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EFFECTS OF TOBACCO FUELWOOD HARVESTING ON WOODY VEGETATION STRUCTURE AND SPECIES DIVERSITY IN MUGARADZIKO VILLAGE, RUSHINGA, ZIMBABWE.



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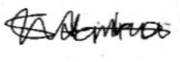
A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HOUNORS DEGREE IN NATURAL RESOURCES MANAGEMENT.

Date:05/2026

DECLARATION

I, SHALOM MUTSA MUTAMBIRWA, I confirm that this work is entirely my own and has not been submitted previously for any academic purpose at this institution or any other academic institution.

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DEDICATION

I dedicate this project to my mother, Letwin Mutambirwa, for her invaluable financial assistance and moral support throughout the entire process. I extend my heartfelt gratitude to my family, whose steadfast support and encouragement have served as the foundation of my academic journey. Their words of encouragement has fueled me to pursue this research and helped me in acquiring my goals. I greatly appreciate you for your patience, understanding and constant motivation throughout this challenging yet rewarding endeavor.

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This couldn’t have been done without the help, direction, and encouragement from many individuals, for whom I am sincerely grateful. I humbly give honor to the Almighty who grants us permission, guidance, and mercy throughout this journey physically and spiritually. Letwin Mutambirwa, my mother, for her unwavering support during the demanding phases of this academic pursuit.

I owe the greatest gratitude to Mr. A Kundhlande for academic guidance and his well heart to forgo his personal time to assist me during this write up. In every time he would support from the the project proposal to the final write-up.

Lastly, I would like to applaud for Bindura University of Science Education and its Faculty of Agriculture and Environmental Sciences for imparting knowledge and providing a conducive academic environment.

Above all, I take full responsibility to all errors that may emanate from this research despite all expect guidance from the academic trio.

ABSTRACT

Tobacco is a major cash crop in many poor countries and its production heavily relies on fuelwood for curing process. However, the impact of tobacco fuelwood harvesting on woody vegetation structure, species diversity and abundance is not well understood. In this study, I conducted a field survey to assess the effects of tobacco fuelwood harvesting on vegetation structure and species diversity the Mugaradziko area. Square Quadrats lots of 10m by 10 were sampled to collect data with 10 plots in protected and 10 plots in the unprotected area to make a total of 20 plots. A total of 690 woody trees were recorded with 479 wood trees in the protected area and 211 in the unprotected area. Four metal pegs, a 200 m ribbon was used to demarcate the area and a 50m tape measure was in the measurement of perimeter of the quadrat and a 10 m pole was used to measure tree height. Shannon-Weiner diversity index was used to calculate species richness in all plots with the protected area recording 4.7 and the unprotected recorded 2.3 on Shannon-Weiner diversity index. The results showed that tobacco fuelwood harvesting had a significant negative effects on woody vegetation structure as demonstrated by reduction in tree diameter and tree height in the unprotected area. Simpson's diversity index of tree species in the protected area was 0.98 while the unprotected recorded 0.71. The Jaccard Similarity index was also used to compare the similarities between the protected and unprotected areas of the Mugaradziko village, a 0.62% similarity was recorded between these two areas. Additionally, species diversity and abundance were significantly lower in the unprotected area compared to the protected area. The null hypothesis stated that there is no significant difference of tobacco fuelwood harvest on the woody tree density is rejected ($p<0.08$) at the 0.05 significant level. My findings suggest that tobacco fuelwood harvesting has a significant ecological implications and highlights the need for sustainable fuelwood management practices in the Mugaradziko area.

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LIST OF ABBREVIATIONS

DBH	Diameter at Breast Height
EMA	Environmental Management Agents
ZNA	Zimbabwe National Army
FAO	Food and Agriculture Organization
G&W	Georges and Williams
TIMB	Tobacco Industrial Marketing Board
FTLRP	Fast Track Land Reform Program
WFP	World Food Program

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Zimbabwe is a poor country that heavily depends on agriculture for livelihood and income generation with tobacco being a crucial crop. However, the use of forest products, particularly for tobacco curing, has led to deforestation and environmental degradation. Tobacco (*Nicotiana tabacum)* production provides with employment and foreign currency, improving the lives of the farmers and the nation at large. Miombo occur on nutrient poor soils, and the woodlands are of importance for carbon sequestration, climate regulation, erosion control, and sustaining the rural livelihoods (Campbell *et al*., 1996, Kalaba *et al.,* 2013). Anthropogenic activities such as land clearing for agriculture and timber harvesting have resulted in significant changes to the structure and composition of woodlands. In response to disturbances woody species abundance, diversity and richness have been shown to decline (Muposhi *et al.,* 2016). The shift from coal to wood fuel since the (FTLRP) of 2000 has further contributed to deforestation, as coal became too expensive for the farmers.

Forest conversion into agricultural land and use of forest products, in particular fuelwood for the construction of tobacco barns and curing, has resulted in the destruction of the already depleted forest. The growth of smallholder tobacco production was impressive since 2009 behind the façade, lies the cost to the environment (McDonald, 2015). An estimated 2000 hectares of woodlands are cut down each year because of tobacco fuelwood (Abdallah, 2007). Wood fuel is 62% approximately used to cure Virginia tobacco in Zimbabwe. Due to the outcome, stock of wood fall from its origin of 845 million to 657 million cubic meters since 1990 to 2011. Since the Fast Track Land Reform Program (FTLRP) (2000) there has been shift from coal to wood fuel. The price of coal had become prohibitive to new farmers, who cannot afford to buy sufficient volumes to cure large quantities of tobacco and so they resorted to cheap sources of energy, notably wood. Tobacco farming appears to have a detrimental effect on the survival and long term viability of honeybees in the natural forest. This

Could also have negative implications for the local communities who rely on beekeeping as a source of livelihood (Mujuni *et al.,* 2012).

