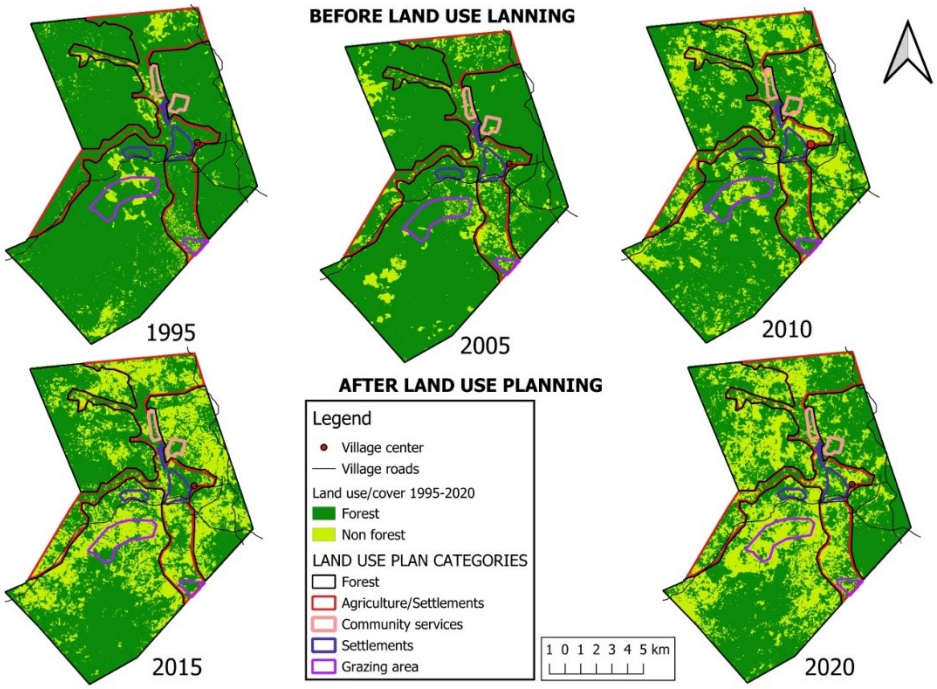
2.3.1 Trends in tree cover before and after land use planning

Results revealed that tree cover in land use category designated as forest reserve was declining by 33.31%, 36.75% and 46.17% before land use planning in Ihombwe, Gole and Kisegese village respectively (Table 2.3; Fig. 2.2a-c & 2.3a-c). However, after land use planning, tree cover in land use category designated as forest reserve increased by 9.74% and 25.23% respectively in Ihombwe and Gole villages but declined by 35.42% in Kisegese village. Furthermore, results revealed that tree cover outside forest reserves (areas allocated for agriculture, grazing, settlement, and community service) continue to decline even after land use planning in all villages (Table 2.3; Fig. 2.2a-c & 2.3a-c).

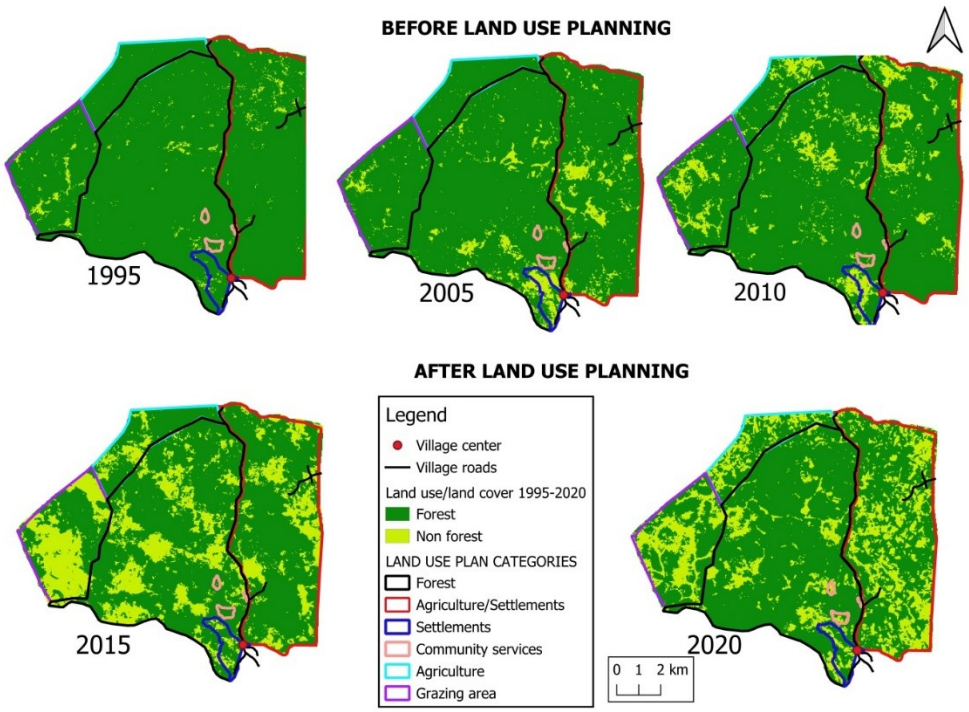
Table 2.3: Change in tree cover before (1995-2010) and after (2010-2020) land use planning in Ihombwe, Gole and Kisegese villages

Land -use category	Transition in vegetation cover before land use planning (1995-2010)			Transition in vegetation cover after land use planning (2010-2020)		
	Ihombwe	**Gole**	**Kisegese**	**Ihombwe**	**Gole**	**Kisegese**
Village forest reserve (%)	-33.31	-36.75	-46.17	9.74	25.23	-35.42
Agriculture and settlement (%)	-19.31	-7.81	-38.74	-16.69	-24.42	-41.50
Agriculture	NA	-11.94	NA	NA	-14.25	NA
Grazing (%)	-35.08	-10.61	*NA*	-49.63	-18.35	NA

Community services (%)	-56.79	-49.99	-28.83	-66.45	-44.12	-57.01
Settlement (%)	-38.82	-26.02	-5.23	-70.24	-56.02	-22.65

