COLLEGE OF NATURAL AND COMPUTITIONAL SCIENCES

DEPARTEMENT OF BIOLOGY

FLORSTIC COMPOSITION, VEGETATION STRUCTURE AND MANAGEMENT PRACTICES IN ZARA NATURAL FOREST IN GETA WOREDA DISTRICT, GURAGE ZONE, CENTRAL ETHIOPIA REGION STATE, ETHIOPA.

BY: JILALU HASSEN

JANUARY, 2025

WOLKITE,ETHIOPIA

Wolkite University

Collage of Natural and Computitional Sciences Departement of Biology

Floristic Composition, Vegetation Structure and Management Practices in Zara Natural Forest in Geta Woreda District, Gurage Zone, Central Ethiopia Region State, Ethiopia.

By: Jilalu Hassen

Advisor: Belachew Garedew (Asst.Prof).

Athesis Submitted to the Department of Biology, Presented in partialFulfillment of the requirement for the Degree of Master in Biology (Botany).

January, 2025

Wolkite, Ethiopia

APPROVAL SHEET FOR ADVISOR

Wolkite University

Department of Biology,College of Computational and Natural Sciences

I hereby confirm that all comments provided by the reviewer have been taken into account, read, and assessed for the thesis titled "**Floristic Composition, Vegetation Structure and Management Practices in Zara Natural Forest in Geta Woreda District, Central Ethiopia Region."** This work was prepared under our supervision by Jilalu Hassen Abdulshikur. We recommend that this thesis be submitted to meet the requirements for the award of a Master of Science degree in Biology (Botany).

Major Advisor's Name: Signature Date

Belachew Garedew (Asst. Prof) _____ _____

APPROVAL SHEET OF EXAMINER

Wolkite University

Department of Biology, College of Computational Natural Sciences

As members of the examination committee for the Master of Science thesis defense, we have reviewed and evaluated the work presented by Jilalu Hassen Abdulshikur and assessed the candidate's performance. We hereby confirm that the thesis fulfills the criteria necessary for the awarding of the Master of Science (M.Sc) degree in Biology (Botany).

---------- ---------- ----------

External Examiner's Name Signature Date

---------- ---------- ----------

Internal Examiner's Name Signature Date

---------- ---------- ----------

Chairman's Name Signature Date

The final approval and acceptance of the thesis depend on the submission of its final version to the council of postgraduate programs (CPGS) via the candidate's department or school graduate committee (DGS or SGC).

AUTHOR'S DECLARATION

I declare that this thesis is my original work and that I have appropriately cited all sources used in its preparation. This document is submitted to meet part of the requirements for the Master of Science degree in Biology (Botany) at Wolkite University. I affirm that this thesis has not been submitted to any other university for the purpose of obtaining any academic degree.

Name: Jilalu Hassen Abdulshikure Signature: _____

Location: Wolkite University, Wolkite. Date of Submission: _____

Advisor: Belachew Garedew (Asst. Prof). Signature: _____

BIOGRAPHICAL SUMMARY

The Author, Jilalu Hassen Abdulshikure, was born on May 08, 1980 in Geta Woreda, Gurage Zone, and Central Ethiopia. He completed his primary and Junior education at Wodaka Junior school from 1988 to 1995, followed bysecondary educationat Arekite secondary schoolfrom 1996 to 1997and preparatory education at Emdiber Comprehensive senior secondary school from 1998 to 1999, Jilalu then pursued his under graduate studies at Wolita Sodo University from 2000 to 2002, earning aBachelor of Education in Biology.in may 2024, he enrolled in the school of graduate studies at Wolkite University to peruse a Degree in biology as master of science**.**

ACKNOWLEDGEMENTS

First and foremost, I want to express my sincere appreciation to Almighty Allah for His help in every aspect of my life. I would also like to thank my advisor, Belachew Garedew (Assistant Professor), for his constant support, guidance, and insightful feedback throughout my research journey. I am especially grateful to the Getta Woreda Administrative Office and the Forest and Environmental Protection Office for their various forms of assistance and for supplying information about the study site during my research.

Isincere appreciation all thestaff members of getta woreda trade and market developmentbureau for their moral and material assistance.I would also like to acknowledge the local residents around the Zara Natural Forest for their help and sharing crucial information during my data collection.

Additionally I want to express my deepest respect to my sister, Ziada Hassen, for her fanatical and moral support. Lastly, I woud like to convey my heartfelt thanks to my Wife,Miss Sada Nedaye, for her support, both moral and material.

ABBRIVATION AND ACRONOMY

BA-----Basal Area

DBH----- Diameter at Breast Height

FAO-----Food and Agriculture Organization

FEE-----Flora of Ethiopia and Eritrea

GPS-----Global Positioning System

GWAO-----Geta Woreda Agriculture Office

GWHO-----Geta Woreda Health Office

IVI-----Important Value Index

m.a.s.l-----meters above sea level

NGO-----Non-Governmental Organization

RD-----Relative Density

RDO-----Relative Dominance

RF-----Relative Frequency

ZNF-----Zara Natural Forest

TABLE OF CONTENTS

Contents page

LIST OF TABELE

Tables Pages

LIST OF FIGURE

Figures Pages

ABSTRACT

This research was conducted in the Zara Natural Forest to evaluate the diversity of plant species, the structure of the vegetation, and the management practices aimed at conserving the forest. There is a notable absence of documentation concerning plant composition, conservation efforts, and management strategies in the area, as no previous floristic studies have been performed on the dry Afromontane vegetation in the district. The study employed a systematic sampling method, collecting vegetation data from 45 quadrats, each measuring 20m by 20m and spaced 100m apart along four transect lines. These transect lines were established every 500m from each direction within the study area. Additionally, smaller plots of 2m x 2m were created within each major plot for collecting herbaceous data. All plant species within each quadrat were recorded, leading to the identification of 66 plant species across 54 genera and 40 families. Of these, 35% were trees, 33% were shrubs, 23% were herbs, and 9% were climbers.The Fabaceae family was the most prominent, featuring eight species, followed by Astraceae with seven species, Rosaceae with four species, and both Euphorbiaceae and Solanaceae with three species each. The remaining thirty-five families were represented by either one or two species. The forest's total basal area and density were recorded at 19.58 m²/ha and 2542.94 stems/ha, respectively. An analysis of the importance value index revealed that Juniperus procera (59.74%) is the most frequent and dominant species, followed by Podocarpus falcatus (39.55%) and Calpurnia aurea (34.98%). This forest type is more associated with dry Afromontane forests and has a promising start in terms of protection and conservation efforts. Community participation in these efforts was at a moderate level. The study of the forest's regeneration status indicated a low level of regeneration. It is recommended to implement a community-based participatory forest management program to enhance the successful conservation of the Zara natural forest.

Keywords: Management practices, Plant species, Vegetation structures, Zara natural forest

1.INTRODUCTION

1.1.Background of the Study

The conservationof plant species is a significant global issue due to rising extinction rates linked to human activities (Ehrlich and Wilson, 1991). Existing conservation methods include protecting plants from harm, pruning, and cultivating tree species in agricultural fields, backyards, and home gardens (Okiror *et al*., 2012). Successful conservation of tree species requires local community involvement, particularly in decision-making processes, and should prioritize resources vital to local economies (Rodrigo *et al*., 2007).Plant species play a crucial role in providing essential resources such as fuel wood, timber, medicines, and food, They also offer important environmental and cultural advantages, including shade for crops and individuals, soil improvement, erosion control, and the preservation of cultural heritage (Rönnbäck *et al.,* 2007; Varghese and Ticktin, 2008). However, many tree species are currently at risk and experiencing decline (Martin *et al*., 2009). Therefore, it is imperative to protect the diversity of tree species and other plants within natural ecosystems (Mishra, 1998). With natural forests facing the threat of extinction, the primary objective for conserving woody species is to safeguard biodiversity (FAO, 2009).

The current data shows that the flora of Ethiopia is an estimated number of indigenous plant species 4481, of which 19.9% are considered to be endemic to Ethiopia (Sosef *et al.*, 2017). It is believed that a significant portion of the highlands in Ethiopia was once covered by forests, which have since diminished. Forest cover decreased from nearly 40% in 1955 to 15% and further to 3.6% in the early 1980s (Leul Kidane, 2003). Currently, due to government initiatives promoting community-based participatory afforestation and reforestation at the national level, Ethiopia's forest coverage has increased to nearly 15%.Various factors contribute to the alarming decline of forest cover in Ethiopia, including rapid population growth, poverty leading to land clearing for agriculture, overgrazing, and the exploitation of forests for firewood and construction materials. Additionally, access to technology may exacerbate deforestation (Kumelachew Yeshitila and Tamirat Bekele, 2002). For example, Ethiopia loses approximately 141,000 hectares of natural forest each year (FAO, 2008).

The loss of these forest resources has significant implications for the environment, biodiversity, and the socio-economic conditions of local communities. Diminished forest cover can lead to various issues, such as soil erosion, decreased watershed protection resulting in potential flooding, reduced carbon sequestration capacity, and loss of biodiversity. The Federal Democratic Republic of Ethiopia has implemented various conservation measures to mitigate the loss of forest ecosystem services (Muluken Nega *et al.*, 2014). Community participation is essential for providing reliable information necessary for developing effective management and conservation plans.

This study investigates the plant composition, structure, and management practices within the Zara natural forest. It evaluates the floristic composition, species diversity, and structural characteristics, which are crucial for understanding the species richness of the forest and for effective forest management (Giriraj *et al*., 2008; Pappoe *et al.,* 2010). Insights into the stable natural regeneration of species and their community structure are vital for promoting appropriate management, utilization, and conservation efforts (Mwa and Witkowski, 2009). Additionally, information on species composition and forest structure aids in identifying ecologically and economically significant plants, as well as in protecting threatened and valuable species (Addo-Fordjour *et al*., 2009). The Zara natural forest is situated in the Geta Woreda of the Gurage Zone in the Central Ethiopia Region of Ethiopia, covering approximately 25.72 hectares. However, there is a lack of documented data regarding the composition, structure, and conservation status of plant species in this forest. Therefore, this study aims to assess the floristic composition, vegetation structure, and management practices of the Zara natural forest. The findings will be crucial for documenting and developing suitable conservation strategies for relevant stakeholders.

1.2.Statement of the Problem

Understanding vegetation is essential for ecological issues, supporting biological conservation and management efforts, contributing to environmental impact assessments, monitoring management practices, and predicting potential future changes. Forests act as the lungs of the Earth, playing a vital role in moderating climate effects and safeguarding important water sources. They provide a variety of products, such as food, fruit, timber, livestock fodder, wildlife habitats and medicines for both human and animals. Forests offer commercially, culturally and

spiritually valuable goods and serve as a source of raw materials for wood-based industries. However, due to their accessibility, these resources have been exploited recklessly and excessively. As a result, urgent measures are needed to address the current situation. According to community elders, the area vegetation was once intact but has now been significantly depleted. This area has not been previously studied, highlighting the importance of gathering information on the forests ecology and composition. In Ethiopia rapid deforestation, primarily driven by the conservation of forests into agricultural land and overuse of forest resources to meet the food and energy needs of a growing population, poses significant environmental challenges. (Demel Teketay, 2001).But such a kind of information is not well documented in Zara natural forest. Therefore, this paper will be aimed to assess plant `species composition, structure and management practices of plant species in the forests.

1.3. Research Questions

1. What plant species are found in the Zara Natural Forest?

2. What is the structure of the vegetation in the Zara Natural Forest?

3. What types of plant communities exist in the natural forest being studied?

4. Are local residents engaged in the management and conservation of the forest?

1.4. Objectives of the Study

1.4.1. General Objective

The primary aim of this study is to investigate the composition of plant species, the structure of vegetation, and the involvement of the community in the conservation of the Zara Natural Forest located in the Gurage Zone of Central Ethiopia.

1.4.2. Specific Objectives

- To document the composition of plant species in the Zara Natural Forest.

- To describe the forest's vegetation structure.

- To evaluate the level of community involvement in forest conservation efforts.

1.5. Significances ofthe Study

The results of this study will provide valuable insights to policymakers, planners, administrators, forest conservation organizations, enabling them to evaluate their strategies and ensure active participation in forest conservation actions and implementation programs. This research offers important information regarding the current status of plant species in the zara natural forest and serves as a foundation for future studies.

1.6. Limitations of the Study

This study is confined to the Zara natural forest in the Geta Woreda district,Due to the recent establishment of the district as a Woreda, there is a lack of locally documented literature and concerning the study forest information, particularly forest management and protection efforts. Consequently the researcher believes that additional evidence to support the study is lacking. Furthermore, the study was affected by a lack of experience in the field and financial constraints.