Hurungwe district in the northern part of Zimbabwe, communal farmers depend on firewood in curing their tobacco crop. Since 2006, about nine out of ten communal farmers were involved in tobacco farming (Shumba *et al.,* 2006). Consequently, about 180 000 trees are cut per year in Zimbabwe (Majuru *et al.,* 2019). The government of Zimbabwe in cooperation with the local tobacco companies are calling for zero tolerance to deforestation and have launched campaigns against environmental degradation resulting from tobacco fuelwood harvest. Since the 2000 era, the number of small-scale farmers has risen significantly with around 90 000 farmers (TIMB, 2014). The vast majority of these farmers (about 90%) cultivate flue-cured tobacco and rely on wood harvested from woodlands from as a source of energy (Sacchetto, 2012). Unfortunately, tobacco production has been the primary driver of deforestation and up to 10 times more aggressive than other factors of deforestation (Sacchetto, 2012). Mugaradziko area has also endured these effects as many people now grow tobacco for their living resulting in loss of vegetation structure and species diversity in the area

To combat these effects of deforestation, Tobacco companies have engaged in providing with Eucalyptus seeds to farmers for firewood in tobacco curing in the future (Masvongo *et al.,* 2013*).* Although there the need and emphasis on viable *eucalyptus* woodlots, shortage of fencing materials to protect planted trees, and limited extension services to educate farmers on afforestation.

Rushinga from 2001 to 2021 has lost 906ha of tree cover, equivalent to a 13 decrease in tree cover since 2000, and 212kt of Carbon dioxide emissions (Madamombe *et al.,* 2019). In 2010, Rushinga had around 5.60kha tree cover, extending about 2.4% of the land area. In 2021, 58.5ha tree cover was lost. Small-scale tobacco farmers continue harvesting fuelwood in the natural indigenous woodlands for tobacco curing process and barn construction. The number of farmers is increasing every year putting more pressure on the already depleted forest. So much research have been done in some other areas leaving the Mugaradziko area in Rushinga unattended therefore a comparative analysis has to be conducted for the area before it is too late.

1.2 PROBLEM STATEMENT

The practice of harvesting of large, durable timber trees to use as fuel for drying tobacco has a detrimental impact on the health of miombo woodlands, however, despite the recent rice in the number of tobacco growers in rural areas of Zimbabwe who rely on fuel wood, only a few studies have quantified the extent of these impacts. EMA and other forest departments have tried their best to protect woodlands but to no avail. Therefore, the need to examine the nature of disturbances, associated with severe loss of woody vegetation structure and species diversity.

1.3 JUSTIFICATION

The natural forest in the Mugaradziko village is one of a beautiful and important source for controlling erosion and providing economic and social benefits. However, people have been indiscriminately destroying the forest through the use of tobacco fuelwood, and if no action is taken, the future generation may not even know what natural forest looks like or have access to its resources in the Mugaradziko village. The researcher has therefore conducted a study to find solutions to the problems of deforestation caused by tobacco fuelwood use and to raise awareness among leaders and the public about responsibility to protect the forest. The study's findings will be of great significance to the people of Mugaradziko area, as it will shed light on how to preserve the forest woodlands and clearly demonstrating the effects of tobacco fuelwood harvesting on the diversity of woody plant species and the structure of the forest.

1.4 AIM

To assess the effects of tobacco fuelwood harvesting on woody vegetation structure and species diversity in the Mugaradziko village.

1.5 OBJECTIVES

1. To determine the effects of tobacco fuelwood harvesting on vegetation structure.

2. To examine the impacts of tobacco fuelwood harvesting on vegetation species diversity.

1.6 HYPOTHESES

1. H0 there is a significant effects of tobacco fuelwood harvesting on vegetation structure.

   H1 there is no significant effects of tobacco fuelwood harvesting on vegetation structure.

2. H0 there is a significant impact of tobacco fuelwood harvesting on vegetation species diversity.

   H1 there is no significant impact of tobacco fuelwood harvesting on vegetation species diversity.

CHAPTER 2: LITERATURE REVIEW

2.1 DEFINITION OF TERMS

The United Nations Food and Agriculture defines a forest as an area of land that spans more than 5 hectares with trees higher than 5 meters and a canopy cover of more than 10%.

The Food and Agriculture Organization (FAO, 2009) defines a forest as a complex system of plants, animals, and microorganism that interact with their abiotic environment, where trees are key components of the system.

Deforestation refers to conversion of forest to another land use or the long-term reduction of the tree canopy cover is reduced below the minimum threshold of 10%. This implies to areas where trees have been removed as a result of harvesting or logging, are not considered deforestation (FAO, 2001).

Vegetation structure refers to the physical arrangement of plants and their components, including their size, shape, height, density, and spatial distribution. It is an important aspect of ecological systems, as it influences the distribution of species, nutrient and water cycling, and ecosystem functioning. Vegetation structure varies greatly depending on the type of ecosystem and plant species present (Turner *et al.,* 2001).

Species diversity refers to a variety of species that are found in a particular ecosystem or in a geographical area. It includes the number of different species present which is species richness and the relative abundance of each species that is species evenness. It is an important component of biodiversity, as it provides a measure of the ecological complexity and stability of an ecosystem (Forman *et al.,* 1987).

2.2 EFFECTS OF TOBACCO FUELWOOD HARVEST

Tobacco (*Nicotiana tabacum*) is an herbaceous plant is from South America and it has been grown in Zimbabwe for about 100 years (TIMB, 2010). Tobacco fuelwood harvesting has significant negative effects on the environment, tobacco farming contributes significantly to deforestation in many countries. For instance, in Malawi, tobacco production accounts for up to

70% of national deforestation (WHO, 2007). In Zimbabwe, poverty-related causes such as fuelwood collection for tobacco curing are the main reasons for deforestation, and the deforestation rate is currently hovering around 1.9% (World Bank, 2015). There is also loss of biodiversity, tobacco farming is a particular threat to biodiversity worldwide. The use of wood resources for tobacco curing has a severe negative impact on forest biodiversity, affecting genetic, species, and ecological diversity. The Miombo ecosystem in central-southern Africa is a global hotspot for tobacco-related deforestation, and tobacco-related deforestation represents up to half of the total annual loss of forests and woodlands in the ecosystem (Geist, 2005).

