EFFECT OF AREA CLOSURE ON SELETED SOIL PHYSICO-CHEMICAL PROPERTIES AND WOODY SPECIES DIVERSITY IN WARJA WATERSHED, EAST SHEWA, ETHIOPIA

MSc thesis

By

Lilo Gemechu Duguma

October 2019

Jimma, Ethiopia

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Submitted to the Department of Natural Resource Management, Jimma University College of Agriculture and Veterinary Medicine, in Partial Fulfillment of the Requirements for the Degree of Master of Science in Natural Resource Management (Watershed Management)

Major Advisor: Alemayehu Regassa (PhD)

Co-Advisor: Amsalu Tilahun (Ass. Prof)

October 2019

Jimma, Ethiopia

APPROVAL SHEET

Jimma University College of Agriculture and Veterinary Medicine

Thesis Submission for External Defense Request Form (F-07)

Name of student: Lilo Gemechu ID No: RM1147/10

Program of the study: MSc. Natural resource management (watershed management)

Title: Effect of Area Closure on Selected Soil Physico-Chemical Properties and Woody Species Diversity in Warja Watershed, Adami Tulu Jido Kombolcha East Shewa, Oromia Regional State, Ethiopia.

I have incorporated the suggestion and modification given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the Department to allow me to submit my thesis for external thesis defense.

Lilo Gemechu ____________ _______________

Name Signature Date

We, the thesis advisors, have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

Major Advisor: Alemayehu Regasa (PhD)

Signature ________________________________Date______________________

Co-Advisor: Amsalu Tilahun (Ass. Prof)

Signature _______________________________Date_______________________

Decision/suggestion of Department Graduate Council (DGC)

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Chair Person, DGC Signature Date

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Chair Person, CGS Signature Date

STATEMENT OF AUTHOR

First, I declare that this thesis is my own work and all sources of materials used for writing has been properly acknowledged. This thesis has been submitted to Jimma University, College of Agriculture and Veterinary Medicine in partial fulfillment of the requirements for the Degree of Master of Science and is deposited at the library of the University to be made available to borrowers under the rules and regulations of the library. I declare that I have not submitted this thesis to any other institution anywhere for the award of any academic degree, diploma, or other certificates.

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Name: Lilo Gemechu Signature______________

Place: Jimma University, College of Agriculture and Veterinary Medicine

Date of Submission: __________________

DEDICATION

This thesis is dedicated to my family especially to my father Gemechu Duguma and my mother Adise Jaleta for their support and devoted partnership in the success of my life.

BIOGRAPHICAL SKETCH

The Author Lilo Gemechu was born in 1996 from her mother Adise Jaleta and her father Gemechu Duguma in Ebantu district, East Wollega Zone, Oromia Regional State, Ethiopia. She attended her elementary school at Hinde elementary school from 1999-2007.

Also her high school (grade 9 and 10) and preparatory at Hinde secondary and preparatory school from 2008-2009 and 2010-2011 respectively. After passing the Ethiopian Higher Education Entrance Qualification Certificate Examination, she joined Wollega University in 2012 and graduated in 2015 with Bachelor of Science Degree in Soil Resource and Watershed Management. Following her graduation, the University employed her as graduate assistant. Then after, she joined Jimma University College of Agriculture and Veterinary Medicine in October 2018 to pursue her MSc studies in Natural Resource Management (Watershed Management).

ACKNOWLEDGMENTS

Above all, I would like to thank my Almighty God for helping me in duties of my health and education to pass through this master program and all time grace that gave me courage to start and finish this thesis work. I would like to express my special appreciation and heartfelt gratitude to Dr. Alemayehu Regassa (major advisor) for his consistent guidance, encouragement and critical remark while developing the proposal and for his constructive and valuable comments that shaped this thesis. I wish to express my gratitude to Mr. Amsalu Tilahun (Ass. Prof) (co-advisor) for his irreversible advice, comments and supports in my thesis work. I also extend my special thanks to Wollega university for the sponsorship as well as Jimma university for helping me with different facilitates. I would like to acknowledge Batu soil laboratory research center staffs to the support and collaboration during data collection and soil laboratory analysis. My special gratitude goes to my mother and father for their endless support and unreserved moral and material supports throughout my postgraduate study. Finally, I would like to acknowledge all my friends, fellows and individuals whom I did not mention, but contributed indirectly or directly to the successful completion of my study.