2. REVIEW LITERATURE

2.1. Floristic Diversity of Ethiopia

Ethiopia is recognized as a significant center for plant genetics diversity, with its native forests serving as a reservoir of biodiversity that includes microorganisms, fungi, soil organisms, medicinal plants, wildlife, birds insects, and humans (Genene Bekele, 2015; Legesse Negash, 2002). The flora of Ethiopia and Eritrea comprises approximately 6,027 species, of which around 647 (10.74%) are endemic to these regions. This means that Ethiopia is homes to about 5,757 species (including subspecies),while Eritrea has roughly 2,152 species (including subspecies), (Ensermu Kelbessa and Sebsebe Demissew, 2014). Unfortunately, the rich biodiversity resources, including forests, are being rapidly depleted primarily due to human activities (Anonymous, 2009). The increasing Population in highlands places significant pressure on natural forests. Consequently, the northwestern highlands of Ethiopia now contain only fragmented natural forests, which are limited to remote and sacred areas (Alemayehu Wassie *et al*., 2005).

2.2. Types of Vegetation

Vegetation refers to a collection of plants that grow together in a particular area or the overall plant coverage of a region (Jennings *et al*., 2003). Understanding vegetation is crucial for tackling ecological issues related to biological conservation and management, aiding in environmental impact assessments, monitoring management practices, and providing a basis for predicting potential outcomes (Friis *et al.,* 2010). Ethiopia is known for having twelve primary types of vegetation, which include: 1) Desert and semi-desert scrubland; 2) Acacia-Commiphora woodlands and bushlands; 3) Wooded grasslands in the Western Gambela Region; 4) Combretum-Terminalia woodlands and wooded grasslands; 5) Dry evergreen Afromontane forest and grassland complexes; 6) Moist evergreen Afromontane forests and bushlands; 7) Transitional rainforests; 8) Ericaceous belts; 9) Afro-alpine belts; 10) Riverine vegetation; 11) Freshwater lakes; and 12) Salt lake vegetation.

2.3. Forest Resources and Their Threats

Forest resources are the result of evolution shaped by the interplay of the physical environmentand human activities, and they hold significant economic, social and cultural importance, especially for many local communities (Abate Ayalew *et al.,* 2008). After the country'sreorganization of However, these forest regions are consistently under severe pressure from factors such as settlement expansion, conversion of land for agriculture and grazing, over-extraction of resources, and inadequate forest management and protection (Duguma Asfaw, 2016).

For thousands of years, most Ethiopians have been engaged in farming. Highland vegetation was cleared to make way for agriculture and grazing, often without proper soil conservation practices. People were drawn to the immediate benefits of early yields, overlooking the long-term consequences they would face (Alemayehu Wassie, 2007). The increase in human and livestock populations has led to several issues in the country, including environmental degradation, severe soil erosion, drought, famine, and the loss of economically valuable native tree species. Any changes in these factors disrupt the composition of vegetation, and ongoing disturbances from human exploitation hinder vegetation recovery, ultimately resulting in a decline in vegetation quality and a reduction in the diversity and abundance of native plant species and wildlife (Shiferew Belachew, 2010).

Ethiopia's forests are facing significant pressure due to a sharp decline in mature forest cover and the ongoing rise in population, putting forest resources at risk. Unfortunately, the focus on conserving and sustainably using these biological resources is insufficient, largely due to a lack of awareness about the importance of forests (Dereje Denu, 2007). While deforestation is acknowledged in the remaining forested areas of the country, the rates of deforestation have been increasing It is challenging to assess.

The primary reason for the swift rate of deforestation in the country is the continuously growing human population. This rapid population growth leads to a significant demand for agricultural and grazing land, as well as forest resources for firewood, charcoal, timber, construction, and

various other uses. Additionally, factors such as fire, poor investment practices, and the absence of effective land use policies have contributed to the rapid loss of forests. Currently, the few remaining high forests are under threat from investors who are transforming moist evergreen montane forests into other land uses, such as coffee and tea plantations (Million Bekele and Leykun Berhanu, 2001; Haile Yineger *et al*., 2008; Friis *et al*., 2011).

2.4. Structures of Forest

The increased richness and density of herb and shrub species in moderately disturbed areas suggest that canopy openings promote the growth of these plants, contributing to the overall stability of the forest ecosystem. Conversely, disturbances that create openings in the forest allow more light to reach the ground, which benefits the growth of herbaceous species. However, this can negatively impact tree diversity, as these herbs may compete with and inhibit the regeneration and 5development of tree seedlings. In many ecosystems, variations in disturbance levels can alter the overall community structure (Lalfakawma *et al.,* 2010). The population structures of plant species are crucial for their management, sustainable use, and conservation. The structural patterns derived from collected data can help assess changes in population dynamics that may result from natural characteristics or human activities, including livestock grazing.

The extraction of forest resources for subsistence or economic reasons can significantly impact the forest's biota.The variety of plant species and the structure of the forest (Fashing *et al.,* 2004; Mligo, 2015) can result in forests being transformed into areas dominated by shrubs (Ribeiro *et al.,* 2015). According to Zelalem Teshager *et al.* (2018), the higher number of mature trees compared to seedlings and saplings suggest that the forest's regeneration is in a poor condition. Tree species that lack seedlings and saplings show fragmented population structures (Getaneh Gebeyehu *et al.,* 2019).

2.4.1. Indices of Species Diversity

The floristic characterization of a vegetation community includes an analysis of species diversity, evenness, and similarity. Species diversity is a crucial metric for assessing the sustainability of forest ecosystems. Among the various species diversity indices, the most commonly used are Simpson's index, Shannon-Weiner index, and Sorenson index of similarity (Mueller D and Ellenberg H, 1974). The values of species diversity are influenced by the levels of species richness and evenness (Dinkessa Beche, 2011). Different researchers have employed various indices to assess species diversity, leading to confusion due to inconsistent terminology and a multitude of potential measures.Assessing diversity allows us to determine the most effective methods for evaluating conservation efforts. The diversity and evenness of species within a specific vegetation community help us understand the variations both among and within that community, shedding light on the reasons for these differences (Eroglu S and Toprak S *et al.,* 2012). The Shannon evenness measure, which evaluates equitability, enhances the effectiveness of the Shannon diversity index by taking into account the relative abundance of each species.

The formulas for the indices are as follows:

Shannon diversity index (H') = $\Sigma si = -\Sigma$ pi ln pi

Where:

H' represents the Shannon-Wiener diversity index.

Pi denotes the abundance of the ith species as a proportion of the total abundance.

ln refers to the natural logarithm.

In the Shannon index, pi is calculated as the ratio of the number of individuals of a specific species (n) to the total number of individuals (N), while ln is the natural logarithm, Σ signifies the sum of the calculations, and S indicates the total number of species.

Shannon's evenness index (J) assesses the relative abundance of various species contributing to the richness of an area (Kent and Coker, 1992).

Where:

EH = evenness

H' = Shannon-Wiener diversity index

S = species richness

ln = natural logarithm

Equitability ranges from 0 to 1, with 0 representing a dominance of a few species and 1 indicating that all species are equally abundant (Kent and Coker, 1992).

2.4.2. Relative Abundance

In any natural community, the species present vary in their relative abundance, typically with a small number of species being quite common while the majorities are much less frequent. This means that in a typical community, most individuals are from the few dominant species. One method to visualize this species abundance data, developed by R. H. Whittaker, is through a rank-abundance curve, where each species is depicted by a vertical bar that reflects its abundance. A community characterized by significant differences in species abundance is described as having low evenness.

2.5. Conservation of Forest Resources

The rapid rate of species extinction poses a significant challenge in many parts of Ethiopia.The in situ approach focuses on protecting species within their natural habitats, whereas the ex situ approach involves collecting and safeguarding them outside their habitats, such as in gene banks (FDRE, 2003). Consequently, conservingplant species at various levels ecosystems, landscapes, communities, populations, individuals, and genes is crucial for maintaining the health and vitality of ecosystems. Studying the distribution of plant species in relation to human activities and environmental factors provides valuable insights for better understanding and managing forests, while also raising awareness among local communities and relevant stakeholders.

3. METHOD AND MATRIALS

3.1. Description of Study Area

3.1.1 Location

The research was conducted on the Zara Natural Forest, located in the Gurage Zone of Central Ethiopia, specifically in Geta Woreda. This area is approximately 250 kilometers southwest of Addis Ababa. Geta Woreda is bordered from south by the Silte Zone, from north by Cheha Woreda, from west by Enemorna Ener, and from east by Gumer Woreda. The total area of the Woreda is 20,202 hectares, which includes 16 rural kebeles and 3 municipal towns. The geographical coordinates range from 7° 26' 08" to 7° 59' 56" N latitude and from 37° 08' 23" to 37° 56' 59" E longitude.

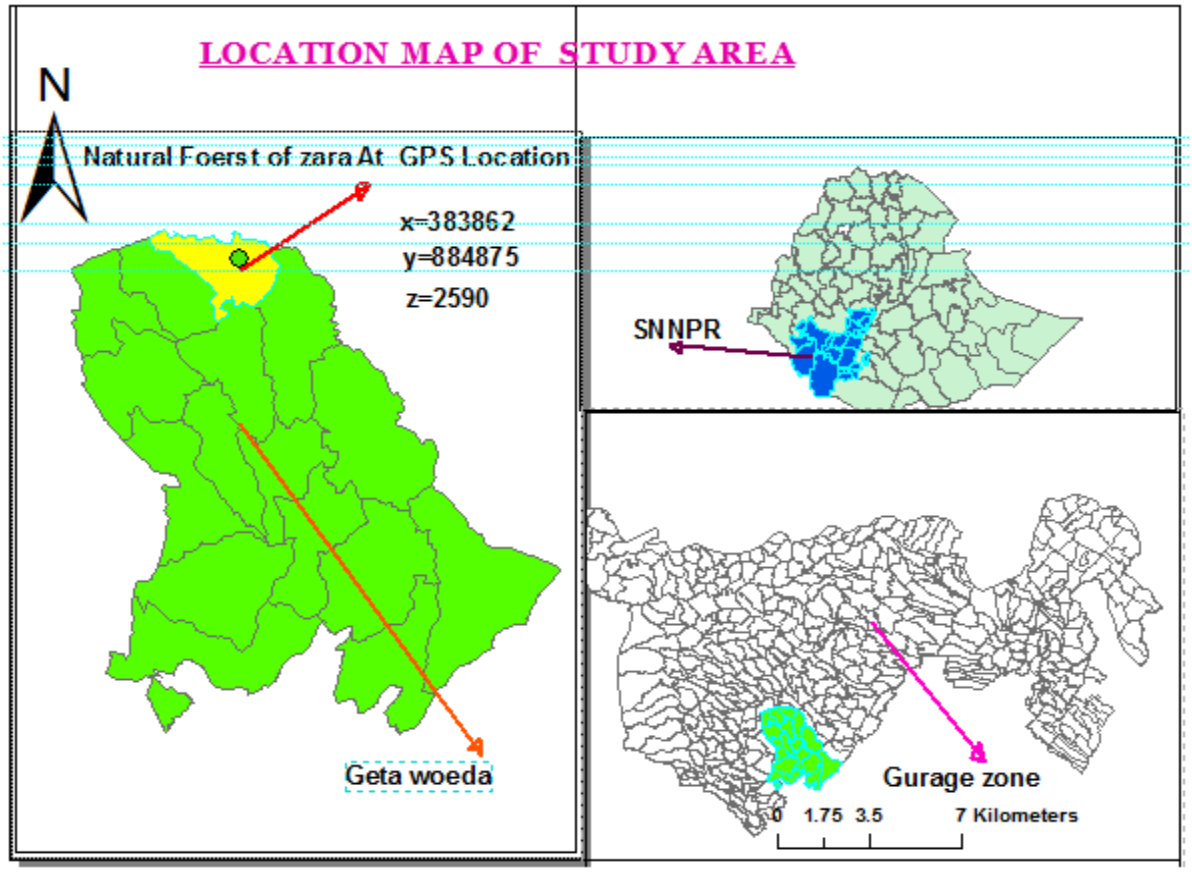


Figure 1: Location map of Zara natural forest.

3.1.2 Soil Type and Topography

The landscape consists of 35% plains, 44% moderately hilly areas, and 21% rugged terrain, with the study area situated at altitudes between 2358 to 2991 m.a.s.l(GWAO, 2014).The primary soil type found in Geta Woreda is Nitisol (GWAO, 2014). The Zara Natural Forest falls under the category of dry evergreen montane forest, which is a highly diverse vegetation type that typically occurs at elevations between 1500m and 3200m. This forest type experiences an average annual temperature ranging from 14 to 25ºC and receives annual rainfall between 700 and 1100mm (Friis, 1992; Zerihun Woldu, 1999).