Tobacco farming has been found to cause soil erosion, as the crop is often grown as a single leaving the leaving the topsoil vulnerable to wind and water damage (FAO, 2006). This has led to desertification in several countries, including Jordan, India, Cuba, Brazil, and various countries in the Miombo zone (WHO, 2006). Additionally, the use of wood resources for tobacco curing contributes to climate change by releasing greenhouse gases. The loss of forested land due to human activity, including tobacco farming, has resulted in the loss of approximately 1.5 billion hectares of mainly tropical forest worldwide since the 1970s. This loss of forested land has contributed to the increase of up to 20% of annual greenhouse gas emissions (WFP, 2001). Overall, tobacco fuelwood harvest has severe negative effects on the environment, including deforestation, loss of biodiversity, soil erosion, desertification, and climate change. These effects not only harm the environment but also have a significant impact on the livelihoods of people who depend on the affected ecosystems. Thus, it is crucial to promote sustainable practices that minimize the negative effects of tobacco farming on the environment.

Fuelwood harvest for flue-cured tobacco result in forest woodland clearance. In Zimbabwe an estimated of 300,000 hectares of woodland forests are destroyed annually mostly by small-scale tobacco farmers (FAO, 2010). Tobacco production poses a threat to environment's sustainability due to its significant impact on the availability wood resources and the disruption of natural wood regeneration. The sustainability of tobacco production is in danger due to decreasing supply of wood to meet growing household demand for fuel, building materials, and tobacco curing (Bunderson and Hayes, 1998). As a result, the use of agrochemicals in tobacco production

has increased, (Gels *et al*., 2002). These chemicals has been proven to reduce honeybees' survival and occurrence, even if used correctly (Balasha *et al*., 2019).

Continuous exposure of honeybees to agrochemicals can result in toxicity and increased mortality rates within honeybee colonies. Herbicides, which are frequently utilized to eliminate weeds, may also adversely affect plants that are essential to honeybees for pollen and nectar (Porrini et al., 1996). The significant rise in production has been associated with deforestation and the depletion of soil nutrients, which greatly influences the ecology of the miombo woodlands. Tobacco is typically cultivated without crop rotation, rendering both the tobacco plants and the soil susceptible to various pests and diseases (WHO 2007). The practice of tobacco farming is linked to harmful consequences for the environment and the health of workers, including exposure to pesticides and green tobacco sickness. Additionally, the clearing of woodlands leaves the soil exposed to erosion agents (Pearce and Moran, 1994). To mitigate the impact of tobacco fuelwood harvesting on wood resources, the use of coal is suggested for short to medium-term applications. Alternatively, it is essential to train farmers in sustainable tobacco production, ensuring a balance between daily survival needs and the rate of forest replenishment.

The harvesting of fuelwood for tobacco farming can also have social impacts, particularly for women and children who are often responsible for collecting the wood. This can lead to increased workloads, time poverty, and reduced access to education and other opportunities. Fuelwood harvesting can have negative impacts on gender equality and social development (Mishra *et al*., 2018).The removal of trees for fuelwood can also result in the loss of wildlife habitat. This can have negative impacts on biodiversity and ecosystem functioning. Fuelwood harvesting for tobacco farming in Zimbabwe resulted in significant loss of forest cover and was associated with declines in bird species richness (Dirks *et al*., 2003).The burning of fuelwood for tobacco curing can also contribute to climate change by releasing carbon dioxide and other greenhouse gases into the atmosphere. Deforestation and forest degradation from fuelwood harvesting and other activities account for approximately 10% of global greenhouse gas emissions (FAO, 2020).

2.3 EFFECTS OF TOBACCO FUELWOOD HARVEST ON WOODY VEGETATION STRUCTURE, SPECIES DIVERSITY AND ABUNDANCE.

The effects of tobacco fuelwood harvest on vegetation structure and species diversity have been studied in various parts of the world. Tobacco farming and fuelwood collection cause habitat fragmentation, which leads to changes in vegetation structure and species diversity (Nyemba *et al.,* 2010). In Argentina, Brazil, and Tanzania, tobacco-driven habitat fragmentation has been associated with the loss of biodiversity (Magurran, 1988). Tobacco farming and fuelwood collection have been found to reduce species diversity. In Tanzania, for example, tobacco curing has been the leading cause for rural communities consuming wood and causing deforestation, which has led to the loss of species diversity (FAO, 2012). Malawi has one of largest shares of agricultural land dedicated to tobacco production in the world. However, this growth has come at a cost-in as in 2008, it was estimated up to 70% of national deforestation was caused by farming activities, primarily for tobacco production. This has resulted in a significant impacts on the diversity of species in the area (WHO, 2007).

The removal of trees for fuelwood can also lead to soil degradation, which can affect the ability of the land to support vegetation. The harvesting of fuelwood for tobacco farming in Zimbabwe was associated with soil erosion and decreased soil fertility, which can have negative impacts on crop productivity and ecosystem functioning (Moyo *et al*., 2015).The removal of trees for fuelwood can also have impacts on non-timber forest products, such as fruits, nuts, and medicinal plants. A study published in the journal Forest Ecology and Management found that fuelwood harvesting for tobacco curing in Zimbabwe was associated with declines in the availability and quality of non-timber forest products, which can have negative impacts on local communities that rely on these resources (Makoni *et al*., 2018).

Tobacco fuelwood harvesting can lead to a reduction in woody vegetation structure, including tree density, canopy cover, and basal area. Fuelwood harvesting for tobacco curing in Zimbabwe resulted in a significant reduction in tree density, canopy cover, and basal area, with the greatest impact observed in areas closest to tobacco curing barns (Kamanga *et al*., 2012). The removal of trees for fuelwood can also lead to a loss of species diversity, particularly for species that are

dependent on forest habitats. A study published in the journal Environmental Monitoring and Assessment found that fuelwood harvesting for tobacco curing in Zimbabwe resulted in a decline in species richness and diversity for woody plant species (Makoni & Moyo, 2015).