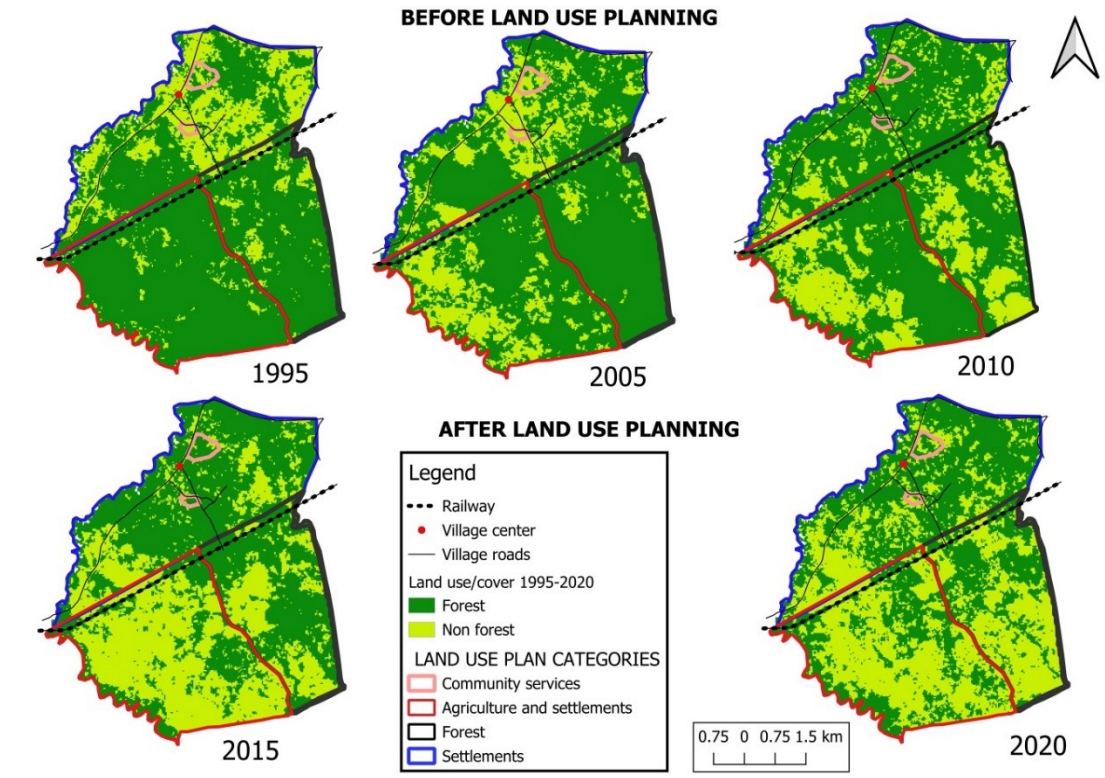


a) Land use and land cover map of image scene in in Ihombwe village, 1995-2020



b) Land use and land cover map of image scene in in Gole village, 1995-2020

Figure 2.2: Land use and land cover map of image scenes



c) Land use and land cover map of image scene in in Kisegese village, 1995-2020

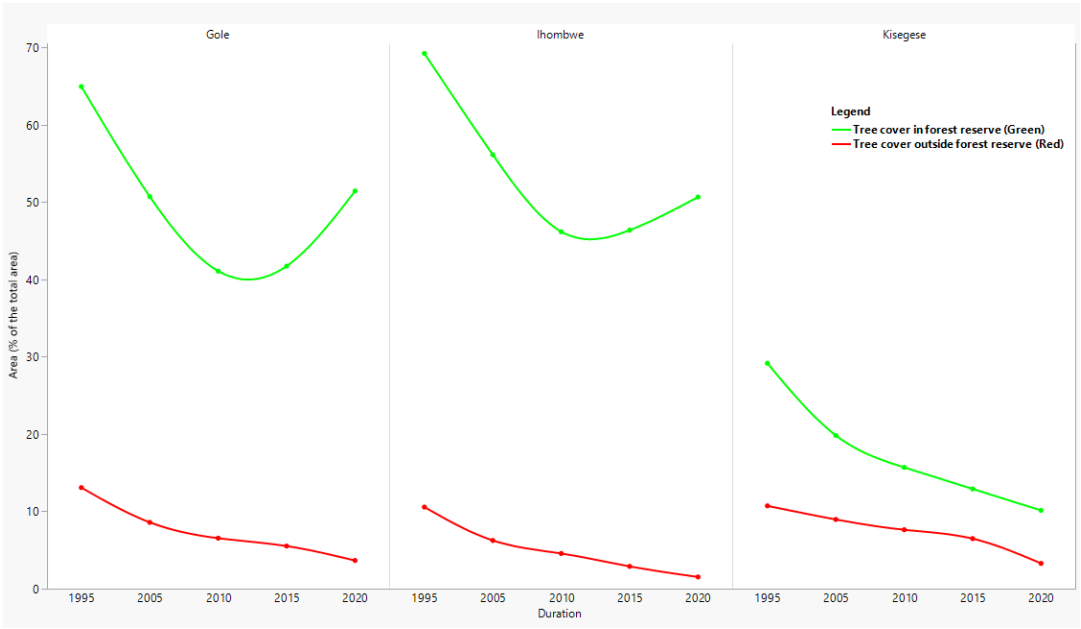


Figure 2.3: Trends in tree cover in (a) Gole (b) Ihombwe (c) Kisegese village

2.3.2 Extent of Implementation of the village land use plan nexus forest conservation

Results revealed that local communities perceived village land use plans were implemented on average by only 47.3% (Table 2.4). Generally, the perception of local communities in implementation of village land use plans n in all land use categories was not pleasing. However, the extent of implementation of land area for grazing was very poor. The area allocated for forest reserve was perceived to be implemented at higher percentage in all villages except Kisegese where it was perceived that the extent of implementation was only by 20%.

Table 2.4: Perception of household on the extent of implementation of different land use categories of land use plans

Land use category	Ihombwe (%)	Gole (%)	Kisegese (%)	Average (%)
Agriculture (%)	52	47	50	**49.7**
Grazing (%)	15	24	0	**13.0**
Forest reserve (%)	57	65	20	**47.3**
Settlements (%)	65	67	70	**67.3**
Community services (%)	56	62	59	**59.0**
Average	**49**	**53**	**39.8**	**47.3**

2.4 Discussion

Results show that tree cover in land use category designated as forest reserve was declining before land use planning but substantially increase after land use planning in Ihombwe and Gole villages. The results suggests that before land use planning there was a substantial loss of forest cover, due to conversion to agricultural, urban land, and other factors such as grazing. After the planning and implementation of the village land use plan vegetation cover increased because of resettlement of people who used to live and practice their economic activities in the forest (Kilawe *et al.,* 2018). Furthermore, by-laws were enacted to restrict land uses such as grazing or shifting cultivation in the forest reserves (Mtinangi, 2012). The results suggests that the land use plan was effective to increase forest cover in areas designated as village forest reserve as anticipated. A study by Alemu *et al.* (2019) found that the implementation of the plan had led to an increase in forest cover by 2.5%, while the rate of deforestation had been reduced by 20% in the Ethiopian Highlands. The results showed that the area of forest cover in the Ethiopian Highlands. Another study conducted in the Kundapura taluk of India found that land use changes due to village land use planning had a significant impact on vegetation cover, and that the implementation of the plan had led to an increase in forest cover and a decrease in agricultural land (Kuchanur *et al.,* 2021).