3.1.3 Climatic Conditions

The climate of the study area is characterized by two agro-ecological zones: the highland (Dega) region, which makes up 85%, and the midland (Woyinedega) region, which accounts for 15%. Rainfall occurs in two primary seasons: the small rainy season from March to April and the main rainy season from June to September, reflecting a bimodal distribution. The average annual rainfall varies between 1000 and 1500 mm. The average maximum temperature throughout the year is 25.2°C, while the average minimum temperature is 12°C. Although there is no meteorological station within the study area, climate data has been sourced from the Indibir district, situated approximately 22 km away.

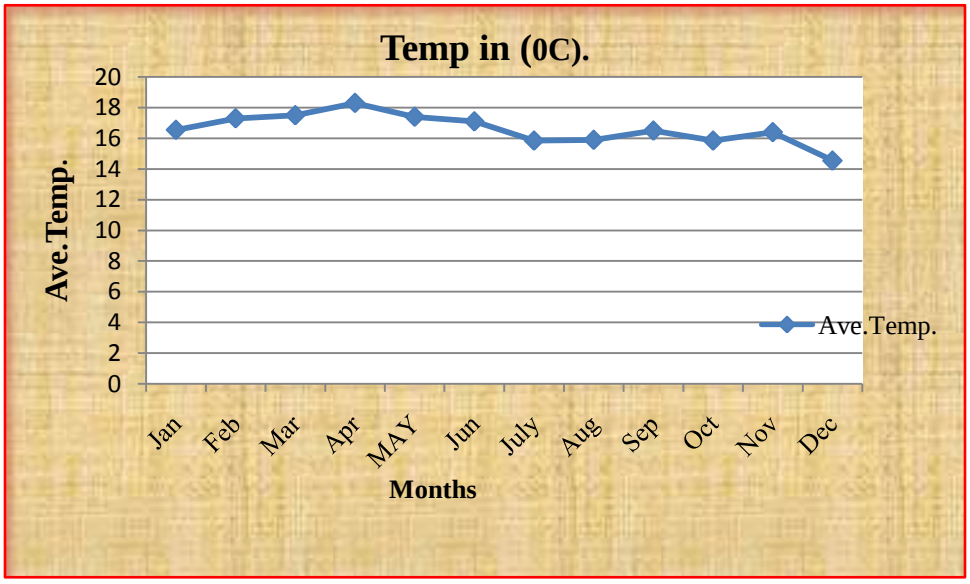


Figure 2:Eight Years (2005 to 2012) Average monthly Temperature of the study Area (Source: Indibir station,2012).about 22 km away from study area.

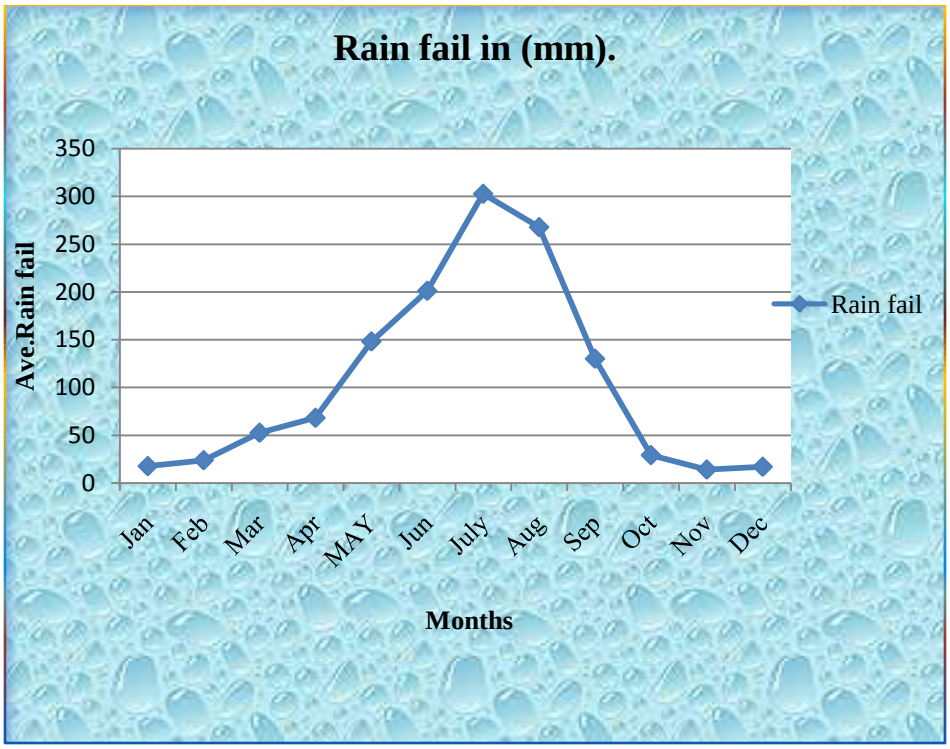


Figure 3: Eight Years (2005 to 2012) Average monthly Rainfall of the study Area (Source: Indibir station,2012).about 22 km away from study area.

3.1.4 Demographic Characteristics

As reported by GWHO (2014), the total population of the Woreda is 98,147, comprising 48,092 males and 50,055 females. Among them, 46,995 individuals are under the age of 15, while those above 15 years old total 51,152. Additionally, there are 255 people with disabilities, including 199 males and 56 females.

3.2. Data Gathering and Sampling Method

3.2.1. Reconnaissance

A reconnaissance survey took place from September 10 to 13, 2023, aimed at visually examining and familiarizing oneself with the study area. During this assessment, the main woody species and the ways in which humans interact with their environment were recorded. Various factors were evaluated, including grazing intensity, settlements, soil erosion, vegetation patterns, topography, forest boundaries, and the conditions of potential sampling sites. Checklists were developed to facilitate open-ended interviews with local elders who have lived in the area for

over 50 years and have expertise in ecology and forest management, which helped in collecting vital descriptive information.

3.2.2. Gathering of Floristic Data

For gathering of floristic data, a systematic sampling method was utilized to establish quadrats for inventory purposes in the study area. A total of 45 quadrats measuring 20 m × 20 m (400 m^2) were set up, spaced 100 m apart. The distance between sampling plots was maintained at 100 m, measured with a tape along an altitudinal gradient from the base to the top of the forest, in accordance with the uniformity of the vegetation (Blanquet J, 1932). The first transect was intentionally placed on one side of the forest following the gradient, and a total of four transects were established on each side, with a spacing of 500 m between each sampling transect.

Altitude was recorded for each quadrat using GPS. The diversity of trees, shrubs, woody climbers, and herbs was assessed following the methodology outlined by Kent and Coker (1992). Within each primary sampling plot, sub-quadrats measuring 2 m × 2 m (4 m^2) were positioned at the corners and center of each 20 m × 20 m quadrat to gather data on herbs. Information regarding plant community structure, species composition, and the conservation status of the forest was collected and identified. All plant species found in each plot were documented.

3.2.3. Gathering Data on Vegetation Structure

The structural features of plant species in the forest were evaluated based on diameter at breast height (DBH), height, density, frequency, basal area, and importance value index. The diameter was measured for each individual tree and shrub with a DBH of 2.5 cm or more, taken at a height of 1.3 meters above the ground. Height was recorded using a measuring tape and a calibrated stick. If trees branched at or below breast height, the branches were measured separately, and the average DBH was determined. For trees with buttressed trunks, the DBH was measured just above the buttresses.

3.2.4. Identification of Plant Species

During the study, all plant species encountered in the forest were documented for identification purposes. The local names of all species were compiled, and their scientific names were determined using colored plant identification guides, such as the "Flora of Useful Trees and

Shrubs in Ethiopia" (Azene Bekele, 2007). This process was supported by advisors, university experts, and secondary sources, including relevant literature and online resources. The nomenclature of the species was based on the publications of the "Flora of Ethiopia and Eritrea" (Hedberg *et al.,* 2003, 2004, 2006).

3.3. Data Analysis

3.3.1. Data Analysis

A descriptive statistical method was applied, using metrics like the percentage, Important Value Index (IVI), Basal Area (BA), Diameter at Breast Height (DBH), and frequency to analyze and summarize the data on plant species composition. This approach is among the most commonly employed multivariate techniques for studying plant community data. The results were presented using tables, figures, and bar graphs.

3.3.2. Structural Data Analysis

In each plot specifically set up to analyze vegetation structure, all plant species were documented. The vegetation structure was characterized using various parameters, including diameter at breast height (DBH), basal area (BA), tree density, frequency, and important value index (IVI). The structural parameters were assessed using the following formula.

The diameter at breast height (DBH) is derived from the circumference (C) as follows:

$C = \pi * DBH$

Therefore,

$DBH = C/\pi$

Where:

C= represents the tree's circumference,

π is approximately 3.14, and DBH is the diameter at breast height of the tree.

This approach is simple, quick, economical, and fairly precise.

There is a direct relationship between DBH and basal area (Kent and Coker, 1992).

Tree height is an easy measurement that can provide information about a plant's age and may indicate disturbances and re-colonization. For example, a uniform group of trees with the same height might imply that the vegetation was cleared and subsequently re-colonized.

Basal area (BA) is defined as the cross-sectional area of a plant at ground level, expressed in square meters per hectare (Mueller-Dombosias and Ellenberg, 1974). It is also used to evaluate the dominance of various species. The formula for calculating basal area is $BA = \pi (DBH/2)^2$, where DBH stands for diameter at breast height.

Density refers to the number of individual species within a specific area, known as a quadrat (Kent and Coker, 1992). Although it is related to abundance, density is more useful for assessing the importance of a species. Counts are usually taken in several quadrats distributed throughout the area being studied, and the total number of individuals for each species is calculated to determine species density in convenient area units, such as per hectare (Mueller-Dombosias and Ellenberg, 1974).

$$\text{Density (D)} = \frac{\text{Total number of stems of a given species}}{\text{Sampled area in hectare (ha)}} \times 100$$

$$\text{Relative density (RD)} = \frac{\text{Density of a single species}}{\text{The total density of all species}} \times 100$$

Frequency refers to the likelihood or chance of encountering a species within a specific sample area or quadrate. This measure is influenced by the size of the quadrate, the size of the plants, and the arrangement of the vegetation (Kent and Coker, 1992). It can be calculated using a specific formula. To better understand the significance of a species in relation to frequency, one

can compare the occurrence rates of all tree species present. This comparison yields a value known as relative frequency, calculated using a particular formula.

$$\text{Frequency} = \frac{\text{number of quadrate with species}}{\text{total number of quadrates}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{frequency of species occur in plots}}{\text{total frequency of all species in all plots}} \times 100$$

$$\text{Relative Dominance (RDO)} = \frac{\text{total BA of a species}}{\text{some of BA of all tree species}} \times 100$$

The Importance Value Index (IVI) is an essential tool for evaluating the ecological significance of different species. It combines data from three key factors: relative frequency, relative density, and relative abundance. This index often reflects the dominance, occurrence, and abundance of a species in a specific area (Kent and Coker, 1992). The formula for calculating the Importance Value Index (IVI) is as follows:

IVI = RD + RF + RDO

Here, RD stands for Relative Density, RF represents Relative Frequency, and RDO refers to Relative Dominance.

The Shannon-Weiner Index, commonly known as the species diversity index, is used to measure species diversity.

The Shannon diversity index

(H') is calculated using this formula:

$$H' = -\sum Pi \ln Pi$$

In this formula, Pi indicates the relative abundance of the ith species, and ln denotes the natural logarithm.