Tobacco farming and fuelwood collection also result in changes in vegetation structure. In southern Brazil, tobacco farming has substantially contributed to the reduction of native forest cover to less than 2% of its original extent, resulting in significant changes in vegetation structure (FAO, 2012).There loss of Endangered Species as a consequence of tobacco fuelwood harvest. In Zimbabwe, for instance, biodiversity abundance is lost due to habitat destruction from the expansion of agricultural lands, timber logging, and fuelwood harvesting for tobacco curing, leading to the loss of endangered species (Nyemba *et al.,* 2010).

Tobacco curing, the process of drying tobacco leaves after they are harvested, can have significant impacts on vegetation species diversity. Tobacco curing can result in a reduction in vegetation cover in the areas where it is practiced. This is due to the clearing of land for tobacco cultivation, as well as the use of fire-curing methods, which can damage or destroy surrounding vegetation. A study conducted in Zimbabwe found that tobacco farmers used fire-curing methods that resulted in the destruction of natural vegetation cover, with negative impacts on soil fertility and water infiltration (Mashingaidze *et al.,* 2013).

The use of fire-curing methods in tobacco production can also result in soil degradation. The removal of vegetation cover exposes the soil to erosion, and the repeated burning of the same area can lead to soil compaction and nutrient depletion. A study conducted in Malawi found that tobacco farmers who used fire-curing methods had significantly lower soil organic matter content and higher soil acidity than farmers who used other curing methods (Kanyama-Phiri *et al*., 2014).Tobacco cultivation and curing can also result in changes in the composition of plant species in the surrounding area. A study conducted in China found that tobacco cultivation led to decline in the abundance and diversity of native plant species in the surrounding area, with a corresponding increase in the abundance of invasive plant species (Li *et al*., 2018). Tobacco farming and curing can also have negative impacts on pollinators, which are essential for maintaining plant species diversity. A study conducted in India found that tobacco cultivation

resulted in a decline in the abundance and diversity of pollinator species, including bees and butterflies, due to the use of pesticides and destruction of natural vegetation cover (Singh *et al*., 2016).

Tobacco cultivation and curing can also have negative impacts on water resources, which are critical for maintaining plant species diversity. A study conducted in Zimbabwe found that tobacco farmers who used fire-curing methods had significantly higher levels of soil erosion and reduced water infiltration rates compared to farmers who used other curing methods (Mashingaidze *et al*., 2013). In addition to affecting species diversity, tobacco fuelwood harvesting can also lead to changes in species abundance. A study published in the journal Forest Ecology and Management found that fuelwood harvesting for tobacco curing in Zimbabwe was associated with changes in the relative abundance of different tree species, with some species becoming more dominant and others declining in abundance (Kamanga *et al*., 2012).The removal of trees for fuelwood can alter the structure of forests, particularly in terms of tree size and age distribution. Fuelwood harvesting for tobacco curing in Zambia resulted in a reduction in large, old trees and an increase in small, young trees, which can have long-term implications for forest regeneration and carbon storage (Rutten *et al*., 2017). The removal of trees for fuelwood can also lead to changes in forest composition, with some species becoming more dominant and others declining in abundance. Fuelwood harvesting for tobacco curing in Zambia was associated with changes in the relative abundance of different tree species, with some species becoming more common and others declining in abundance (Rutten *et al*., 2017).

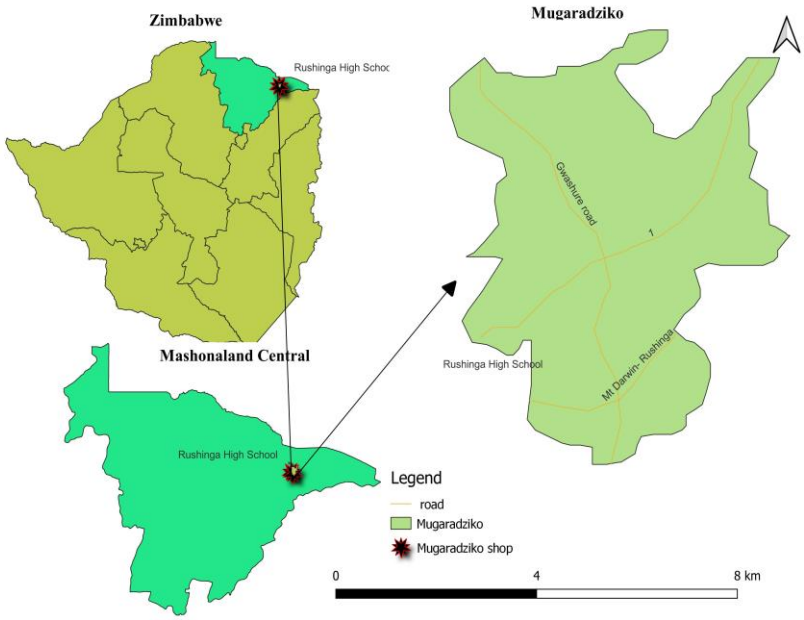
Tobacco curing can have significant impacts on vegetation species diversity, including reductions in vegetation cover, soil degradation, changes in plant species composition, impacts on pollinators, and impacts on water resources. It is important for tobacco farmers and policymakers to consider these impacts when making decisions about tobacco cultivation and curing methods.

CHAPTER 3 METHODOLOGY

3:1 DESCRIPTION OF THE STUDY AREA

3:1.1 LOCATION

Study area, Mugaradziko area is located in Rushinga District Mashonaland Central, Zimbabwe. It is 4km from Rushinga Growth point on the north east. Located at an elevation of 733.69 meters above sea level, it has a humid subtropical, dry winter climate. The area's yearly temperature is 24.16oC and it is 1.43% higher than Zimbabwe's averages. Mugaradziko typically



receives 123.9 millimeters of precipitation and has 133.3 rainy days annually.