For the Kisegese village, the trend in tree cover in and outside forest reserve was declining even after land use planning. The decline in tree cover in this village is attributed to the fact that the gazettement of village forest reserve was not approved after village land use planning. There is no protected village forest reserve in this village, deforestation continue through due to unsustainable land use practices such as expansion of agriculture, logging and sand mining. This phenomenon can be observed in the Namwai Village Forest, presently lacking any protection despite being designated as a potential Forest Reserve in 2004. The Namwai area is crucial, and since the Forestry

and Beekeeping Division has already surveyed and mapped it as part of plans to gazette this area as a National Forest Reserve, the best course of action may be to start the process as soon as feasible (Jones *et al.,* 2007). Before 2005, Namwai had no human inhabitants, but immigrants started to establish a settlement within the forest, leading to the creation of the sub-village known as Ihenga (Bamford *et al.,* 2018). It appears that there was an increase in settlements and farmland after land use planning. The village possesses a pathway used by animals, and the most likely corridor for these animals is on the eastern side of the Ruipa River, passing through the Namwai Village Forest. Consequently, the Ruipa corridor now consists of a complex mix of land uses and protections, spanning two administrative districts: Kilombero District to the north of the Kilombero River and Ulanga District to the south of the river. Along the Ruipa River, the land is owned by two villages, Kisegese and Mofu (Bamford *et al.,* 2018).

The results of this study revealed that tree cover substantially declined in areas outside reserved forest reserve due to agricultural expansion, settlements establishment, extraction of forest products such as timber, charcoal, firewood and medicinal plants. The implication of low tree cover in other land uses for example is that there will be a shortage of products such as firewood, charcoal, medicine, timber which will attract people to encroach the forest to obtain the needed products for their wellbeing. Initiatives are needed to increase the tree cover outside the forest. Reforestation programs are needed in collaboration with schools, colleges, and local organizations to promote environmental education and tree planting programs. Awareness campaigns to educate the village residents about the benefits of trees and green spaces and agroforestry practices, which involves integrating trees into agricultural landscapes.

Socio-economic data revealed that local communities perceived land use planning was implemented by only 47%. The poor implementation of the land use plan hinders the conservation efforts. The results are similar to findings of another study which found that local communities perceived land use planning implemented by only 45% (Kilawe *et al.,* 2011). Low implementation of the plans has and lessened the outcomes desired by the outsiders who drafted the plans, which included improving conservation and reducing deforestation. Low level of implementation of some land use categories is attributed to the incompatibility of some of the proposed land use categories when placed in one area-for example agriculture and grazing (Kilawe *et al.,* 2011). Another explanation for the low level of enforcement of land use categories is low level of local communities' participation in the land use planning process (Kilawe *et al.,* 2011). The outsiders who drafted the plans lacked a comprehensive understanding of the socio-economic, cultural, and religious contexts within the villages. This led to mismatches between the suggested land use categories, land use utilization needs and the existing socio-economic settings of the local communities. Consequently, a significant number of these plans were either not implemented or were eventually abandoned (Kilawe *et al.,* 2011). Land allocated for grazing in Ihombwe and Gole received low rating due to inadequate availability of the grazing resources in the designated grazing areas which in return the pastoralists graze in the forest and other areas out of the forest reserves. In Kisegese there is a passage of the railway and the electrical lines, and they are not allowed to conduct agricultural activities within 30m of both sides of the line thus the village did not designate the grazing area because it was claimed the area for agriculture would be reduced.

2.4 Conclusion

The results of this study show that the implementation of village land use planning has contributed to the increase in tree cover in areas in allocated for forest reserve but contributed to a significant decline in tree cover outside reserved forest, area allocated for grazing, agriculture, settlement, and socio-services. The decline in trees outside reserved forest is concerning due to their importance in the provision of products and services such as fuel wood, timber, medicine, and nutrition. Strategies are needed to provide incentives for local communities to keep trees in their landscapes. The study found further that the land use prescribed by expert was perceived to be implemented on average by only 47%. Low implementation of the plan impedes the conservation of the forest reserves. Poor perception was attributed to exclusion of the communities during the drafting of the plans. It is recommended that the local communities to be effectively engaged during land use planning and land use suitability analysis to be carried out before and during land use planning process.

Conflict of interest

The authors declare that are no conflicts of interest.

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Author contributions

Prince Batamuzi: Conceptualization, Data collection and analysis, Writing first draft. Charles Joseph Kilawe: Conceptualization, Writing review and editing. Proches Hieronimo: Conceptualization, Methodology, Writing review and editing.

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CHAPTER THREE

Manuscript Two

Extent of implementation of the village land use plans in Miombo Woodland Landscapes of Tanzania

Abstract

This study assessed land management in the Miombo woodlands of Tanzania by assessing the implementation status of village land use plans in Ihombwe, Gole, and Kisegese villages. The study assessed the extent to which the village land use plans have been implemented in Ihombwe, Gole, and Kisegese villages located in various climatic areas in Miombo woodlands of Tanzania. Results revealed that local communities perceived village land use plans were implemented on average by only 47.3%. The perception of survey participants regarding the extent of implementation of the approved village land use plan was higher in areas designated as forest reserves but very poor in areas designated for grazing. Poor implementation of the land use plans was mainly constrained by the resistance of certain village inhabitants who did not approve of certain specified land use classifications and exclusion of the communities during the drafting of the plans and partly due to the lack of suitability of the land use categories. The level of involvement in the planning and implementation process varies, with Ihombwe and Gole villages showing higher participation than Kisegese to which to which the respondents were only involved in implementation of the plan. Drivers that motivated the formulation of the land use plans are mainly deforestation, immigration and occurrence of the land use conflicts. Exclusion of the communities during the drafting of the plans led to poor plans implementation. Active community engagement during planning process is needed to contribute to the alignment of land use plans with local needs and fostering ownership.

Keywords: Deforestation; Immigration; Adoption; Land use utilization; Grazing

3.1 Introduction

Approximately 75% of the Earth's land area has undergone human-induced modifications in the past thousand years. Effectively addressing worldwide sustainability issues like climate change, biodiversity decline, and food security hinges on alterations in land use (Winkler *et al.,* 2021). Land use plans are crucial for maintaining sustainable land use practices. When land is properly planned, surveyed, titled, and utilized in a sustainable manner, it becomes a fundamental catalyst for economic growth, ensuring food security, and reducing poverty in Tanzania (N.L.U. P, 2017). Conflicts between resource users and unsustainable land use practices are less likely when the land use planning is properly carried out because they specify what has to be done and where (Mugasha and Katani, 2016). The allocation of land to diverse purposes (the drafting of a land use plan) in a participatory way by incorporating the community who are the land users is one of the major components during the implementation of Village Participatory Land Use Plans (VPLUPs) in Tanzania (Kalenzi 2016, URT, 2007).

Village land use planning emerges as a valuable instrument for enhancing the management of village land resources. It facilitates environmental protection, fosters sustainable development, and enhances the well-being of villagers. The studies on plan implementation, thus far, indicate that successful plan implementation depends on meeting many conditions such as political-institutional factors, attributes of the plan system factors such as population growth and economic activity (Yunos *et al.*, 2015). Village land use planning practices differ from country to country, and they can fall into two broad categories: informal or formalized. Informal land use planning is based on customary management norms and institutions, whereas formalized land use planning is documented and aligned with national and global standards. In certain countries like India, local-level land use plans do not hold any legal status (Huggins, 2020). Conversely, in Tanzania, Village Land Use Plans (VLUPs) can be officially approved by the state and serve as formal planning tools. Village lands encompass communal areas as well as areas designated for individual use (Huggins, 2020). The adoption of participatory land use plans has been embraced across different sectors due to its effectiveness in problem-solving through involving local communities in the planning and decision-making processes (Naiposha *et al*., 2021).