In this study, PAS software was employed to evaluate species richness, abundance, diversity, dominance, and the diversity profile

Shannon Evenness (E')

Evenness is assessed to compare the observed distribution of various species within the studied plant species to the most evenly distributed scenario possible. Maximum evenness occurs when all species have the same or nearly identical numbers. The evenness index (Shannon equitability) can be calculated as outlined by Kent and Coker (1992) to estimate the uniformity of distribution, represented as E = Equitability (evenness) index, which ranges from zero to one.

$$E = \frac{H''}{Hmax} = \frac{\sum_{i=1}^{n} pilnpi}{lns} = \frac{H''}{lns}$$

Where:

E = Evenness index, ranging from 0 to 1

H' = Shannon Diversity

Max = The highest potential diversity within a specific population

Pi = The proportion of individuals belonging to the ith species

S = The total number of species (1, 2, 3, … s)

3.3.3. Regeneration Status•

Regeneration is the ability of organisms to replace lost or damaged body parts, and this ability varies greatly among different life forms. Plants have the capability to regenerate all their parts from precursor cells. For example, many trees can be felled at ground level, and eventually, new shoots will grow from the edges of the stump, developing into new stems, leaves, and flowers. In biological terms, regeneration is the process through which certain organisms replace or restore lost or severed body parts (https://www.britannica.com/science/regeneration-biology, 2014).The forest's regeneration status was assessed by comparing the quantities of saplings and seedlings to mature trees, using the methodology outlined by Dhaulkhandi *et al.*, (2008), which suggests that

the regeneration status is favorable. Regeneration is categorized as follows: if there are more seedlings than both saplings and adults, it reflects fair regeneration; if the number of seedlings is equal to or exceeds that of saplings, which are in turn equal to or fewer than the adults, it indicates poor regeneration; if a species is present solely in the sapling stage (regardless of whether it outnumbers the adults), it is considered to be surviving poorly; and if a species is found only in the adult stage, it is regarded as not regenerating.

4. RESULTS AND DISCUSSION

4.1. Floristic Composition of the Study Area

A total of 66 plant species belonging to 40 families and 54 genera were identified in the 45 plots surveyed. The Zara Natural Forest exhibits a lower level of floristic diversity compared to several other forests in Ethiopia, such as the Gole Natural Forest, which has 114 recorded species (HaileMariam M, 2018), the Yegof Dry Afromontane Forest with 76 species (Mesfin Woldearegay *et al.,* 2018), and the Belete Moist Evergreen Montane Forest, which boasts 157 species. However, Zara is somewhat more diverse than the Hallideghie Wildlife Reserve, where only 46 species were documented (Endris *et al.,* 2017). The differences in floristic composition among these various study sites may be attributed to factors such as significant human disturbances, variations for reproductive condition, and the over-destruction of certain species. Additionally, the geographical locations of the different study areas may also contribute to these variations. In the Zara Natural Forest, the Fabaceae family was the most represented, with eight species (20%), followed by Asteraceae with seven species (17.5%), Rosaceae with four species (10%), and both Euphorbiaceae and Solanaceae with three species each (7.5%). The families Anacardiaceae, Arecaceae, Primulaceae, and Myrtaceae each contributed two species (5%). Together, these four families accounted for 57.14%, while the remaining 31 families were each represented by a single species (Figure 3).

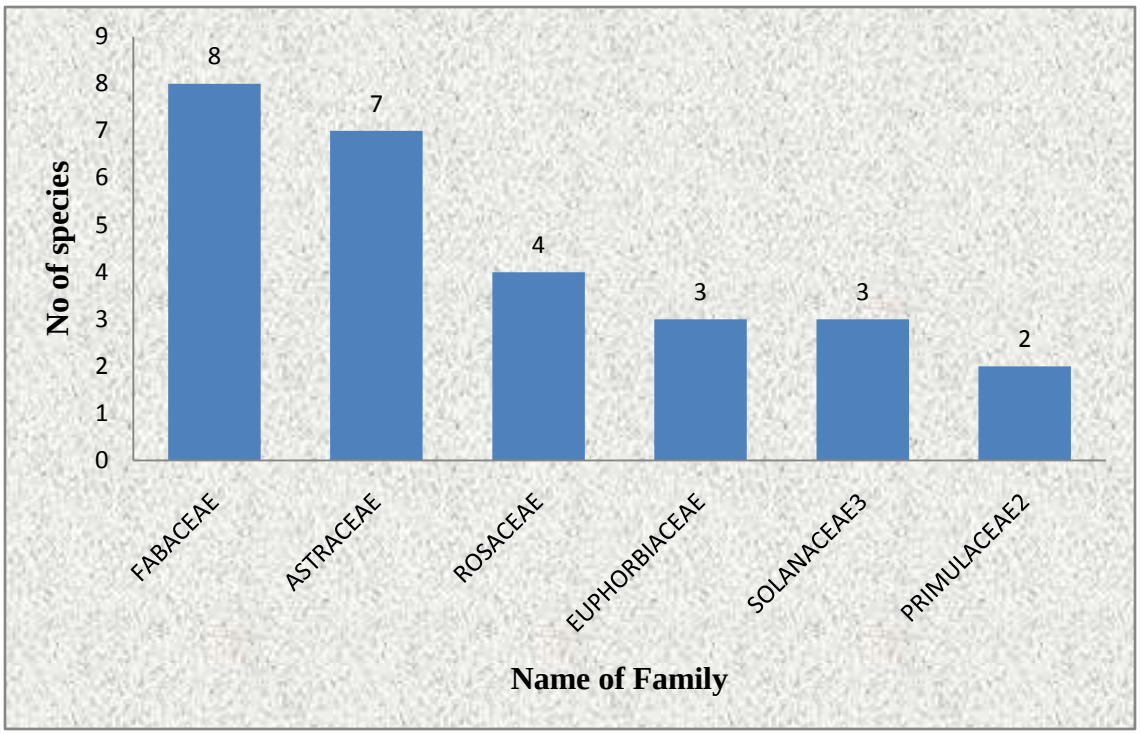


Figure 4:Zara Natural Forest with their most dominant families and number of species

4.1.1. The Growth Forms of Zara Natural Forest

The recorded species of Zara Natural forest 23(35%) were trees, 22(33%) were shrubs, 15(23%) were herb and 6(9%) were climbers (Fig: 4)

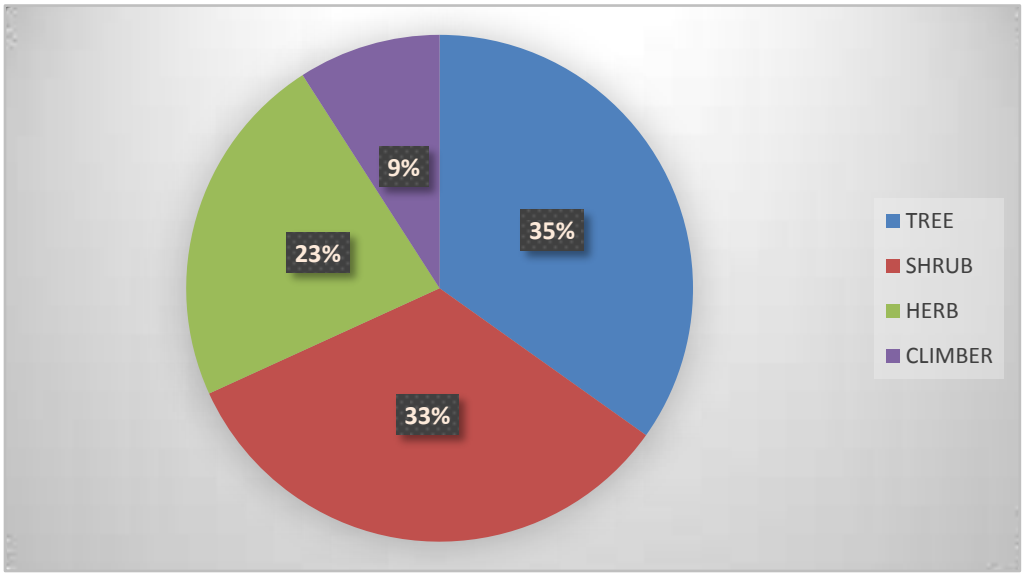


Figure 5: Growth forms of recorded plant species in Zara Natural forest.

4.1.2 The Shannon Diversity Index and Evenness

The diversity and evenness of species in the Zara Natural Forest were evaluated using the Shannon-Wiener diversity index. The calculated Shannon-Wiener diversity index for the plant species in the study area was 3.832, with an evenness value of 0.699. The Shannon index is a statistical tool that measures heterogeneity; a higher value indicates greater species diversity within the ecosystem. There is a direct relationship between diversity and the stability or health of an ecosystem, with unstable ecosystems showing lower heterogeneity and more stable ecosystems exhibiting higher heterogeneity. A low evenness value indicates that one or a few species are significantly dominant, while other species are represented by only a small number of individuals.

4.2.Vegetation Structureof Zara Natural Forest.

4.2.1. Plant Species Density

The overall density of all plant species in the Zara natural forest is 2542.94 stems per hectare. The results of this study show that the density of plant species in the Zara Natural Forest surpasses that of Belete Forest (1066 individuals/ha) (Kflay Gebrehiwot *et al.,* 2013) and Sire Beggo Forest (1845 individuals/ha) (Abiyou Tilahun et al., 2014). However, it is lower than the density recorded in Weiramba Forest (3547 individuals/ha) (Zelalem Tshager *et al.,* 2018) and significantly less than the densities found in Dirki and Jato woodland forests (5145 individuals/ha) (Zerihun Tadesse, 2015).

Among the plant species identified in the study area, the five most common were *Juniperus procera* (26.66%), *Podocarpus falcatus* (20%), *Calpurnia aurea* (15.55%), *Ocimum utricifolium* (13.33%), and *Vachellia abyssinica* (8.88%), which collectively make up 84.42% of the total abundance in the forest.

The species with the highest density in the study area were *Juniperus procera* (197.97 individuals per hectare), followed by *Podocarpus falcatus* (117.35 individuals per hectare), *Calpurnia aurea* (116.64 individuals per hectare), *Ocimum utricifolium* (106.04 individuals per hectare), and *Vachellia abyssinica* (102.50 individuals per hectare). In contrast, the least dense

plant species recorded were *Gomphocarpus integer* (5.65 individuals per hectare*), Rhus nantalensis* (4.24 individuals per hectare), and *Phoenix reclinata* (2.82 individuals per hectare).The findings indicate that *Borassus aethiopum* has an average of 1.41 individuals per hectare.

Table:1 Zara Natural Forest and density of five dominant plant species with their percentage coverage.

No	Species	Family	Density	%
1	*Juniperusprocera*	Cupressaceae	197.97	7.78
2	*Podocarpus falcatus*	Podocarpaceae	117.35	4.61
3	*Calpurnia aurea*	Fabaceae	116.64	4.58
4	*Ocimum utricifolium*	Lamiaceae	106.04	4.16
5	*Vachellia abyssinica*	Fabaceae	102.50	4.03
Total			640.5	25.16

4.2.2. Distribution of Diameter at Breast Height (DBH) Classes

A total of 1210.32 per hectare of plant species with a (DBH), larger than 2.5 cm were documented, leading to the establishment of seven DBH classes for analysis. The classes are as follows: Class 1 (2.5 to5 cm), Class 2 (5.01 to 10 cm), Class 3 (10.01 to 15 cm), Class 4 (15.01 to 20 cm), Class 5 (20.01 to 25 cm), Class 6 (25.01 to 30 cm), and Class 7 (>30 cm). The highest number of individuals was observed in the larger DBH classes. Population density increased with larger DBH sizes, with 75 individuals in Class 1, 90 in Class 2, 134 in Class 3, 165 in Class 4, 234 in Class 5, 248 in Class 6, and 264 in Class 7. This indicates a J-shaped population distribution (see Fig 7a), suggesting limited regeneration potential in the forest area, attributed to various anthropogenic and natural factors.