Fig 3.1 Shows the location of Mugaradziko area**.**

The predominant soil types in Mugaradziko area are deep, well drained soils that are rich in iron and aluminum oxides. They are reddish-brown color suitable for crops such as tobacco, cotton, groundnuts and maize for example ferric acrisols and chromic acrisols. Mugaradziko area is

typically miombo woodland which is mainly dominated by *Brachystegia spicifomis*, *Julbernardia globiflora, Isoberlinia doka,* and *Terminalia sericea*. The area is also dominated by *Themeda triandra* and *Hyparrhenia tuandra* grass species. There are also animal species which are found in the area mainly P species.

The area has Quarry Mining by the G&W dolomite company. It is dominated by white stones that are extracted both on the surface and beneath. These stones are used for lime and gypsum production. The G&W is the biggest industry in the area which is along Mount Darwin and Chimhanda road. The area is characterized by a Humid subtropical, dry winter climate receiving an annual precipitation of 123.9mm which is received from November to March and has 133.03 rainy days which is 36.45% of the time annually. It has an average maximum temperature of 24.16C.

Other activities that are found are Religious shrines such as Masowe eNguwo tsvuku, Johanne Marange, Masowe echushanu, Rainmaking rituals (Dendemaro) and also agriculture as the source of food and income for the locals.

3.2 RESEARCH DESIGN METHODS

A forest survey was carried out to gather data on the woody vegetation species. The survey involves laying out of transects of the map and plots on the ground of the forest area. Simple random sampling method was used to collect data on the two areas, the protected area where there is ZNA barracks which is intact and the unprotected area where tobacco fuelwood harvesting is being practiced.

The areas were divided into plots with 10 plots, blocks at Mugaradziko unprotected area and 10 plots at the protected are in total of 20 plots. Plots were divided into square sample of 10m by 10m for stock data collection in the area. Tools used for the survey were four metal pegs, a 200m ribbon was used to demarcate the area and a 50m tape measure was used in the measurement of perimeter of the quadrat. These tool were used to measure all the plots (Zisadza-Gandiwa *et al.*, 2013).

All the woody species that are affected by tobacco fuelwood harvest were recorded in the woody strata and their sampling was recorded by their scientific names with their distribution per hectare. Plant status which include canopy diameter, stem height was measured and recorded. Species richness was recorded and a 10 metre pole was used to measure the height of tree species

3.3 METHODS OF DATA ANALYSIS

The collected data was summarized and analyzed for normality using the Jaccard Index to examine species diversity similarities, Shannon-Weiner diversity index was used to determine species richness in different plots (Ludwig *et al*., 1998).To measure species evenness across the areas Simpson D index was used. T-test was used to test the different in species height, a Diameter at Breast Height (cm) was measured at 1.3m while the young trees shorter than the breast height, diameter was measured at 0.1mand 0.3m (Kalema, 2010), canopy diameter and species abundance in the area (Gandiwa, 2011). Excel was used for the construction of graphs.

Observations and photographic pictures of the unprotected area being exploited for tobacco fuelwood and the protected area were captured during the survey.

CHAPTER 4 RESULTS

4.1 SPECIES DIVERSITY

Brachystegia spicifomis, Julbernardia globiflora, Brachystegia boehmii, Burkea africana, Pterocarus angolensis and *Diplorhynohus condylocarpon were* the most abundant species in all sampling sites and affected woody species in unprotected area but with more evidence of being deforested whereas in the protected area these species are more abundant. The calculated density of woody vegetation richness in the Mugaradziko unprotected area was 3.2m\100m^2 whereas the protected recorded 9.07/100m^2. Table 4.1 below illustrate the woody species identified during the survey and species density.

Table 4.1 Shows woody vegetation identified during the study per 100m^2

Species name	Unprotected area	Protected area
Brachystegia spiciformis	0.2	8.2
Julbernardia globiflora	0.3	2.1
Lantana camara	15.9	26.8
Ficus burkei	0	0.2
Bauhinia thonningii	1.1	1.8
Azanza garckeana	0.5	0.3
Khaya nyasica	0.3	1.2
Bauhinia petersiana	2.7	8.1
Gardenia volkensii	0	0.6
Ziziphus mucrotana	0.3	5.9
Terminalia sericea	0.4	0.1
Acacia polyacantha	1.5	0.5
Flacourtica indica	0	1.2
Piliostigma thinningii	0	0.8
Brachystegia boehmii	0.1	2.7

Ficus sycomorus	0.3	1.7
Uapaca kirkiana	0	1.3
Pterocarpus angolensis	0.6	1.1
Isoberlinia doka	0.2	0,7
Combretum molle	0.1	0.1
Afzelia quannzensis	0	2.1
Diplorhynohus condylocarpon	7.4	18.2
Mangifera indica	0.3	0
Albizia harveyi	0	1.4
Psidium guajava	0.2	0

4.2 EFFECTS OF FUELWOODWOOD HARVESTING ON SPECIES DIVERSITY AND SIMILALITY

There was a significant different in species diversity and richness that was noted across the two areas, Simpson's diversity index on woody vegetation species of the unprotected area to be 0.71 and 0.98 on the protected area. On Shannon H Diversity index the highest diversity was recorded on the protected area with 4.7 and the unprotected recorded 2.3.The Jaccard index was also used to compare the similarities in species between these two areas, a 0.62% similarity was recorded between these two areas. The null hypothesis stated that there is no significant difference of tobacco fuelwood harvest on tree density is rejected ($P<0.08$) at the 0.05 significant level, indicating that tobacco fuelwood harvest for tobacco curing significantly affect the tree densities

Table 4.2 Shows species diversity and similarity of the two areas

AREA	SHANNON H	SIMPSON D	JACCARD
UNPROTECTED	2.33	0.71	0.32
PROTECTED	4.78	0.98	0.94

4.3 VEGETATION STRUCTURE

Protected area DBH class of 30-35cm had the highest trees with a maximum of 70 woody trees plants in the area followed by 40-45cm DBH class with 68 trees. The lowest was on DBH class

of 1-5cm and 45-50cm. The unprotected had highest number of trees on DBH class of 1-5cm from with a maximum of 45 woody plants species in the area, followed by DBH class of 5-10cm and the lowest was DBH class of 35-40cm with only 3 woody trees followed by 25-30cm with only 5 woody trees in the area.