The village land use plan primary goal is to promote conservation, minimize conflicts related to resource utilization, and mitigate degradation. The Kilombero Valley presents the most urgent and greatest conservation challenge among all the areas in this region, it's crucial for connecting the Udzungwa and Selous ecosystems, but due to dramatic changes in land use in the Kilombero Valley over recent decades, there's very limited opportunity for animal movement between these two protected areas, despite their proximity (Jones *et al.,* 2007). Moreover, the significant historical use of forests prior to the implementation of VPLUPs suggests that many forests were overexploited leading to deforestation due to various uses (Uisso *et al.,* 2019). A critical element of the Village Participatory Land Use Plans (VPLUPs) in Tanzania, as highlighted by (Kalenzi, 2016), is the collaborative allocation of land for various purposes, involving the local community who are the land users. Village land use planning process can't be abrupt or disruptive; it requires a deep understanding of the social and economic factors driving land use patterns, and it necessitates agreement between the community and policymakers regarding the use of natural resources (Erdogan and Bastidas, 2020).

Although there are high expectations and considerable investments associated with this plan, there is limited understanding of its adoption and implementation (Kilawe *et al.,* 2011). The implementation extent of village land use plans has rarely been assessed if are being put into practice and if are not put into practice, the factors that impede the implementation are unknown. Studies show that land use disputes, deforestation, and forest degradation have increased despite land use plans being in place (Benjaminsen *et al.,* 2009; Kilawe *et al.,* 2018). The field of planning research often neglects the crucial aspect of implementation, despite its significance (Calbick, 2003). Village land use plans were formulated in the year 2013 in Ihombwe village, 2011 in Kisegese and 2012 in Gole village in Kilosa, Kilombero and Handeni districts and the implementation of village land use plans (VLUPs) in Kisegese, Gole and Ihombwe villages in the Handeni, Kilombero and Kilosa districts have been a mixed bag. Existing studies on land use implementation have mostly focused on assessing urban land use plans. Thus investigation of implementation of land use plans at village level has largely been ignored on the one hand (Naiposha *et al.,* 2021).

3.2 Material and Methods

3.2.1 Study area

The study was conducted in three villages located in various climatic zones of Miombo woodlands of Tanzania. The villages in districts were chosen due to the existence of village land use plans and knowledge of land use planning. The villages are; Ihombwe village in Kilosa District, Kisegese village in Kilombero District, Morogoro region and Gole village in Handeni District, Tanga region (Fig.3.1). Ihombwe village, situated in the Kilosa District of the Morogoro Region in Tanzania, is located approximately 15 km from Mikumi and 65 km from Kilosa urban along a rough road. Positioned at an altitude of around 400 meters above mean sea level, the village spans from 7° 10' S to 7° 30' S and 36° 40' E to 37° 0' E, nestled within the miombo woodlands of Kilosa district adjacent to Mikumi National Park. The village experiences variable annual precipitation levels ranging from 800 mm to 1600 mm, influenced by its altitude. Ihombwe is home to a relatively small population, estimated at 3450 people residing in approximately 750 households (NBS, 2022). The native tribes of Ihombwe village are the *Wavidunda* and *Wasagara* people. However, the village has been receiving migrants from other tribes such as *Wagogo, Wasukuma, Wanyakyusa, Maasai, Iraqi, Wakurya, Waha* and *Wanyakyusa.* It's essential to note that some individuals who don't live in the village still own cultivated land (Strömquist and Backéus, 2009). The soils are leached reddish soils developed under a moister climate. The village is known for pastoralism, agriculture, and charcoal production as the main economic activities. The temperature fluctuates with elevation. The yearly average temperature stands at 25°C, with July being the coldest month and March the warmest. Temperature fluctuations throughout the year span from 19°C to 30°C (URT, 2020). The village possesses a 10-year land use plan which was developed in 2013. The land use categories included in the land use plans are agriculture, settlements, forest reserve, grazing, and community services. The village landscape is dominated by tree species of the genera Brachystegia, Julbernardia and Isoberlinia.

Gole, the second village under study, is situated approximately 57 km from Handeni Urban in the Kang'ata ward, near Madebe village, within Handeni District, Tanga Region, Tanzania. Positioned between latitudes 5°40' S to 5°45' S and longitudes 37°55' E to

38°05' E, at an elevation of around 600 m above sea level, Gole experiences an average annual rainfall ranging from 800 to 1,400 mm. Its topography consists of undulating plains intersected by valleys and isolated hills. The approximate population of the village is assessed to be 11,332 total population with 2850 households (NBS, 2022). The indigenous *Zigua* tribe is prevalent, though various other tribes such as *Wakurya, Wasukuma, Wahehe, Waha, Wagogo,* Barbaigs, and Iraqis have migrated to the village, with Iraqis, Kurya, and Zigua currently forming the majority. The acidic-clay soils characterize Gole, and socio-economic activities predominantly revolve around pastoralism (53.1%), farming (44.9%), and mining (2%). Pastoralists in the region depend on livestock husbandry for income, deriving revenue from the sale of livestock-related products such as meat, skin, hide, and milk (Mwakalonge and Chingonikaya, 2023). The village initiated the implementation of a land use plan in 2014, encompassing categories such as agriculture, forest, settlements, grazing areas, and community services (Fig. 3.1). The natural vegetation primarily comprises dense miombo woodland dominated by *Brachystegia spp., Julbernardia spp., Pterocarpus angolensis, Brachystegia huillensis*, and *Afzelia quanzensis*. Gole also boasts a village forest reserve, the Gole Forest Reserve, managed locally by the village.

The third village investigated, Kisegese, is located in the Kilombero District of the Morogoro Region in Tanzania. The Kilombero valley is particularly valuable for agricultural purposes, particularly rice and sugar cane farming. Over the past few decades, the local human population has rapidly increased, resulting in extensive conversion of wildlife habitats into farmland. Additionally, there has been a notable influx of pastoralists and their cattle in recent years (Jones *et al.,* 2012). The village, with an estimated total population of 12,167 and 4,736 households (NBS, 2022), spans an area between 7° 9' 34" S to 9° 9' 34" S and 34° 20' 28" E to 38° 20' 28". Nestled at an altitude of approximately 200 meters above sea level, the landscape of Kisegese is predominantly flat, offering a vast expanse of level terrain. The climate in Kisegese is classified as tropical, characterized by consistently high temperatures and abundant rainfall. The area experiences regular and substantial precipitation patterns, contributing to the overall lushness of the surroundings. The wet and humid conditions are conducive to diverse flora and fauna, fostering rich biodiversity in the region. Dominated by woodlands and grasslands, often featuring sandy and clay soils, Kisegese is known for its agricultural productivity, particularly in rice farming. The natural vegetation consists of the miombo woodland dominated by *Diplorhynchus condylocarpon* followed by *Antidesma venosum, Stereospermum kunthianum, Julbernardia globiflora* and *Combretum molle.* The village is home to diverse tribes, including the Sukuma, Nyakyusa, Hehe, Waha, and Maasai. The population density is notable, with livelihood strategies primarily centered on agriculture. The village formulated a land use planning process in 2011, aiming to organize and manage its resources effectively. However, despite these efforts, the Ruipa corridor, a vital migration route for large mammals, has lost its effectiveness and faces threats to its existence due to rapid destruction and overexploitation of the Namwai forest situated in Kisegese village (Jones *et al.,* 2007). Restoring the corridor's functionality would require significant resources and investment.