LIST OF ACRONYMS AND ABBREVIATIONS

AC	Area closure
ASLNP	Awash Shalla Lakes National Park
ATARC	Adami Tulu Agricultural research center
ATJK	Adami Tulu jido kombolcha
AV.k	Available potassium
AV.P	Available phosphors
Ca	Calcium
CEC	Cation Exchange Capacity
CRGE	Climate-Resilient Green Economy
CSA	Central Statistical Agency
CSI	Channel State Information
EC	Electrical conductivity
FAO	Food and Agricultural Organization
GPS	Global Position System
K^+	potassium cation
MANR	Ministry of Agricultural and Natural Resource
MEA	Millennium Ecosystem Assessment
Mg	Magnesium
Mg^{+2}	Magnesium cation
NGO	Non-Government Organization
NF	Natural Forster
OM	Organic Matter
P	Phosphorus
SM	Soil Moisture
SNNPR	Southern Nations Nationalities Peoples Region
SPSS	Statistical Package for Social Science
SWC	Soil and Water Conservation
TN	Total Nitrogen
UNEP	United Nations Environmental Program

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ABSTRACT

Land degradation has been a major challenge of environmental problem in highlands of Ethiopia. In East Shewa, as part of the government responses to land degradation, area closure has been mainly implemented to improve land management and the sustainability of environmental resources. This study was initiated with the objective of investigating the effect of area closure on selected physicochemical properties of soils and woody species diversity in Warja watershed, Adami Tulu Jido Kombolcha districts, East Shewa. Systematic sampling method was employed to take vegetation and soil sample. Sampling plot of 20mx20m was established for quantitative data for both vegetation data and soil samples. Sample of woody species, regeneration and soil were taken from both area closure and adjacent open grazing land. The soil samples and vegetation data were taken from 9 plots for each site. Both disturbed and undisturbed soil samples were collected from topsoil (0-30 cm and soil laboratory analysis were done for bulk density, soil texture, soil moisture, soil PH, Av. P, Av. K, total N, CEC, $Mg^{+2,}$ K^{+}, Ca^{+2}, Na^{+} and EC. These data were analyzed by using Excel spreadsheet and SPSS software. Also independent t-test was employed to evaluate the significance level. The analyzed data of all soil physicochemical properties were shown significant differences except soil texture class, Mg^{+2} and $K^{+.}$ The total density of individuals woody species in the area closure and adjacent open grazing land were 938.75/ha and 352.75/ha respectively. The diversity of all woody species in area closure was greater than in the adjacent open grazing land. The total density of regeneration in study site were 1,056.5 /ha. Out of this, the regeneration species in area closure were 867.75/ha while the density of regeneration in adjacent open grazing land were 197.75/ha. The in area closure total mature trees were greater > seedlings >sapling. Both species diversity and regeneration of vegetation in adjacent open grazing land and area closure revealed significant difference. Therefore, this study comes up with the evidence that the establishment of area closure improved woody species diversity and soil physicochemical properties of degraded land of the study area. Thus, area closure plays a key role to rehabilitate woody vegetation diversity and soil qualities of degraded land. This study did not assess the status of herbaceous plant species diversity and the extent to which enclosures in the study area could reduce soil loss compared to open grazing lands. So other researcher can be to assess area closure will significant or not.

Keywords: Area closure, Open grazing, Regeneration, Soil physiochemical properties, Species diversity, and Warja watershed

1. INTRODUCTION

1.1. Background

Natural resources are in rapid anthropogenic driven changes throughout the world. These rapid changes brought are about by land cover changes, fragmentation, invasive species and pollution (MEA, 2005). Fragmentation of natural ecosystems occurs whenever removal of pre-existing land cover and replacement of other cover types occur, be it urban, agriculture, forestry production or other anthropogenic land uses (Hobbs and Saunders, 1993; Schwartz, 1997). In many developing countries, the resource base has been deteriorating over time and there is severe problem resulted in natural capital asset depletion, drought, environmental and ecological imbalance. Deforestation is a conventional environmental challenge substantially affecting the resilience and distribution of forests across different boundaries. It simply defined is as the loss of trees cover usually because of forests cleared being for other land uses (Gorte and Sheikh, 2010).