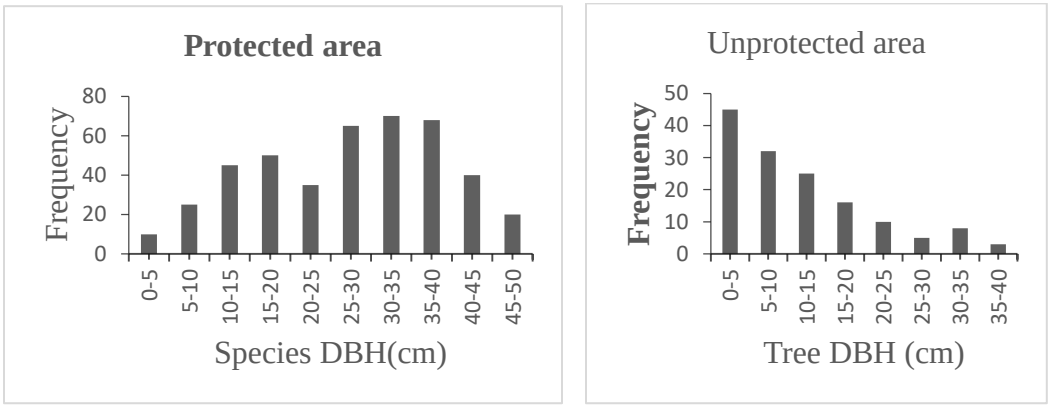


Fig 4.1 Shows DBH classes and frequencies in protected and unprotected areas

4.4 EFFECTS OF WOOD HARVESTING ON TREE HEIGHT IN PROTECTED AND UNPROTECTED AREAS

The protected area had abundant vegetation with tall height, the height class of 4-5m had the highest number of trees 68, followed by height class of 5-6m with 63 trees. The lowest tree height was on class of 8-9m. The unprotected area had few tall woody vegetation with class of 6-7m recording the lowest number of only 2.The unprotected area had more short woody vegetation with highest height class of 1-2m with 60 tree species

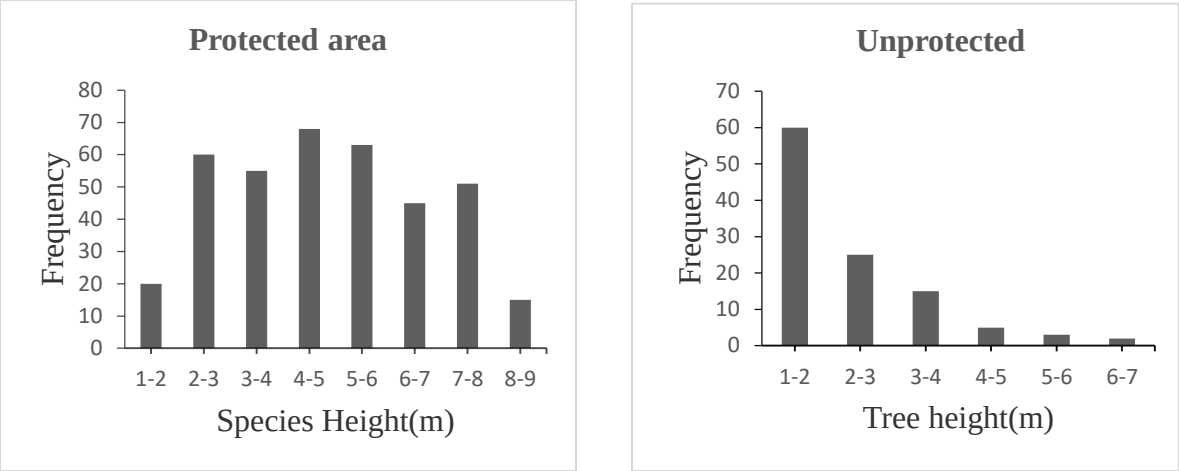


Fig 4.2 Showing height and frequencies in protected and unprotected areas

Table 4.3 Shows mean and standard errors of species dbh, species height, canopy diameter, and across two areas.

VARIABLE	UNPROTECTED AREA	PROTECTED AREA
NUMBER OF SECIES	3.27±1.63	11.14±4.07
HEGHT	0.93±0.32	6.48±0.78
CANOY DIAMETER	3.17±0.42	7.53±1.2
DBH	12.15±0.81	33.52±0.89

Diplorhynohus condlycarpon had a high density across the two areas with high matured vegetation on the protected area and extensively deforested in the unprotected area. *Lantana camara* had the highest density on the unprotected area and low on the protected area. *Brachystegia spiciformis* had high density on the protected area and much matured, unprotected area showed massive deforestation on *Brachystegia spiciformis* and *Julbernardia globiflora*. *Ziziphus mucrotana* had medium density on both areas Table 4.4below illustrate the densities of the dominant woody vegetation species across observed areas.