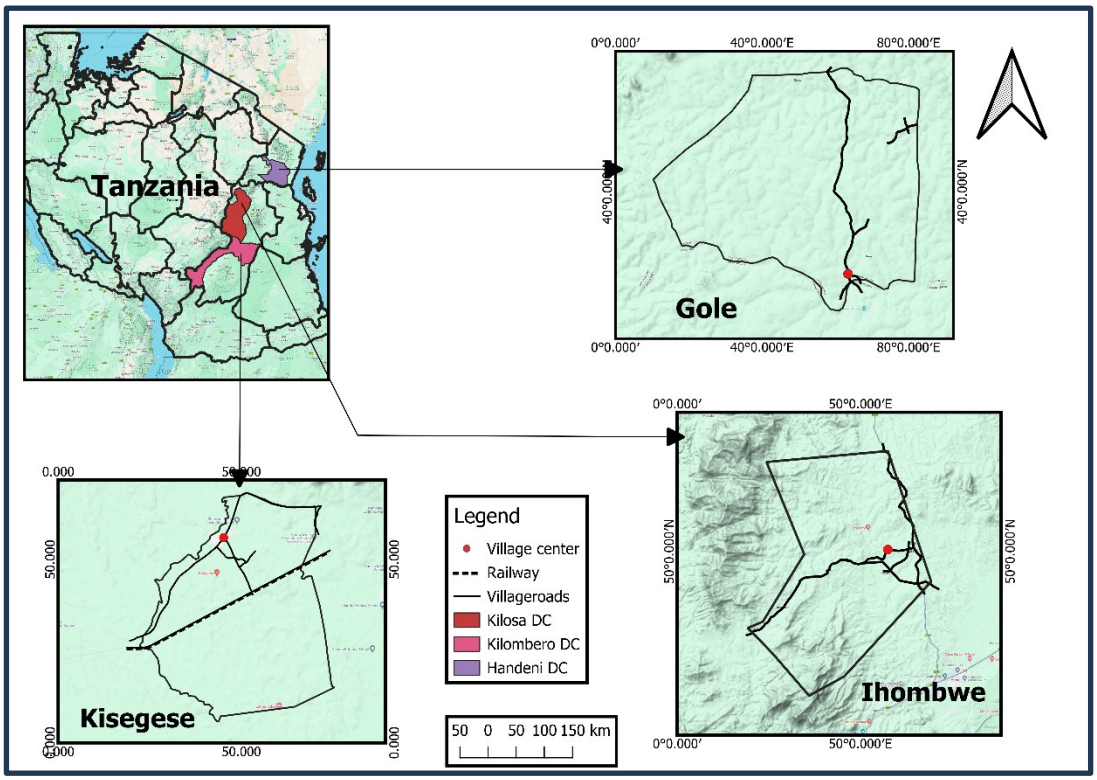

Figure 3.1: A map showing the study areas

3.2.2 Data collection and analysis

i. Study design and sampling techniques

Study Design: Assessing Household Perception and Participation in Village Land Use Plans

ii. Sampling Methodology:

1. Representative sample size

In each village, a sample was taken from 5% of the total number of households in the village. Sampling intensity of 5% from the 5% of the population, sample size was determined by the following formulae (Krejcie and Morgan, 1970):

$$n = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where:

X^2 = Tabulated value of Chi-square for one degree of freedom at the desired confidence level (1.96 for 95% confidence level)

N = Total number of households in the village

P = Population proportion (assumed to be 0.5 which provide the maximum sample size)

d = Degree of accuracy expressed as a proportion (0.05)

2. Stratified Sampling

To ensure that all cultural groups (pastoralists, agro-pastoralists and farmers) are included in the study we used the proportionate stratified sampling where each cultural group represented particular strata. The sample size for each stratum (Ns) was determined by the formula (Rahman *et al*., 2022: Pirzadeh *et al.*, 2011):

$$Ns = Sample ¿¿ Population ¿¿ Stratum ¿¿¿¿$$

Where:
Ns= Number of households per strata

The household survey was used to determine the perception of local communities on the current extent of implementation of the village land use plans. A structured questionnaire was administered to 30 household heads selected randomly from the list of total number of households in each village. The respondents were asked about the implementation of the village land use plan. Focus groups and key informant interviews were done to gain deeper insights into the findings, allowing for a comprehensive understanding of land use implementation. The focus group consisted of seven individuals representing diverse cultural groups, including pastoralists, agro-pastoralists, and farmers. Additionally, five key informants were included, comprising the Village Executive Officer (VEO), village chairperson, male village elder, female village elder, and youth leader. Focus group discussion and key informants gave information on population density, characteristics, and ethnicity, services and information access and implementation of the land use plan. Data from the questionnaires were analyzed using descriptive statistics in the Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp., 2011). The focus groups and key informants' findings were summarized using content analysis.

3.3 Results

3.3.1 Implementation of the village land use plan

Results revealed that local communities perceived village land use plans were implemented on average by only 47.3% (Table 3.1). Generally, the perception of local communities in implementation of village land use plans n in all land use categories was not pleasing. However, the extent of implementation of land area for grazing was very poor. The area allocated for forest reserve was perceived to be implemented at higher percentage in all villages except Kisegese where it was perceived that the extent of implementation was only by 20%.

Table 3.1: Perception of household on the extent of implementation of different land use categories of land use plans

Land use category	**Ihombwe** (%)	**Gole** (%)	**Kisegese** (%)	**Average** (%)
Agriculture (%)	52	47	50	**49.7**
Grazing (%)	15	24	0	**13.0**
Forest reserve (%)	57	65	20	**47.3**
Settlements (%)	65	67	70	**67.3**
Community services (%)	56	62	59	**59.0**
Average	**49**	**53**	**39.8**	**47.3**

3.3.2 Community engagement in the planning and implementation process of land use planning

The level of involvement in the planning and implementation of Village Land Use Plans (VLUPs) varies among the studied villages. Majority of the community were involved in the implementation process and very few were involved in all processes of the introduction, preparation, and implementation stages. The overall percentages reflect the

extent of community participation in different stages of VLUPs, revealing the variation in engagement levels among the surveyed villages (Table 3.2).