The (DBH), of Zara forest which greater than 2.5 cm was categorized into these seven classes

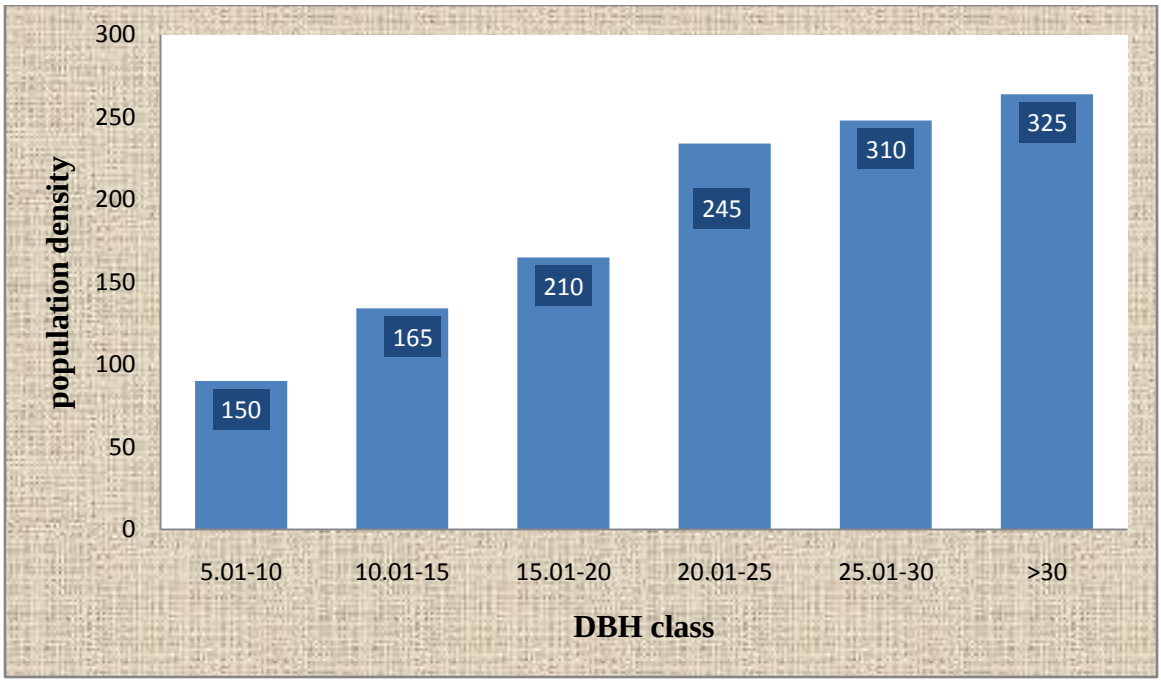


Figure 6: The DBH classes of Zara forest which>2.5cm were recorded under seven classes**.**

4.2.3. Height Classes Distribution

The height class distribution of trees and shrubs in the Zara Natural Forest it revealed that the tallest individuals predominantly fell into the highest height class (E), accounting for 83.27%. Height can serve as an indicator of the forest's age(see Figure 7). As height increases from one class to the next, the density of individuals also rises, suggesting that the area is primarily occupied by taller, older plant species. The distribution of diameter at breast height (DBH) among individuals across various size classes indicated a significant number of individuals in the largest diameter class, which could potentially contribute to the recruitment of individuals into larger diameter classes, thereby ensuring limited regeneration within the forest. Nevertheless, density increased with larger DBH classes, highlighting the prevalence of medium and large-sized species such as *Juniperus procera, Podocarpus falcatus*, *Olea europaea*, and *Hagenia abyssinica*. This phenomenon may be linked to a low regeneration rate but a high recruitment rate in the forest, possibly due to the age of the trees, the shading around the plants, and the microclimatic conditions present. Overall, this suggests a dominance of larger individuals, a lack of regeneration, but a high recruitment rate, indicating an area primarily occupied by mature plants.

Table: 2height class distribution.

Class	Height in (m)	No of stem	Density/ha	Density in (%)
A	(<5)	250	176.74	13.55
B	(5.01-10)	285	201.48	15.45
C	(10.01-15)	325	229.76	17.61
D	(15.01-20)	343	242.48	18.59
E	(>20)	642	453.87	34.80
Total		1845	1304.33	100

4.2.4. Basal Area

The total basal area of tree species in the Zara Natural Forest is 19.58 m²/ha. Six woody species account for approximately 13.94 m²/ha, or 71.19%, of the total basal area, including *Juniperus procera* (21.61%), *Podocarpus falcatus* (15.33%), *Ficus sur* (12.65%), *Erythrina abyssinica* (11.98%), and *Hagenia abyssinica* (9.62%)(See Table 3). When comparing the basal area of the Zara Natural Forest to other forests in Ethiopia, it is found to be greater than that of the Yegof dry Afromontane forest, which has a basal area of about 15.85 m²/ha (Mesfin Woldearegay *et al.,* 2018), and the Achera natural forest, which has a basal area of 3.61 m²/ha (Habtam Gand, Ali S., 2015). It also significantly exceeds the basal area of the Hallideghie wildlife reserve, which is approximately 0.997 m²/ha (Endris *et al.,* 2017). However, the basal area of the Zara Natural Forest is lower than that of Denkoro forest, which has about 45 m²/ha (Abate Ayalew et al., 2006), Alemsaga Forest at 75.3 m²/ha (Getinet Masresha *et al.,* 2015), and Belete forest at 103.5 m²/ha (Kflay Gadissa *et al.,* and Kitessa Hundera, 2014).

Table 3: Zara Natural forest with the basal area of five top selected tree species

No	Species	Basal area in M2/ha	%
1	*Juniperus procera*	5.12	21.61
2	*Podocarpus falcatus*	3.46	15.33
3	*Ficus sur*	2.11	12.65
4	*Erythrina abyssinica*	1.94	11.98
5	*Hagenia abyssinica*	1.31	9.62
Total		13.94	71.19

Table 4: Zara Natural Forest Compare the basal area with other Forests in Ethiopia in M2/ha

Forests	Basal Area in M**2**/ha	Author
Belete	103.5	Kflay *et al.,* (2014)
Bibita	69.9	Dereje D, (2006)
Wof-Washa	64.32	Fisaha *et al.,* (2013)
Zara	19.58	Present study
Yegof dry Afromontane	15.85	Mesfin Woldearegay *et al.,(*2018)

4.2.5. Frequency

According to the results, the most commonly observed plant species in the Zara Natural Forest (Table 5) were *Juniperus procera*, with a relative frequency of 26.76%, followed by *Podocarpus falcatus* at 20%, *Calpurnia aurea* at 15.55%, *Ocimum utricifolium* at 13.33%, and *Vachellia abyssinica* at 8.88%.

In contrast, the species with the lowest frequency percentages included *Eucalyptus calmaldulensis* (0.63%), *Euphorbia ceratocarpa* (0.52%), *Cuccinia abyssinica* (0.50%), *Maytenus arbutifolia* (0.44%), *Erythronium japonicum* (0.38%), and *Euphorbia candelabrum* (0.33%), which were all found in the study area.

Table 5: The Zara natural forest with their five top frequented plant species

No	Scientific Name	Family of species	Relative frequency(%)
1	*Juniperus procera*	Cupressaceae	26.76
2	*Podocarpus falcatus*	Podocarpaceae	20
3	*Calpurnia aurea*	Fabaceae	15.55
4	*Ocimum utricifolium*	Lamiaceae	13.33
5	*Vachellia abyssinica*	Fabaceae	8.88

4.2.6. **Importance Value Index (IVI)**

In this study, the eight most dominant and ecologically significant woody plants in the Zara natural forest, based on their IVI, were *Juniperus procera* (59.74%), *Podocarpus falcatus* (39.55%), *Calpurnia aurea* (34.98%), *Vachellia abyssinica* (26.05%), *Prunus africana* (18.43%), *Prunus pomaderris* (19.61%), *Averrhoa bilimbi* (13.39%), and *Erythrina abyssinica* (10.23%) (see Table 6).

These species exhibited higher IVI values due to their greater relative density, relative frequency, and relative dominance compared to other woody species in the forest, indicating their dominance and ecological importance.

Conversely, the woody species with the lowest IVI values in the study area were *Maytenus arbutifolia* (1.22%), *Euphorbia abyssinica* (1.22%), *Euphorbia candelabrum* (1.03%), *Olea europaea* (0.83%), *Rhus nantalensis* (0.75%), and *Phoenix reclinata* (0.68%).

Table 6: The eight most ecologically significant tree species in Zara natural forest with the highest Importance Value Index (IVI) values, along with their RDO, RD, and RF.

No	Scientific Name	RDO	RD	RF	IVI
1	*Juniperus procera*	25.20	7.78	26.76	59.74
2	*Podocarpus falcatus*	14.94	4.61	20	39.55
3	*Calpurnia aurea*	14.85	4.58	15.55	34.98
4	*Vachellia abyssinica*	13.14	4.03	8.88	26.05
5	*Vernonia auriculifera*	9.90	3.05	6.66	19.61

6	*Prunum Africana*	9	2.77	6.66	18.43
7	*Bersama abyssinica*	6.84	2.11	4.44	13.39
8	*Erythrina abyssinica*	6.12	1.89	2.22	10.23

Key: - Relative Dominance = (RDO),

Relative Density = (RD),

Relative Frequency = (RF),

Important Value Index = (IVI)

4.3. The Selected Tree Species in Zara Natural Forest with TheirPopulation Structure.

4.3.1 DBH Class Distribution and Structural Patterns of Selected Woody Species

The diameter at breast height (DBH) class distribution for five selected woody species in Zara Natural Forest identified due to their height and showsdifferent distribution patterns. The first pattern was seen in *Juniperus procera*, which displayed a high number of individuals in the larger diameter classes, with an upward trend towards these larger DBH classes (Fig 7a). This indicates a J-shaped population pattern, implying inadequate regeneration and continuous recruitment into the larger size classes.One possible explanation for this trend is the dominance of older *Juniperus procera* plants in the forest. Additionally, lower regeneration rates may be influenced by the species' characteristics and the area's microclimatic conditions. The second pattern was seen in *Hagenia abyssinica*, which exhibited a low number of individuals in the smallest diameter class, followed by an increase in higher diameter classes. This showed irregular patternthey significant presence of individuals in the larger diameter classes. This phenomenon may be attributed to the separation of male and female *Hagenia abyssinica* plants, which negatively impacts the species' reproductive capacity and, consequently, its reproduction rates. Another likely reason for this pattern is that *Hagenia abyssinica* is one of the most local communities around the forest utilize various medicinal plants. The female parts of these plants serve as a treatment for tapeworm infestations, which can hinder the production of viable seeds

necessary for germination and the growth of seedlings and saplings (Figure 7b). Additionally, species such as *Podocarpus falcatus* and *Olea europaea* exhibit similar population patterns. This type of population structure indicates moderate reproduction and a healthy recruitment status (Figure 7c and d).

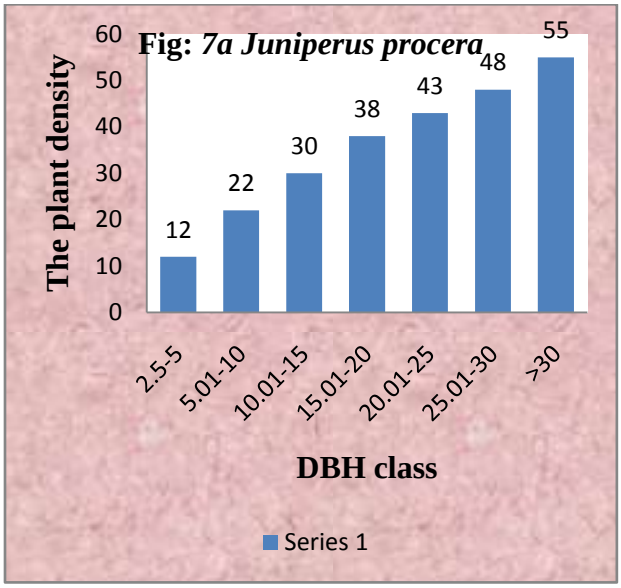


Fig: *7a Juniperus procera*

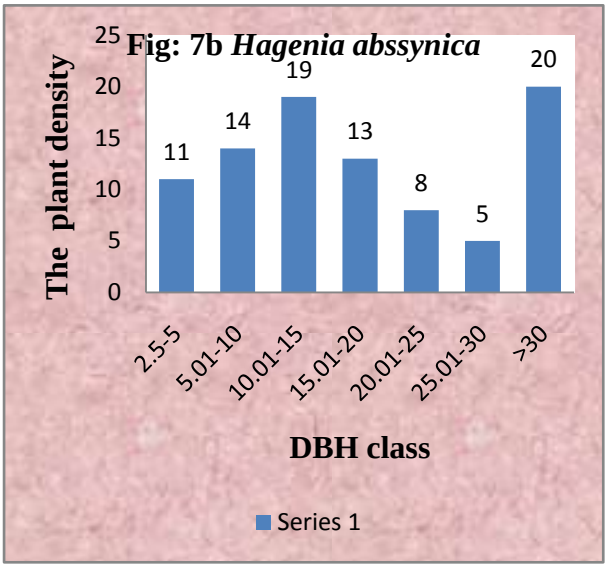
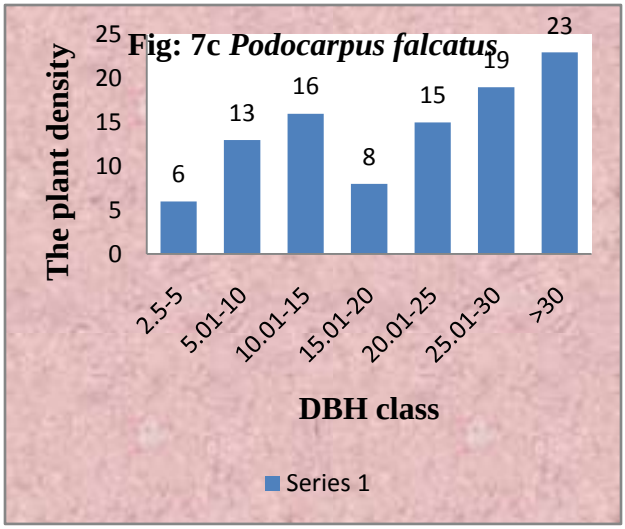