Table 4.4 Shows density of dominant woody vegetation across all areas per $100m^2$

Species	Protected	Unprotected
Brachystegia spiciformis	8.2	0.2
Ziziphus mucrotana	5.9	0.6
Diplorhynchus condlycarpon	18.2	7.4
Lantana camara	26.8	15.9
Acacia polyacantha	0.5	1.5
Bauhinia ptersiana	8.1	2.7
Julbernardia globiflora	2.1	0.3
Bauhinia thinningii	1.8	1.1

Table 4.5 Shows the number of species, species height, canopy diameter, dbh mean and standard errors of dominant species across two areas

VARIABLE	PROTECTED AREA	UNPROTECTED AREA
NUMBER OF SPECIES	4,2±1.05	1.02±0.56
HEIGHT	5.8±0.95	2.6±0.70
CANOPY DIAMETER	7.8±1.1	3.4±0.98
DBH	18.3±4.3	2.47±1.79

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The dominant woody tree species which were found in both areas, *Lantana camara* had the lowest height. *Diplorhynohus condylocarpon* was the most dominant in both areas .*Brachystegia spiciformis* had highest height recorded and the canopy diameter was also high in *Brachystegia spiciformis* and *Julbernardia globiflora*. Therefore on the structural analysis *Brachystegia spiciformis* and *Bauhinia ptersiana* had the highest value in every analysis .Null hypothesis states that there is no significance difference in tobacco fuelwood harvest on woody vegetation structure and density is rejected ($p \leq 0.08$) at the 0.05 significance level, proving that tobacco fuelwood harvest massively affect the woody vegetation structure and species abundance

4.6 SPECIES EVENNESS AND RELATIVE ABUNDANCE

The species evenness indicated the degree that the unprotected area recorded lower value of 3.2/100m^2 and the protected area recorded higher value of 9.07/100m^2, hence there was no evenness in woody vegetation composition. The most dominant woody species in the two areas of Mugaradziko was *Lantana camara* which is an invasive species that is dominating the most part of the unprotected area of Mugaradziko village where there is no control of tobacco fuelwood harvesting in the area. There was *Brachystegia spiciformis* which is one of the most valuable woody tree for the construction of tobacco barns and fuelwood for drying up tobacco leaves. It was dominant in the protected area though in the unprotected area there were very few (Fig 4.3).

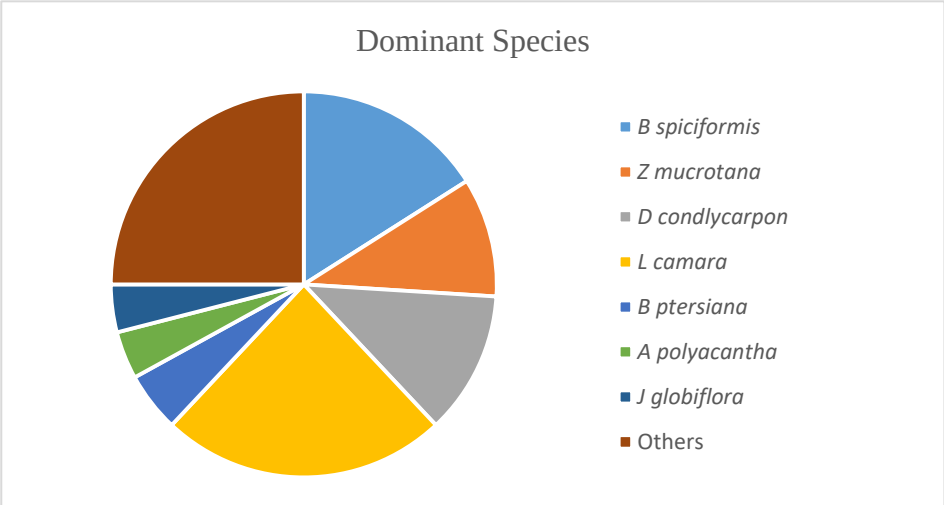


Fig 4.3 Shows species abundance in protected and unprotected

CHATER 5 DISCUSSIONS

5.1 VEGETATION STRUCTURE

The study found out a significant different in the woody vegetation structure of the protected area and unprotected areas of the Mugaradziko village. The woody vegetation height was high in the protected area where there is no cutting down of trees and height was very low in the unprotected area .This could be as a result of the cutting down of matured trees for tobacco curing process and also construction of tobacco barns which requires matured and strong woody trees for construction. Tree species such as *Brachystegia spiciformis* and *Julbernardia gobiflora* were the most harvested woody trees in the unprotected area due to their strong woody and good for tobacco curing. The Miombo woodlands are characterized by deciduous trees belonging to the genera Brachystegia, Julbernardia, and Isoberlinia, which are part of the legume family Fabaceae (White, 1986). These woodlands are influenced by three interacting factors: human activity, fire, and herbivory (Frost, 1996).Therefore in the Mugaradziko area there is no sign or evidence of fire and there is no herbivory such as elephants that can determine the shape and structure of the woody vegetation. Woody vegetation height can be influenced by ecological factors such as topography and moisture variations in the area like *Brachystegia boehmii* thrives in areas with high soil moisture content and is dominant in undisturbed woodlands (Chidumayo, 1997). In addition, while disturbances have altered woody species assemblages, the herbaceous layer was not affected in the unprotected area confirming that harvesting of woody products like poles and fuel woody is the major form of disturbance in the Mugaradziko area (Campbell *et al*., 1996).

The Mugaradziko village used to have large diameter trees that were ideal for building barns and tobacco curing, but they were harvested from the woodlands. The findings of the study indicate that mature trees were more common in the area, species richness and abundance was greater in the protected area where there are no disturbances indicating the overharvesting of large trees in

the unprotected area .The study also found that there was low recruitment of smaller sized trees into mature trees, which could limit the availability of adequate fuelwood for tobacco curing in the future (Muvengwi *et al.,* 2020). The unprotected area of Mugaradziko was also occupied with more grass cover compared to the protected area confirming that there is less dense vegetation that can hinder grass growth such as *Themeda triandra* and *Hyparrhenia filipendula*

Canopy diameter in some species in the unprotected area was very low and high in the protected area. The protected area is undisturbed hence matured trees with wide branches while the unprotected area has been disturbed resulting in *Lantana camara* invading the area and *Khaya nyasica* recording high canopy diameter due to not suitable for tobacco curing and barn construction .