Table 3.2: Household engagement in the planning process the village land use plans

Involvement in the planning process	Gole		Ihombwe		Kisegese	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Implementation	20	62.5	26	86.7	31	100
Preparation and implementation	6	18.8	2	6.7	0	0
Introduction of the idea and implementation	1	3.1	0	0	0	0
Introduction of the idea, preparation and implementation	5	15.6	2	6.7	0	0

3.3.3 Drivers that motivated the formulation of the village land use plan

The formulation of the village land use plans was driven by several key factors (Table 3.3). Deforestation is propelled by factors like agricultural expansion, charcoal burning, settlements, and grazing. Immigration is driven by similar causes, primarily related to agricultural expansion, charcoal burning, and settlements, but Kisegese experiences fewer drivers. Land use conflicts stem from agricultural expansion, corruption, and grazing in farms, with politics playing a significant role in Kisegese. These drivers highlight the complex interplay of land use, resource management, and socio-political factors in these Tanzanian regions.

Table 3.3: Drivers towards the formulation and implementation of the village land use plans

Driver	Gole Causes	Ihombwe Causes	Kisegese Causes
Deforestation	Agricultural expansion, charcoal burning, settlements and grazing	Agricultural expansion, charcoal burning and settlements	Agricultural expansion, settlements charcoal burning, illegal logging
Immigration	Agricultural expansion, charcoal burning, settlements and grazing	Agricultural expansion, charcoal burning, settlements and grazing	Agricultural expansion
Land use conflicts	Agricultural expansion, corruption, grazing in farms	Agricultural expansion, corruption and grazing in farms	Agricultural expansion, politics

3.4 Discussion

The findings of the study revealed that local communities perceived land use plans were implemented by only 47%. The results are similar to findings of another study which found that local communities perceived land use planning implemented by only 45% (Kilawe *et al.,* 2011). Poor perception on the extent of implementation was driven by the low level of local communities' participation in the land use planning process. This lack of involving of the communities during the development of the VLUP was the main cause of poor adoption and failure of the plans. The outsiders who drafted the plans clearly lacked a comprehensive understanding of the socio-economic, cultural, and religious contexts within the villages. This led to mismatches between the suggested land use categories, land use utilization needs and the existing socio-economic settings of the local communities. Consequently, a significant number of these plans were either not implemented or were eventually abandoned (Kilawe *et al.,* 2011). Land allocated for grazing in Ihombwe and Gole received low rating due to inadequate availability of the grazing resources in the designated grazing areas which in return the pastoralists graze in the forest and other areas out of the forest reserves. In Kisegese there is a passage of the railway and the electrical lines, and they are not allowed to conduct agricultural activities within 30m of both sides of the line thus the village did not designate the grazing area because it was claimed the area for agriculture would be reduced. Several iterations of land zoning simulations can be conducted until a general agreement is achieved, leading to the collaborative approval of the ultimate plan (Bourgoin and Castella, 2011). There is a lack of enforcement or compliance where land use plans have been developed, with political, social and commercial interests frequently take precedence over agreed-upon land use plans. Land allocated for grazing in Ihombwe and Gole received low rating due to inadequate availability of the grazing resources in the designated grazing areas which in return the pastoralists graze in the forest and other areas out of the forest reserves.

Community engagement plays a vital role in the planning and implementation process of the village land use plans. Such involvement is crucial for ensuring the plan's effectiveness and aligning it with the needs and aspirations of the community in Ihombwe village. However, it is noteworthy that only a small percentage of respondents were engaged in introducing the idea and preparation of the plan in Gole village and none was involved in the introduction of the idea and implementation on Ihombwe village. This indicates a lack of proper community consultation and involvement in the initial stages of the planning process which may lead to less satisfaction of the planned land use categories among the community members. The research by (Uisso *et al.*, 2022) in Kilosa highlighted community's involvement in the preparation stage is essential as it ensures that the plan aligns with the community's needs, interests, and aspirations.

The formulation of the village land use plans was driven by several factors. These factors include deforestation, immigration and land use conflicts. Deforestation is a pressing issue and the driver behind this environmental concern varies across different areas. The main causes of deforestation include agricultural expansion, charcoal burning, settlements, and grazing. These activities lead to the clearance of forests to make way for agriculture, the production of charcoal as a source of fuel, the establishment of new settlements, and allowing livestock to graze in forested areas. These activities result in the conversion of forested areas into agricultural fields, the production of charcoal for

energy needs, and the establishment of new settlements. Land use involves purposefully modifying the existing land cover, such as vegetation, by transforming it into alternative forms, such as constructing buildings, utilizing it for medicinal purposes, or harvesting wood and fuel. As a result, this process can contribute to deforestation, the removal or reduction of forested areas (Nzunda and Monjare, 2013). According to the village chairman in Ihombwe village, the main driver for the village land use plan was to protect the forest which was massively destroyed by cultivation practices charcoal making activities and the illegal timber harvesting. On the day of discussion, a lot of confiscated charcoal bags were also brought to the village office further cementing the presence of illegal charcoal burning. Other problems that contributed to the village land use plan was the conflict between different land users mainly farmers and livestock keepers. Therefore, the village government with the aid of the central government and TFCG, decided to prepare the village land use plan.

The arrival of migrants seeking better opportunities increases the demand for land and contributes to land use changes. This can lead to the conversion of forests into agricultural fields or settlements to accommodate the growing population. According the village chairman in Ihombwe village:

"The first group to come here were the Mang'ati (Barbaigs), after sometime, the Sukuma so did move into the village. But you know these people only have camps during the search f pastures so once the rain comes, they go back. Once they go back is when the Sukuma come in. These Sukuma usually build houses on the places vacated by the Maasai and the Mang'ati (Barbaigs). But once the Sukuma builds a house, they cannot be moved, hence, they settle."

In Gole village, the Barbaigs started migrating into the village from 2013 to 2014 followed by the Sukuma. 2015s witnessed the increase in the influx of pastoralists and agro pastoralists in the village. The main reason for the migration of pastoralist societies in the village was the availability of pasture and fertile land in the village. *"There was enough forest in the village, therefore the agro pastoralists had enough fertile land for agriculture"* the village chairperson explained. However, it is important to consider that there are individuals who own cultivated land in the village but do not reside there (Strömquist and Backéus, 2009). The migrants who migrate to Kisegese village were attracted by the fertile soil and availability of land for farming and pastures. Many of them were farmers and livestock keepers. The pastoralists are the Maasai, the agro pastoralists are Sukuma and other tribes such as Hehe, Ngoni, Pogoro, Nyakyusa and Ngindo engage themselves in farming activities and keep livestock for farming purposes only. They grow crops such as maize, rice. Ndamba people engage themselves in fishing activities in River Kilombero and River Ruipa.

Land use conflicts are prevalent issues in many communities worldwide. These conflicts arise when different stakeholders have competing interests and conflicting demands over the utilization and management of land resources. When two groups of land users claim the same land at the same time, normally conflicts occur. Not only are the conflicts between individuals, there are also bordering conflicts between Ihombwe village and other villages. These nearby villages include Kitunduweta and Kisanga according to the village chairman added:

"These two villages are still new as compared to ours, so we gave them specific sites that were not demarcated on the map. But the initial maps were not updated and hence, almost every time they take their satellite image, they claim we (Ihombwe) have destroyed the reserved forest land, while actually, it is the other villages."