Fig: 7b *Hagenia abssynica*



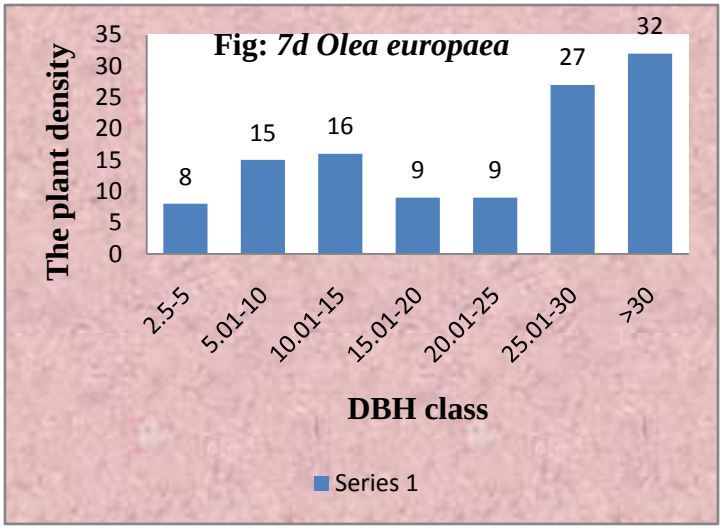


Figure 7:DBH class distribution of structural patterns of selected tree species in Zara forest

4.4. Status of Forest Regeneration

Regeneration is the process by which organisms can replace lost or damaged parts, and this ability varies widely among different species. Plants have the capacity to regenerate all their components from precursor cells. For example, many tree species can be cut down to ground level, and over time, new shoots will sprout from the edges of the stump, eventually developing into new stems, leaves, and flowers (https://www.britannica.com/science/regeneration-biology, 2014). The number of seedlings, saplings, and mature plants for each selected species was evaluated and expressed on a per-hectare basis. The composition and density of seedlings and saplings offer valuable information about the regeneration status of the studied area. Examining the population structure helps in understanding the regeneration trends of a species (Swamy *et al.,* 2000). The results of the interview, as summarized in the table above, can be discussed briefly as follows. It was found that forest-dependent communities with traditional religions possess strong indigenous knowledge and a positive attitude toward forest conservation in the area. Educated members of the community play a more significant role in forest conservation activities compared to their uneducated counterparts, in addition to their indigenous knowledge. The understanding of forest conservation practices tends to increase with age, indicating that older individuals are more inclined to conserve and manage forests effectively than younger ones. Communities that engage with extension services for forest conservation are more likely to apply the important lessons and training provided by the government regarding sustainable forest

use, compared to those who do not have access to these services, alongside their indigenous knowledge. Therefore, to combat deforestation, it is essential for stakeholders to manage forest resources to ensure environmental sustainability. Currently, the forest is in good condition, thanks to community involvement. Moving forward, traditional community leaders should be empowered, and the administrative structures at the district and kebele levels should be integrated with them to improve forest conservation and enhancement efforts.

Table7: Status of five selected plant species in the forest with their growth habit

No	Selected Tree Species	Seedling	Sapling	Adult	Total
1	*Acacia dealbata*	4	21	119	144
2	*Calpurnia aurea*	8	13	144	165
3	*Juniperus procera*	12	30	238	280
4	*Podocarpus falcatus*	0	19	147	166
5	*Vachellia abyssinica*	16	20	110	146
Density per hectare		28.27	72.81	535.87	636.95

4.5. Community Participation in the Conservation of Zara Natural Forest

Data was gathered from forty local community members who have lived near the study area for many years. The participants included various community representatives such as religious leaders, community elders, and Kebele leaders. Each individual was interviewed regarding their involvement in the conservation practices of the Zara natural forest, and their responses were analyzed. Additionally, information was collected through questionnaires and interviews with selected experts from the Agriculture and Forest and Environmental Protection Office, which was also analyzed. Based on the insights provided by the respondents chosen from the study area, feedback from experts at the Geta Woreda Environmental Protection and Forest Management Office, and the researcher's on-site observations, several activities were identified as being undertaken to promote purposeful regeneration and enhance the protection of the forest in the area.

- The government provided important training and awareness-raising lessons to local community members about forest conservation and utilization.

- With the cooperation and agreement of local communities, relevant sectors and stakeholders hired guards to protect and oversee the forest.
- The forest boundaries were separated from the farmland of nearby farmers to ensure ongoing preservation.
- Afforestation and reforestation efforts were initiated in areas of the forest where trees had been destroyed and the soil had cracked due to rainwater.
- A fundraising program was launched, involving collaboration between the Woreda Agricultural Office and an NGO to enhance the protection and conservation of the forest.
- Currently, the forest is experiencing positive progress in protection and conservation efforts from the Woreda and other stakeholders, but it requires ongoing promotion and scaling up of activities.
- The level of community participation in these initiatives varied among individuals from different social backgrounds.

Table: 8 Socioeconomic/ perception and participation of community for Zara forest management.

			Frequency	%
1	Community knowledge on the current states of the zara forest?	Very good	8	20
		good	17	42.5
		Rarely	9	22.5
		No at all	6	15
2	How often your participation in forest management activities?	Frequently	13	32.5
		Sometimes	11	27.5
		Rarely	7	17.5
		No at all	9	22.5
3	Who is responsible for the forest's protection?	Children	5	12.5
		Farmers	10	25
		Government	13	32.5
		Non-Government	3	7.55
		All individuals	9	22.5
4	Understanding of community on the importance of forest?	Social benefit	6	15
		Cultural benefit	5	12.5
		Economic aspects	17	42.5
		Ecological balance	3	7.5

Table: 9presents the explanatory variables, categories of respondents, and the number of participants involved.

Variables	Category of respondent	Numbers of respondent	%	The inline study (source)
Religions	Traditional Believer	26	65	Michon G.de Foresta, H.Levang P. and kusworo (2000).
	Others	14	35	
Education	Educated	30	75	Flintan F.(2003).
	Uneducated	10	25	
Age	Older	28	70	Temesgen Workayehu (2007).
	Young	12	30	
Extension service (training)	Trained	22	55	Endrias Geta Legesse Dadi and Teresse Adugna (2005).
	Untrained	18	45	

In order tosummarize in the above table, can be discussed briefly as follows.

- It was found that forest-dependent communities with traditional religions possess strong indigenous knowledge and a positive attitude toward forest conservation in the area.
- Educated members of the community play a more significant role in forest conservation activities compared to their uneducated counterparts, in addition to their indigenous knowledge.
- The understanding of forest conservation practices tends to increase with age, indicating that older individuals are more inclined to conserve and manage forests effectively than younger ones.
- Communities that engage with extension services for forest conservation are more likely to apply the important lessons and training provided by the government regarding sustainable forest use, compared to those who do not have access to these services, alongside their indigenous knowledge.

- ❖ Therefore, to combat deforestation, it is essential for stakeholders to manage forest resources to ensure environmental sustainability.
- ❖ Thus special attention should be given to protect these species like *Juniperus procera* and *Hagenia abyssinica* because of building house and constructing different house holding material from the forest.

4.6 Threats to the Zara Natural Forest

Ethiopia's trees and forests are facing significant threats due to a sharp decline in mature forests and ongoing pressures from population growth, primitive farming practices, competition for land use, land tenure issues, and forest degradation and conversion. The condition of forest resources is considered to be at risk. Unfortunately, efforts to conserve and sustainably utilize these biological resources are insufficient, largely due to a lack of awareness regarding the importance of forests (Dereje Denu, 2007). While deforestation is acknowledged in the remaining forested regions of the country, accurately estimating the rate of deforestation has proven challenging. The primary driver of the rapid deforestation in Ethiopia is the continuous growth of the human population, which leads to an increased demand for agricultural and grazing land, as well as forest resources for firewood, charcoal, timber, construction, and various other needs. According to community data, several factors threaten the Zara Natural Forest and put it at risk for the future, including the expansion of agricultural land, road and building construction, grazing, and firewood collection.

Additionally, natural factors such as soil degradation and erosion, similar to those affecting other Ethiopian forests, also pose a threat. Therefore, it is essential to manage the forest area to allow for the natural regeneration of plant species.

Distraction of ZNF by Natural and Man-made activities (photo by Jilalu Hassen, 2025).

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In the research area, 66 plant species belonging to 54 genera and 40 families were identified. The Zara Natural Forest exhibits low floristic diversity. The family with the highest number of species was Fabaceae, which included eight species, followed by Asteraceae with seven, Rosaceae with four, and both Euphorbiaceae and Solanaceae, each contributing three species. The study noted the presence of significant species such as *Juniperus procera,Podocarpus falcatus, Ficus sur, Erythrina abyssinica,* and *Hagenia abyssinica,* all of which have a considerable basal area. The total basal area for the site was determined to be 19.58 m^2/ha, with the five dominant woody species comprising 71.19% of this area. Additionally, the overall density of all plant species in the Zara Natural Forest was found to be 2542.94 stems/ha. An analysis of the height class distribution for four selected woody species revealed two primary patterns. The first pattern, represented by *Juniperus procera* and *Hagenia abyssinica,* showed a high number of individuals in the taller height classes and fewer in the shorter and mid-height classes, indicating a J-shaped distribution. The observed population patterns were J-shaped and bell-shaped, respectively.This type of population structure suggests limited regeneration and somewhat favorable conditions for recruitment, influenced by the characteristics of the plants and the area's microclimate (such as low light levels). The second population pattern shows a small number of individuals in the middle height class, with a higher count in the lower height classes, creating a bell-shaped distribution. This indicates moderate reproduction and good recruitment conditions, represented by species like *Podocarpus falcatus* and *Olea europaea*. This pattern is a result of the plants' characteristics, with fewer individuals in the lower height classes and more in the larger diameter (DBH) classes. The overall data on DBH classes for tree species in Zara Natural Forest reveals that the density of tree species increases with larger DBH sizes, indicating a prevalence of medium and large individuals in the area. Consequently, the results of this study suggest that the regeneration status of Zara Natural Forest is poor.

5.2 Recommendations

This study aimed to examine the composition of plant species, the structure of vegetation, and the management practices in the Zara Natural Forest. Key human activities identified in the area include the use of plants, like*Juniperus procera* and *Podocarpus falcatus*, for house construction, overgrazing, road construction, and other natural factors such as inadequate regeneration. These elements have significantly impacted the dynamics and density of the forest's vegetation. To reduce the current human and natural impacts on the area and to promote sustainable management for the future, the following recommendations are proposed:

- It is crucial to improve forested areas to support the natural regeneration of woody species and to raise awareness among local communities and government officials about the importance of conserving forest resources and the ecological impacts of forest degradation.
- Local communities are becoming more aware of the value of forest resources and their ecological significance.
- A forest management program should be developed and implemented to encourage local communities to take ownership and responsibility for the management and protection of the forest.
- Regular forest inventories should be conducted, and comprehensive research should be initiated to document the uses of various plants.
- While the current study has focused on cataloging plant types, their structures, and management practices, further botanical research is needed to identify effective forest management systems, ensure the sustainable use of natural vegetation resources, and create suitable conservation strategies for vegetation regeneration.

REFERENCE

Abate A, 2008.A floristic composition and structural analysis of Denkoro Forest, South Wello.MSc.Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Abiyou T, 2015 Structure and regeneration states of Menagesha Amba Mariam forest in central highlands of shewa, Ethiopia' Agriculture, Forestry and Fisheries, 4(4),p. 180.doi: 10. 11648/ j. aff. 20150404.16.

Addo-Fordjour,P.,Obeng,S.,Anning A. and Addo,M, 2009.Floristic composition,structure andnatural regeneration in a moist semi deciduous forestfollowing anthropogenic disturbances and plant invasion.*Int. J. Biodivers.Conserv*.**1:** 21- 37.

AlemayehuWassie, 2007. Ethiopian Church Forests: opportunities and challenges for restoration. PhD Thesis, Wageningen University, Wageningen.The Netherlands

Alemayehu Wassie, Demel Teketay and Powell N, 2005. Church forests in North Gonder Administrative Zone,northern Ethiopia. *Forests, Trees and Livelihoods,* **15**: 349- 373.

Anonymous,2009.Convention on Biological Diversity (CBD) *Ethiopians 4th CountryReport*, AddisAbaba, Ethiopia.