5.2: WOODY VEGETATION DENSITY

The harvesting of woody trees has led to significant deforestation in the Mugaradziko region of Rushinga. This has caused a decline in biodiversity and the degradation of essential forest services. Numerous individuals in the area depend on the natural forest for their livelihoods and to alleviate poverty (Campbell et al 1996). Miombo woodlands are essential for over 100 million people, providing daily necessities such as construction materials, fuelwood, animal feed, medicinal resources, and food sources like insects and honey (Campbell et al 1996) and (Sileshi et al., 2007).

The unprotected area is sparse and has the lowest total basal area and density per $100m^2$ which recorded $3.2/100m^2$ compared to the protected area which recorded density of $9.07/100m^2$. Most of valuable woody trees in the Mugaradziko area were found closer to ritual sites like Rainmaking ceremony areas. Closer to these areas people are afraid to cut down these trees as it is stipulated that they will face harsh consequences from big snakes or bees bites and the spiritual medium or (Vadzimu). The availability of trees like *Julbernardia globiflora*, *Brachystegia spiciformis* and *Brachystegia boehmii* indicate that these trees area harvested in the areas that are not close to ritual site.

The result of the study had it that the invasive species *Lantana camara* is the most dominating species in the unprotected area of Mugaradziko followed by *Acacia polyacantha.* The species

diversity (Shannon-Weiner: H) of matured trees was greater in the undisturbed woodland than in the unprotected area ($p<0.05$). *Bauhinia ptersiana* recorded high canopy diameter in the unprotected area due to its poor woody which cannot be used for either barn construction or tobacco curing process

The Simpson's diversity index confirmed that the protected area has high tree diversity with 0.98 while the unprotected area recorded low woody diversity with 0.71. Woody species such as *Diplorhynchus condlycarpon* and *Bauhinia ptersiana* were even dense near religious sites like Masowe .It is believed that they use leaves of the *Diplorhynchus condlycarpon for* prayers and *Bauhinia ptersiana* for shade as they pray in the forest where they call (Kurenje) and people respect these areas hence do not cut trees on those sites. In addition *Brachystegia boehmii* favors areas with high soil moisture hence were dominant in the undisturbed woodland suggesting that *Brachystegia boehmii* have been preferably harvested in the unprotected area (Chidumayo, 1997) and (Muvengwi *et al.*, 2020). There were also some tree species which were recorded only in the protected area such as *Ficus burkei* and *Uapaca kirkiana* suggesting that they may have been overharvested and extinct in the unprotected area of Mugaradziko. Also some tree species were not found in the protected area such as *Psidium guajava* and *Mangifera indica* which are human planted tree species in the area. Julbernardia globiflora have significant coppicing abilities that enable regeneration despite any disturbance in the environment (Chinuwo *et al.*, 2010). Mature, large-diameter trees that are appropriate for barn construction and tobacco curing were extracted from the woodlands located in the unprotected region (Luoga et al., 2002) and (Vermeulen, 1996). Consequently, this study found that mature trees were prevalent and plentiful in the protected area, while their numbers were significantly reduced in the disturbed or unprotected area, highlighting the overharvesting of large trees within the Mugaradziko protected area (Gotore et al., 2020).

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Jaccard Similarity percentage was low on the unprotected area in species 0.32 and this might be as a result of that many other species were harvested and extinct in the area while in the protected area the Jaccard Similarity percentage was high 0.94 indicating undisturbed and species richness compared to the unprotected area hence a significant difference in species richness and diversity.

5.3 FIELD OBSERVATIONS

Observations and recordings which were captured during the survey are as follows. Woody harvest for tobacco curing was practiced in the area of Mugaradziko which is unprotected. Dry harvested woody trees were found in the area. The harvested woody trees in the unprotected area are dying and no sign of reshooting or survival hence proving that these trees will extinct in the area if strict actions are not taken efficiently. There is evidence of woody sliced pieces ready for barn use due to their size in the area, which may have been left during transportation by the farmers in the area.

The protected area had a dense vegetation and matured wood trees with less grass cover under the trees while on the harvested area is now dominated by bush woody trees and grass cover. There was enough evidence in the unprotected area on Mugaradziko village with wood stumps as shown in **fig 4.4** and also wood pieces in **fig 4.5**

CHAPTER 6 CONCLUSIONS AND RECOMMNDATIONS

6.1 CONCLUSIONS

Extensive fuelwood harvest for tobacco curing process and barn construction has resulted into loss of woody vegetation species leading to loss of biodiversity, watersheds as vegetation richness and density decrease in the unprotected. The disturbance which happens every rain season has become uncontrollable and rampant resulting in the extinction of valuable woody trees species, thereby reducing the diversity of species in the unprotected area of Mugaradziko. Based on the results of the study, tobacco fuelwood harvest have a significant harm or effects on the wood tree diversity and abundance.

6.2 RECOMMENDATIONS

Therefore, to improve vegetation structure and species diversity of the Mugaradziko area, to minimize the negative effects of tobacco fuelwood harvest and improve a sustainable utilization of the forest resources so as to retain and save for the coming future generation and even the present to keep enjoying the benefits of the Mugaradziko forest. The following points are recommendations

- Policies and law enforcement must be implemented effectively by the Environmental Management Agency on the harvesting of natural forest working together with Forestry Commission and ZRP.
- Involvement of local leaders in the construction of laws such as chiefs and village heads as they are the close people that can carry out day to day investigation of tree harvesting in their communities.

- EMA 20; 27 of 2007, SI 7 should be implemented with heavy fines to those found cutting tree for tobacco fuelwood.
- Provision of coal as an alternative energy and affordable.
- Farmers of tobacco should have licenses from an Environmental Management plan (EMP) with a Forest Restoration Plan.
- Tobacco Companies must provide with tree seedlings for revegetation to their farmers and these trees must be of use for tobacco curing process such as Eucalyptus trees/ gumtrees.

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APPENDIX

PLATE 1 PICTURES OF DRY HARVESTED WOOD PIECES IN UNPROTECTED AREA.



Fig 4.4 showing dry harvested pieces of *Brachystegia spiciformis.*



Fig 4.5 showing dry harvested wood stump