The primary reasons for conflicts between pastoralists and farmers in Kilosa and many other regions are connected to political ecological variables, including laws and policies governing land tenure, agricultural policies, and widespread corruption among government officials and the general population (Sulle and Mkama,2019). Conflicts usually arise between livestock keepers and other land users such as the village government and farmers. When cattle are captured in the forest, usually the pastoralist is fined heavily, the conflicts between farmers and the livestock keepers are usually solved by themselves. According to the village chairperson in Kisegese:

"The pastoralists usually walk with weapons and uses the weapons to hurt the farmers as the cattle continue feeding in the farms."

For unwise pastoralists, usually there are fights and the village chairperson signs the forms to take the case to the police and to take the injured to the hospital for check-ups. Participatory land use planning involves the collaboration of various stakeholders to collectively generate a common pool of ideas, reach consensus on appropriate land usage, and facilitate the resolution of conflicts related to land use (Uisso *et al.*, 2018). In spite of initiation of VLUPs to mitigate land use conflicts, the incidences of land use conflicts still exist in some districts including Kilosa and Handeni Districts (Naiposha *et al*., 2021).

3.4.1 Policy implication

The village land use plan in Tanzania encompasses various policy implications intended to provide guidance and regulation for land utilization within villages. These policy implications have been formulated to advance sustainable development, enhance land governance, safeguard natural resources, and empower local communities. Some of the primary policy implications arising from the village land use plan in Tanzania based on this study include:

i. Strengthen Community Participation and Consultation: The study found that community involvement was a key factor in the success of the village land use plans in Kisegese, Gole and Ihombwe villages. When communities are involved in the planning process, they are more likely to feel ownership of the plan and to be more willing to participate in its implementation. This can lead to more effective and sustainable land use planning. Strengthening community participation can enhance the effectiveness of land use plans and foster a sense of ownership among the community members.

ii. The need to address the concerns of different stakeholders in the planning process. The study found that there were some concerns about the village land use plans from different stakeholders. For example, some farmers were concerned that the plans would not allocate enough land for agriculture. Others were concerned that the plans would not protect the environment. It is important

to address the concerns of different stakeholders in the planning process to ensure that the plans are acceptable to everyone.

iii. Address Conflicts and Land Use Challenges: Land use conflicts, including issues between farmers and livestock keepers, deforestation, and immigration, have led to the development of village land use plans. To address these conflicts, policymakers should focus on effective conflict resolution, promoting sustainable land management practices, and regulating land use activities. This can be achieved by implementing clear land use regulations, enforcing boundaries, and fostering dialogue and cooperation among stakeholders.

iv. Enhance Monitoring and Evaluation: The study found that the village land use plans in Kisegese, Gole and Ihombwe villages were not being adequately monitored or evaluated. This makes it difficult to assess their effectiveness and to identify areas where they need to be improved. Regular monitoring and evaluation is essential for ensuring that village land use plans are effective and sustainable.

Policy implications emphasize the importance of community involvement, awareness, conflict resolution, and monitoring in the successful implementation of village land use plans. By addressing these aspects, policy-makers can enhance the effectiveness, satisfaction, and compliance with land use regulations, leading to more sustainable and equitable land use practices in Kisegese, Gole and Ihombwe villages.

3.5 Conclusion

The implementation of village land use plans (VLUPs) is a complex process with unique challenges and implications. The study found that the land use prescribed by expert was perceived to be implemented on average by only 47%. Poor perception was attributed to exclusion of the communities during the drafting of the plans. It is recommended that the local communities to be effectively engaged during land use planning and land use suitability analysis to be carried out before and during land use planning process. Active participation of community members contributes to the alignment of land use plans with local needs, fostering ownership and reducing conflicts. Addressing the challenges posed by immigration and land use conflicts requires a holistic approach and engaging with immigrant communities and incorporating their needs into the land use plans can help prevent conflicts. Establishing a robust system for monitoring and evaluating the implementation of VLUPs is essential. This will help identify challenges and successes, enabling timely adjustments and improvements.

Conflict of interest

The authors declare that are no conflicts of interest.

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Author contributions

Prince Batamuzi: Conceptualization, Data collection and analysis, Writing first draft. Charles Joseph Kilawe: Conceptualization, Writing review and editing. Proches Hieronimo: Conceptualization, Methodology, Writing review and editing.

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CHAPTER FOUR

General Discussion

The land is a vital resource for human life and progress in Tanzania and around the world. For most rural and urban inhabitants, it is a key source of income and livelihood. The allocation of land to different uses (development of land use plan) in a participatory manner by incorporating the community who are the land users is one of the major elements during the implementation of Village Participatory Land Use Plans (VPLUPs) in Tanzania (Uisso *et al.,* 2018). The land-use planning for a sustainable future needs research into probable land-use changes and the influence it has on ecological functions and processes at the local level (Zebisch *et al.,* 2004). Land-use planning (LUP) at the local level is frequently promoted as a means of attaining numerous objectives at the same time, such as land dispute resolution, environmental conservation, improved land tenure security, and the identification of places for commercial agricultural investment (Huggins, 2018). However, the current worldwide land-use change has resulted in a significant loss of plant cover around the forest reserves, making them more vulnerable and ecologically fragile (Houessou *et al.,* 2013). To conserve natural forest systems and assure the long-term provision of forest resources for sustainable livelihoods, the ability to monitor and identify drivers and patterns of forest loss and degradation is fundamental (Ahrends *et al.,* 2021).

The land-use planning is anticipated to lower the rate of deforestation, land use conflicts and poverty (URT, 2017) (Mugasha and Katani, 2016). However, the implementation extent of village land use plans has rarely been assessed. A study by Kilawe et al., (2011) found that only 48% of Ibingu village and 42% of Chabima village communities perceived that land use planning was effectively put into action. Moreover, despite the existence of land use plans in place, several studies indicate an increase in deforestation and forest degradation. (Benjaminsen *et al.,* 2009; Kilawe *et al.,* 2018). There are few cases however, where the implementation of land use plans has resulted to the improvements in forest management (Uisso *et al.,* 2019) (Mndeme *et al.,* 2012). Most of the previous studies were conducted in less than 5 years after the implementation of land use plans, thus the impact of the plans might not be clearly observable. Hence the objectives of this study were:

i. To determine trends in tree cover before and after village land use planning.
ii. To determine the extent of implementation of village land use plans.

The study shows that tree cover in land use category designated as forest reserve was declining before land use planning but substantially increase after land use planning in Ihombwe and Gole villages. This suggests that there was a substantial loss of the forest cover before land use planning. The loss in forest cover was driven by conversion of the forest patches to agricultural, urban land, and other factors such as grazing. It was observed that after the planning and implementation of the village land use plans, vegetation increased due to resettlement of people who used to live and practice their economic activities in the forest (Kilawe *et al.,* 2018).