Azene Bekele, 2007. Useful tree and shrubs in ethiopia: identification,propagation and management for 17 agro climatic zones.

Blanquet J,1932. Plant sociology.*The study of plant communities*.Hafner publishing company.New York and London.

Demel Teketay, 2001.Soil seed banks and regeneration of tropical forest plants.*BiodiversityNewsletter,* **1**(1): 4, 6 and 15.

Dhaulkhandi, M., Dobhal, A., Bhatt, S & Kumar, M., 2008.Community structure and regeneration potential of natural forest site in Gangotri, India.*Journal of Basic &Applied* Sciences, **4**: 49-52.

Dinkissa Beche, 2011. Floristic Composition, Diversity and Structure of Woody plant Species in Mengesha Suba State Forest, Central Ethiopia. MSC thesis submitted to Addis Ababa university faculty of life science

Duguma Asfaw, 2016. Floristic composition, structure, regeneration status and economic importance of woody plant species in Duro mountain forest.

Ehrlich, P.R. & Wilson, E.O, 1991. Biodiversity studies science and policy.Science 253: 758 Ethiopia.Research Report. Center for Human Environment, Addis Ababa, Ethiopia.

Endris Ahmed, seid Aliand Asefa Addisu, 2017.*International Journal of Biodiversity and Conservation.*

EnsermuKelbessa andSebsbe Demissew, 2014.Diversity of vascular plants taxa of the floraof ia and Eritrea.*Ethiopian Journal of science***,13**:34-40.

Eroglu S., Toprak S., Urgan O, MD, Ozge E. Onur, MD, Arzu Denizbasi, MD, Haldun Akoglu, MD, Cigdem Ozpolat, MD, Ebru Akoglu, M, 2012.Biodiversity and Traditional Knowledge.SaudiMedJ(Vol.**33**).Retrieved from: http://doi.org/10.1073/pnas.0703993104

FAO. 2008. Global forest resources assessment 2005. Food and Agriculture Organization of the United Nations, Rome

FAO. 2009. State of the World's Forests 2009. Food and Agriculture Organization of the United Nations, Rome.

FDRE (Federal Democratic Republic of Ethiopia)., 2003 State of environment report for Ethiopia, Published by environmental protection authority, Addis Ababa, Ethiopia.

Friis, I, SebsebeDemissew& van Breugel, P, 2011.Atlas of the potential vegetation of Ethiopia,Addis Ababa University. *Press* &*Shama Books, Ethiopia***,501:** 120-29.

Gadissa T, and Hundera K, 2008.Speciescomposition, Plant Community structure and Natural Regeneration status of Belete Moist Evergreen Montane Forest, Oromia Regional state, Southwestern Ethiopia. *Momona Ethiopian Journal of Science*.

Genene Bekele and Reddy P, 2015.Study of Vegetation Composition of Magada Forest, Borana Zone, Oromia, Ethiopia.*Universal Journal of Plant Science*,**3**(5): 87-96.

Getaneh Gebeyehu, Teshome Soromessa, Tamrat Bekele and Teketay Demel, 2019.Species composition, stand structure, and regeneration status of tree species in dry Afromontane forests of Awi zone, northwestern Ethiopia. *Ecosystem Health and Sustainability*.vol. **5**.

Getaneh H, and Seid A, 2015.Floristic composition, structure and regeneration status of Achera Natural forest in chilga district, northwest Ethiopia, Ethiop. *J. Biol. Sci.*

GetinetMasresha, 2015.Status and Species Diversity of Alemsaga Forest, Northwestern, Ethiopia.

Giriraj,A., Murthy, M., and Ramesh, B, 2008.Vegetation composition, structure, and patternsofdiversity: a case study from the tropical wet evergreen forests of the Western Ghats, *India. Edin.*J. Bot., **65**: 1– 22.

Haile Yineger, EnsermuKelbessa, Tamrat Bekele and Ermias Lulekal,2008.FloristicComposition and Structure of the Dry Afromontane Forest at Bale Mountains National Park.*SINET: Ethiop. J. Sci*., **31**(2): 103-120.

Hailemariam,M.B and Temam,T.D, 2018. the vegetation composition, structure and regeneration status of Gole Natural forest, Wast Arsi zone ,Oromia regional state Ethiopia, *Journal of Agricultural science and Botany*,**02**(02).doi: 10, 35841/2591-7897.2.2.10-21.

Hedberg, I., S. Edwards and S. Nemomissa , 2003.Flora of Ethiopia and Eritrea. 4,1. Apiaceae to Dipsacaceae, Part 1. The National Herbarium, Uppsala, Sweden, ISBN- 13: 9789197128551, Pages: 352.

Hedberg I, Friis I and Edwards S, 2004.Flora of Ethiopia and Eritrea.Asteraceae.Part 2. Vol. 4, Addis Ababa University, Addis Ababa and Uppsala University, Uppsala, Pages: 408.

Hedberg I, E. Kelbessa, S. Edwards, S. Demissew and E. Persson, 2006. Flora of Ethiopia and Eritrea: Gentianaceae to Cyclocheilaceae. Vol. **5**, The National Herbarium, Uppsala, Sweden, ISBN-13: 9789197128568690, Pages: 690.

Jennings, M., Jennings, O., Glenn-Lewin, D., Peet, R., Faber-Langendoen, D., Grossman, D., Damman,G., Barbour, M., fister, R., Walker, M., Talbot, S., Walker, J., Hartshorn, G.Waggoner, G.Waggoner, G., Abrams, M., Hill, A., Roberts, D. and Tart, D, 2003. Guidelines, for describing Associations and Alliances of the U.S.

Kent, M. and Coker, P, 1992.Vegetation Description and Analysis.A practical approach. John Wiley and Sons, New York, 363p

Kflay,G& Kitessa H, 2013.Species Compostion, Plant community structure & Natural Regeneration Status of Belete Moist Ever green Montane Forest, Oromia Reginal State, South Western,Ethiopia. *Ethiopian, J.Sci:*(METs),V.**6**(1): 97-102

Kumilachew Yeshitela and Tamirat Bekele, 2002.Plant community Analysis and Ecology of Afromotane and Transitional Rainforest vegetation of south western Ethiopia.SINET: *Ethiop.J,of sci***., 25:** 155-175.e.

Lalfakawma, 2010.Disturb and Perish, Conserve and Flourish Regenerating Forests. *A Review Science Vision,***10**: 3-7.

LegesseNegash, 2002. Review of research advances in some selected African trees with special reference to Ethiopia. *Ethiopian Journal of science*,**1**(1): 81-126.

Leitner W and Turner W, 2001.Measurement and analysis of biodiversity. In: Levin S.A (ed.) *Encyclopedia of biodiversity, Vol **4***. Academic Press, Princeton, pp 123-144.

Leul kidane, 2003.Floristic composition and human interaction in the Hugumborda Gratkassu forest.M.sc.Thesis Addis Ababa university.

Lisk F,1985.Popular participation in Planning for Basic Needs, Gower House: and Croft Road Alder Shot HampShire England**. 8:**231-274.

Martin, F.S. and van Noordwijk, M, 2009.Trade-offs analysis for possible timber-based agroforestry scenarios using native trees in the Philippines. *Agroforestry systems*, **76**(3): 555- 567.

Mesfin W, Zerihun W and Lulekal E, 2018.Species diversity, population structure and regeneration status of woody plants in Yegof dry afromontane forest, South eastern Ethiopia, *European Journal of advanced research in Biological and life science* , **6**(4), pp. 20-34.

Million Bekele and Leykun Berhanu, 2001.State Forest Genetic Resources in Ethiopia.Sub-Regional workshop FAO/IPGRI/ICRAF on the conservation, management, sustainable utilization and enhancement of forest genetic resources in Sahelian and North-Sudanian Africa (Ouagadougou, Burkina Faso, 22-24 September 1998).Forest Genetic Resources Working Papers, Working Paper Forestry Department, FAO, Rome.

Mishra, A.K. and Spreitzer, G.M, 1998. Explaining how survivors respond to downsizing: The roles of trust, empowerment, justice, and work redesign. *Academy of management Review*, **23**(3): 567-588.

Muller D. and Ellenberg H, 1974.Aims and Methods of Vegetation Ecology.

Muluken Nega, Teshome Soromessa and Eyale B, 2014.Carbon Stock in Adaba Dodoly Community Forest of Danaba District.West-Arsi Zone of Oromia Region, Ethiopia: An implication for Climate change Mitigation. *Journal of Ecology and the Natural Environment***7**(1): 14-22.

Mwa vu and Ed T. Witkowski, 2009.Population structure and regeneration of multiple-use tree species in a semi-deciduous African tropical rainforest: Implications for primate conservation. *For. Ecol. Manage***, 258**(5): 840-849.

.

Okiror, P., Chono, J., Nyamukuru, A., Lwanga, J.S., Sasira, P. and Diogo, P, 2012.Variation in woody species abundance and distribution in and around Kibale National Park, Uganda. *ISRN Forestry*, *2012*.

Rönnbäck, P., Kautsky, N., Pihl, L., Troell, M., Söderqvist, T. and Wennhage, H, 2007.Ecosystem goods and services from Swedish coastal habitats: identification, valuation, and implications of ecosystem shifts. *AMBIO: a Journal of the Human Environment*, ***36***(7): 534- 544.

Rodrigo, L. C., Ernani, M. F. and Elcida, L.A, 2007.Conservation Priorities and Population Structure of Woody Medicinal Plants in an Area of Caatinga Vegetation (Pernambuco State, NE Brazil). *Environ Monit Assess,***132**: 189–206.

Shannon, C. E.,& Wiener, W., 1949.The mathematical theory of communication.University of Illions Press.

Shiferaw Belachew, 2010.Floristic composition, Structure and regeneration of Sese Forest, Oromia National Regional State, Southwest Ethiopia.MSc.Thesis.

Sosef *et al.*, 2017. The flora of Ethiopia is an estimated number of indigenous plant species.

Swamy, P. S., 2000. Plant species diversity and tree population structure of a humid tropical forest in Tamil Nadu, India. *Biodiversity and conservation*.9, 1643-1669.

Tamrat Bekele., 2002.Studies on remnant Afromontane forests on the central plateau of Shewa, Ethiopia.Ph.D.Thesis.Uppsala University, Sweden.Pp.59.

Yap, Kioe-Sheng, 1990.Community Participation in Low Income Housing Project people prospect, *community development of Journal*, **25**(1); 521-540.ue in Ethiopia. *European Journal of Botany, plant science, and phytology*, **1**: Pp. 10-17.

Zelalem Teshager., 2018 woody species diversity, structure and regeneration status in Amhara regional state, Ethiopia: *Journal of Natural Science Research*.Implication of Managing Forest for Biodiversity Conservation.

Zerihun Tadesse, 2015.Floristic Composition and plant community analysis of vegetation in Ilu Gelan District, West Shoa Zone of Oromia Region, Ethiopia.MSc Thesis, Addis Ababa University, Ethiopia.

Zerihun Woldu, Feoli E and Lisanwork Niguu, 1999.Partitioning an elevation gradient of vegetation from south eastern Ethiopia by probabilistic methods vegetation, **81**: 89- 198.

APPENDICES

Appendix ⅰ: Eight years (2005-2012 EC.) monthly total rains falls in(mm) and mean annual Minimum and Maximumtemperature (^{O}C). Indibir station 22 km away from study area.