Furthermore, by-laws were enacted to restrict land uses such as grazing or shifting cultivation in the forest reserves (Mtinangi, 2012). The study suggests that the land use

plan was effective to increase tree cover in areas designated as village forest reserve as anticipated. A study conducted by Alemu *et al.* (2019) revealed that the execution of the plan resulted in a 2.5% increase in forest cover, accompanied by a 20% reduction in the rate of deforestation in the Ethiopian Highlands. This study demonstrated an expansion in the area of forest cover in the Ethiopian Highlands. Another study conducted in the Kundapura taluk of India indicated that changes in land use due to village land use planning had a notable impact on vegetation cover. The study by Kuchanur *et al.* (2021) found that the implementation of the plan led to an increase in forest cover and a decrease in agricultural land.

In Kisegese village, the tree cover trend both within and outside the forest reserve has been on a decline despite the implementation of land use planning. The decrease in tree cover is attributed to the absence of approval for the gazettement of the village forest reserve after land use planning. With no protected village forest reserve, deforestation persists due to unsustainable land use practices like agricultural expansion, logging, and sand mining. This situation is mirrored in Namwai Village Forest, designated as a potential Forest Reserve in 2004 but lacking protection. The Namwai area, crucial for conservation, has been surveyed for gazettement as a National Forest Reserve. Settlements and farmland increased after land use planning, particularly with the establishment of Ihenga sub-village. The Ruipa corridor, essential for animal movement, now experiences a mix of land uses and protections, spanning two administrative districts: Kilombero District to the north of the Kilombero River and Ulanga District to the south of the river. The lands along the Ruipa River are owned by Kisegese and Mofu villages, showcasing the complex interplay of human settlements and conservation efforts (Jones *et al.,* 2007; Bamford *et al.,* 2018).

This study found a substantial decline in tree cover outside reserved forest areas, attributed to factors like agricultural expansion, settlements, and extraction of forest products. The decline raises concerns about the scarcity of essential items like firewood, charcoal, medicine, and timber, potentially leading to forest encroachment. To address this issue, initiatives are recommended to enhance tree cover beyond forests. Collaborative reforestation programs involving schools, colleges, and local organizations can play a crucial role in promoting environmental education and tree planting. Additionally, awareness campaigns are proposed to educate villagers about the advantages of trees, green spaces, and the implementation of agroforestry practices in agricultural landscapes.

Furthermore, the study found that local communities perceived the implementation of land use planning to be at a low rate, with only 47% perceiving its implementation. This aligns with similar findings of another study indicating a 45% of local perception of village land use plan implementation (Kilawe *et al.,* 2011). Low implementation of the plans has lessened the outcomes desired by outsiders who drafted the plans which included improving conservation and reducing deforestation. The poor perception was driven from limited community involvement during the land use planning process, leading to inadequate consideration of socio-economic, cultural and religious contexts. Outsiders drafting the plans lacked a comprehensive understanding, resulting in mismatches between proposed land use categories and the actual needs of local communities. Plans

allocated for grazing faced challenges due to insufficient grazing resources in designated areas, leading pastoralists to graze in forests and other unauthorized zones.

In Kisegese, restrictions within 30m from both the railway and electrical lines impacted the designation of the grazing area since it raised concerns on the availability of adequate land for agriculture. This suggests a potential area of concern for forest conservation in Kisegese because the Namwai forest reserve in Kisegese has been totally degraded to an alarming rate. In contrast, both Ihombwe and Gole exhibit higher percentages of the adherence of the land use plan towards the designated for forests which indicates a positive inclination toward forest conservation in these areas. The lack of enforcement and compliance in developed plans, influenced by political, social, and commercial interests, poses a challenge. The study suggests that collaborative efforts, iterative zoning simulations, and community involvement are essential to improve the effectiveness of land use planning and promote sustainable practices.

The formulation of village land use plans was motivated by deforestation, immigration, and land use conflicts. Deforestation, driven by activities like agricultural expansion, charcoal burning, settlements, and grazing, results in the conversion of forested areas for agriculture, charcoal production, and settlement establishment. The lack of community involvement during planning contributes to mismatches between proposed land use categories and local needs Several iterations of land zoning simulations can be conducted until a general agreement is achieved, leading to the collaborative approval of the ultimate plan (Bourgoin and Castella, 2011). The presence of illegal activities, such as charcoal burning, further emphasizes the need for effective land use planning. Migration, spurred by opportunities and population growth, leads to increased demand for land and potential conversion of forests into agricultural fields or settlements. Land use conflicts arise due to competing interests and demands over land resources, often involving disputes between different user groups. Migration-related conflicts occur, such as the settlement and land utilization claims between Ihombwe village and neighboring villages. Conflicts between livestock keepers and farmers highlight political ecological factors, including land tenure laws, agricultural policies, and corruption. Participatory land use planning is proposed as a solution to collectively generate ideas, reach consensus, and resolve conflicts. Despite land use planning initiatives, conflicts persist due to factors like land scarcity.

CHAPTER FIVE

Key Contributions, Conclusion and Recommendations

5.1 Key Contributions of the Study

Overall, this comprehensive nexus between dynamics in vegetation/tree cover and the implementation of the village land use plan found that the implementation of village land use planning has contributed to the increase in tree cover in areas in allocated for forest reserve but contributed to a significant decline in tree cover outside reserved forest, area allocated for grazing, agriculture, settlement, and socio-services.

By recognizing and accounting for the influence of the village land use plan on vegetation cover, conservationists can tailor more targeted and effective strategies to prepare and ensure effective implementation of the drafted land use plans in the villages with no land use plans. The research findings collectively imply that village land use planning can significantly affect vegetation cover and that remote sensing data can be useful for evaluating these consequences. Identifying locations where land use planning interventions have successfully supported sustainable land use practices and safeguarding the health of the local ecosystem, remote sensing data can give a quantitative assessment of vegetation cover dynamics across time.

5.2 Conclusion

The study found that the recommended land use, as advised by experts, was perceived to be executed at an average rate of only 47%. The poor perception was linked to the exclusion of communities during the formulation of the plans. Additionally, the study show that the implementation of village land use planning led to an increase in tree cover in areas designated as forest reserves. However, it also resulted in a significant decline in tree cover outside contributed to a significant decline in tree cover outside reserved forest, area allocated for grazing, agriculture, settlement, and socio-services. The decline in trees outside reserved forest is concerning due to their importance in the provision of products and services such as fuel wood, timber, medicine, and nutrition.

5.3 Recommendations

It is essential to develop strategies that encourage local communities to maintain trees in their landscapes. To achieve this, active involvement of local communities is recommended during both the pre and ongoing land use planning processes and land use suitability analysis to be carried out. Active participation of community members effectively ensures that land use plans align with local needs, fostering a sense of ownership and minimizing conflicts. Dealing with challenges arising from immigration and land use conflicts requires a comprehensive approach, involving collaboration with immigrant communities and incorporating their requirements into land use plans to prevent land use conflicts. It is crucial to establish a robust monitoring and evaluation system for the implementation of VLUPs, enabling the identification of challenges and successes for timely adjustments and improvements.

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