Rainfall												
Year	JA	FE	MA	AP	MA	JU	JUL	AU	SE	OC	NO	DE
2005	35.4	0.0	31.7	34.6	30.8	181.7	334.5	227.9	181.2	50.3	21.0	2.6
2006	7.7	33.8	143.6	89.0	140.0	177.6	253.6	296.7	186.5	75.8	6.0	7.4
2007	43.5	89.9	98.4	68.4	148.1	146.3	249.8	256.4	298.7	46.5	0.0	0.0
2008	2.5	6.8	7.3	94.3	235.6	183.0	319.8	226.0	117.0	69.0	80.5	0.0
2009	41.7	34.2	50.2	63.2	56.9	82.8	327.4	248.6	73.8	57.3	2.8	51.0
2010	25.8	58.2	68.0	103.7	252.4	196.0	375.4	285.9	131.7	18.9	7.4	20.1
2011	0.0	0.0	77.9	58.4	238.7	314.6	257.6	323.1	117.4	8.3	41.3	0.0
2012	2.0	0.0	7.4	46.9	49.5	224.5	256.5	221.1	168.8	19.3	0.0	4.2
Ave	13.01	44.58	60.56	69.81	144.00	188.31	296.82	260.71	159.38	43.17	26.50	16.30

Temperature

T.Max	24.9	25.6	24.6	25.0	24.6	22.4	20.4	20.8	22.3	23.5	25.2	23.8
T.Min	8.2	9.0	10.4	11.6	10.2	11.8	11.3	11.0	10.7	8.2	7.6	5.3
Ave	16.55	17.3	17.5	18.3	17.4	17.1	15.85	15.9	16.5	15.85	16.4	14.55

Appendix ⅱ: Families with number of species recorded in Zara Natural forest

No	Family Name	No of Species	%	No	Family Name	No of Species	%
1	Acanthaceae	1	2.5	21	Horbiaceae	1	2.5
2	Apiaceae	1	2.5	22	Hypericaceae	1	2.5
3	Apocynaceae	1	2.5	23	Lamiaceae	1	2.5
4	Ancardiaceae	2	5	24	Lianthaceae	1	2.5

5	Areceae	2	5	25	Menispermaceae	1	2.5
6	Asclepiadaceae	1	2.5	26	Moraceae	1	2.5
7	Astraceae	7	17.5	27	Myrtaceae	2	5
8	Aryllidaceae	1	2.5	28	Oleaceae	1	2.5
9	Balsaminaceae	1	2.5	29	Phytolaceae	1	2.5
10	Celastraceae	1	2.5	30	Podocarpaceae	1	2.5
11	Companalaceae	1	2.5	31	Primulaceae	2	5
12	Crassulaceae	1	2.5	32	Proteaceae	1	2.5
13	Cucurbitaceae	2	5	33	Ranthaceae	1	2.5
14	Cupressaceae	2	5	34	Rhamnaceae	1	2.5
15	Dichapetalaceae	1	2.5	35	Rosaceae	4	10
16	Dioscoriaceae	1	2.5	36	Sapindaceae	1	2.5
17	Dryoteriaceae	1	2.5	37	Scrophulariaceae	1	2.5
18	Euphorbiaceae	3	7.5	38	Solanaceae	3	7.5
19	Fabaceae	8	20	39	Sterculiaceae	1	2.5
20	Flacourtiaceae	1	2.5	40	Teliaceae	1	2.5

Appendix Ⅲ: List of Plant Species of Zara Natural Forest in Central Ethiopian regional state.

No	Scientific Name	Family	Local Name	Growth Habits
1	*Justicia schimperiana L.*	Acanthaceae	Sensen	S
2	*Rajania cordata L.*	Dioscoriaceae	Yefur gero	CL
3	*Periploca sepium Bunge*	Apocynaceae	Yedber wedere	CL
4	*Carissa spinarum L.*	>>	Wetera	S
5	*Rhus nantalensis Bernh. Ex Krauss*	Ancardiaceae	Kushem	S
6	*Phoenix reclinata Jacq.*	Arecaceae	Ersiye zenbaba	T

7	*Borassus aethiopum Mart.*	>>	Nekiye zenbaba	T
8	*Vernonia amygdalina Delile.*	Astraceae	Gora	S
9	*Inuia confertifiora A.Rich.*	>>	Monare	S
10	*Vernonia auriculifera Hiern.*	>>	Huret	H
11	*Solanecio gigas (Vatke) C.Jeffrey.*	>>	Yegawa andahore	S
12	*Haplocarpha* rueppelii (Sch.Bip.) Beauverd.	>>	Eakure eset	H
13	*Cirsium discolor*(Muhl.ex Willd.) Spreng.	>>	Zambeden	H
14	*Carduus chamaecephlus* (Vatke) Oliv.& Hiern.	>>	Etaysohe	H
15	*Gomphocarpus integer* (N.E.Br.)Bullock.	Asclepiadaceae	Afakeu	S
16	*Scadoxus multiflorus* (Martyn),	Aryllidaceae	Solla	H
17	*Impatiens tinictoria* A.Rich.	Balsaminaceae	Enshoshila	H
18	*Maytenus arbutifolia* (A.Rich.) Wilczek.	Celastraceae	Atate	T
19	*Lobelia giberroa* Hemsl.	Companalaceae	Gemare	S
20	*Kalanchoe densiflora Rolfe.*	Crassulaceae	Andahore	H
21	*Juniperus procera Hochst.ex Endl.*	Cupressaceae	Abesha det	T
22	*Cupressus lusitanica Mill.*	>>	Evehar det	T
23	*Cuccinia abyssinica (Lam.) Cogn.*	Cucurbitaceae	Wanjofers	CL
24	*Momordica foetida Schumach.*	>>	Shemchachinet	CL
25	*Dichapetalum cymosum*(Hook.) Engl.	Dichapetalaceae	Adda	S
26	*Matteuccia struthiopteris*(L.) Tod.	Dryoteriaceae	Anbesa eset	H
27	*Ricinus communis* L.	Euphorbiaceae	Kebbo	S
28	*Euphorbia abyssinica* J.F.Gmel.	>>	Adamy	S
29	*Euphorbia candelabrum* Kotschy	>>	Kulkal	T
30	*Acacia vachellia Wight& Arn.*	Fabaceae	Gerar	T

31	*Sesbania sesban (L.) Merr.*	>>	Shawshawiye	S
32	*Erythrina abyssinica DC:*	>>	Burat	T
33	*Crotalaria longirostrata*Hook & Arn.	>>	Kuashekuashiey	S
34	*Calpurnia aurea*(Aiton) Benth.	>>	Anfugatere	S
35	*Vachellia abyssinica*(Hochst.ex.Benth).	>>	Lefeto	T
36	*Acacia dealbata*Link.	>>	Watogerare	T
37	*Vachellia nilotica*L.	>>	Gerare	T
38	*Hypericum revolutum*Vahl.	Hypericaceae	Abeja	S
39	*Clutia abyssinica*Jaub.&Spach.	Horbiaceae	Emukir echea	H
40	*Ocimum utricifolium*L.	Lamiaceae	Fuanfua	H
41	*Stephaniaabyssinica*(Qurt.-Dill.& A.Rich.) Walp.	Menispermaceae	Forefimate	CL
42	*Ekebegiacapensis*Sparrm.	Meliaceae	Kerero	T
43	*Ficus sur*Forssk.	Moraceae	Shebra	T
44	*Eucalyptus globulus*Labill.	Myrtaceae	Neche antacret	T
45	*Eucalyptus calmaldulensis*Dehnh.	>>	Bsha antacret	T
46	*Olea europaea*L.	Oleaceae	Wera	T
47	*Phytolacca dodecandra*L'H'er.	Phytolaceae	Endoda	H
48	*Podocarpusfalcatus*(Thunb.) C.N.Page	Podocarpaceae	Zigeba	T
49	*Myrisne Africana*L.	Primulaceae	Kichemo	S
50	*Maesa lanceolata*Forssk.	>>	Kelewa	T
51	*Gravillia robusta*A. Cunn. ex R.Br.	Proteaceae	Geravilia	T
52	*Englerina woodforiodioide*(Schweinf.) Balle	Ranthaceae	Shera	S
53	*Prunum africana* (Hook.f.)	Rosaceae	Werer	T
54	*Hagenia abyssinica*Willd.	>>	Chema	T

55	*Rosa abyssinica*R.Br.	>>	Enkoche	S
56	*Rubus steudneri*Schweinf.	>>	Engeba	H
57	*Rhamnus alaternus*L.	Rhamnaceae	Bitara	S
58	*Dodenaea angustifolia*(L.f.) Benth.	Sapindaceae	Hetehheta	CL
59	*Buddleja polystachya Fresen.*	Scrophulariaceae	Anfuar	S
60	*Discopodium penninervium*Hochst.	Solanaceae	Enchecheka	S
61	*Solanum incanum*L.	>>	Yegeya emborepore	H
62	*Datura stramonium*L.	>>	Afer emborepore	H
63	*Dombeyatorrida*(J.F.Gmel.) Bamps.	Sterculiaceae	Zeweter	T
64	*Dovyaliscaffra (*Hook.f.et.Harv.)	Salicaceae	Koshem	T
65	*Bersama abyssinica*Fresen.	Francoaceae	Abariyet	S
66	*Erythronium japonicum*	Liliaceae	Ekonche eset	H

Key:-

T= TREES

S= SHERUBS

H= HERBS ANDCL= CLIMBERS

Appendix IV: Listof eight tree species recorded in Zara Natural Forest with their Relative Dominance, Relative Density, Relative Frequency and Important Value Index.

No	Scientific Name	Family	RDO	RD	RF	IVI
1	*Juniperus procera*	Cupressaceae	25.20	7.78	26.76	59.74
2	*Podocarpus falcatus*	Podocarpaceae	14.94	4.61	19.72	39.27
3	*Calpurnia aurea*	Fabaceae	14.85	4.58	14.08	33.51
4	*Vachellia abyssinica*	>>	13.14	4.03	7.04	24.21
5	*Prunus pomaderris*	Rhamnaceae	9.90	3.05	11.26	24.21

6	*Prunum Africana*	Rosaceae	9	2.77	8.48	0.25
7	*Averrhoe bilimbi*	Oxalidaceae	6.84	2.11	5.62	14.21
8	*Erythrina abyssinica*	Fabaceae	6.12	1.89	7.04	15.05

Appendix V: Status of five important plant species in the forest and their growth habits.

Selected plots	Selected plant species	Growth habits			Total
		Seedling	Sapling	Adult tree	
Plot-1	Acacia dealbata	4	21	119	144
Plot-6	Calpurnia aurea	8	13	144	165
Plot-13	Juniperus procera	12	30	238	280
Plot-17	Podocarpus falcatus	0	19	147	166
Plot-24	Vachellia abyssinica	16	20	110	146
Density/ha		28.27	72.81	535.87	636.95

Appendix VI: Interview Guide for Experts from the Geta District Forest and Environmental Protection Bureau

Dear respondents, I would like to express my gratitude for your willingness to participate in this interview. The objective of this discussion is to gather information for a study aimed at evaluating the floristic composition, vegetation structure, and management practices of the Zara Natural Forest. This research will be beneficial for various organizations, including government bodies and scientists focused on biodiversity and future studies. Your insights are crucial for the success of this study, so I kindly ask for your full cooperation in providing accurate information for easy transcription. Please rest assured that your responses will remain confidential.

Instructions:- Please listen to the following questions and the possible responses, which reflect the opinions, feelings, and reactions we expect from you. Then, provide your answers verbally to the person asking the questions.

1. What is your view on the conservation of the Zara Natural Forest area? _____

2. Which organization is responsible for overseeing and managing the Zara Forest? _____

3. As a government agency, what are your office's responsibilities and authority regarding the conservation and management of the Zara Forest? _____

4. How do you collaborate with local community members? _____

5. Do you believe that local communities understand their ownership and the benefits of the forest? _____

6. What measures have been implemented? _____

7. What is your perspective on involving local community and religious leaders in the restoration of the forest? _____

8. Do you believe that you provide financial and training assistance to religious leaders to improve forest habitats? _____

9. Have you monitored the conservation condition of the forest? _____

10. What factors contribute to the degradation of the forest? _____.

Appendix VII: Interview Guide for Local Community Members

A semi-structured interview will be held to collect pertinent information for a study investigating community perceptions and the condition of the Zara Natural Forest. This research will be beneficial to various professionals, organizations, and government agencies dedicated to biodiversity conservation. You have been selected for this study because your insights on the subject are invaluable; thus, your full cooperation in providing important information is greatly appreciated. Thank you for your willingness to participate in this questionnaire.

Instructions: - Please listen to the following questions and the options provided regarding your opinions, feelings, and reactions, and then provide the necessary information by signing for the interviewer.

Part 1: General Information

Gender _____ Age _____ Kebele _____

Woreda _____ Zone _____ Region _____

Ethnic Group _____

1.Knowledge on the current states of the Zara forest? A. very good B. Good C. Rarely D. No at all

2. How often do you direct participate in forest management activities? A. Frequently B. Rarely C. No at all

3. Who is responsible for the forest's protection? A. Children B. Farmers C. Government D. Non-Government E. All individuals

4. What is the importance of the forest? A. Social benefit B. Cultural benefit C. Economic aspects D. Ecological balance

Part 2:Feelings the necessary information

1. What is your age, education level, and religion? _____ _____

2. What are your views on the current state of the Zara forest? _____ _____

3. Are you involved in forest management activities? If so, how frequently do you participate? _____

4. In your view, who is responsible for the forest's protection? _____

5. What advantages does the forest offer you in terms of social, cultural, and economic aspects? _____

6. Do you think the forest holds significance for both the local community and the nation? _____

7. What actions do you believe are needed to rehabilitate the forest ecosystem? _____

8. If you have any additional recommendations, please share them. _____