Over the years, the world has experienced unprecedented loss of its forests particularly in tropical areas, though it observed is on a global scale that the rate of deforestation has shown signs of a decrease. This is because of the high rate of deforestation, which is still alarming; the world had lost over 4 billion hectares of forested area, which corresponds to an average of 0.6 ha forest per capita (FAO, 2010). Such disturbances were caused by both natural and human influence that has been resulted in forest dynamics and loss of tree diversity at local and regional scales (Sapkota *et al.,* 2009) and regeneration and dominance of tree species (Lawes *et al.*, 2007). The other cause of land degradation in Ethiopia was overgrazing which is most affecting the reduction of natural resource. Overgrazing in the central Rift; valley area has resulted in increased erosion and runoff, which may have affected the regional hydrology (Hengsdijk and Jansen, 2006). However, there is a prospect of reverting vegetation degradation by taking proper vegetation restoration measures and incentive schemes to the local communities (Feoli and Zerihun, 2000).

Enclosures (area closures) are among various land management and rehabilitation mechanisms that are flourishing strategies practiced to improve species diversity, soil quality and ecosystem productivity (UNEP, 2010). An area closure is areas closed off from the interference of human and domestic animals with the goal of promoting natural regeneration of plants and reducing land degradation of formerly degraded communal grazing land (Mekuria and Aynekulu, 2011).

Rehabilitation of natural vegetation provides multipurpose benefits like animal fodder, fuelwood access, fiber, access of medicinal plants. Also rehabilitation of soil fertility (Example: Leguminous plants) and provide habitats for various beneficial species (pollinators and biological control) and wildlife as well (FA0, 2005). An area closure established is usually in steep, eroded, and degraded areas that users have been for grazing in the past (Descheemaeker *et al.,* 2006). Indeed, laws and legislation should support community management systems to avoid the "tragedy of the commons". Enclosures with locality specific and community-based co-management systems are crucial and regarded can be as alternative approaches to managing degraded lands (Mekuria and Rao, 2002).

The importance of area closure to improve vegetation cover, composition, density, richness, diversity and providing economic and ecological benefits to local communities around is widely documented (Emiru, 2002; Tefera, *et al*., 2005; Emiru *et al*., 2006) in northern and southern Ethiopia. Furthermore, a study made to compare three area closures and an open area in terms of woody species diversity frequency and density revealed that area closures had higher values in these parameters than an open area (Yosef, 2015). According to Yosef, (2015), the reports from case studies conducted on closure in the central and northern highlands of Ethiopia; the closed area had twice the plant species richness. Diversity value compared with communal grazing lands after 22 years of closure establishment Tefera *et al.,* (2005) and an increase in soil organic matter of 1.1% and total nitrogen of 0.1% after 10 years of closure establishment (Mekuria *et al*., 2007). Also area closure technologies for restoration of degraded soils by establishing ecological based vegetation cover, using appropriate soil and water conservation measures.

1.2. Problem Statement

Studies indicated that the efforts made in the past have rehabilitated degraded farmlands and improved soil water holding capacities, increased woodlots, and improved the productivity of the pastured lands in some watershed in Ethiopia (Sonneveld and Keyzer, 2003). However, the current rate and status of environmental degradation still call for more extended and coordinated intervention actions to rehabilitate degraded lands (Edward, 2000; Kindeya, 2004; Mengistu, 2011). On the other hand, overgrazing reduces plant biomass causing reduced vegetation cover and productivity and replaces preferred species by less preferred species leading to species dominance (Keya, 1997; Oztas *et al*., 2003). As a result, overgrazing severely affects not only soil properties but also vegetation composition and diversity (Beukes and cowling, 2003), which were evident in this study. Therefore, area closures were suggestive defense measures for soil restoration, vegetation recovery and climate change mitigation (Mengistu, 2011).

Currently, the government of Ethiopia also has been the undertaking of the area closure practice through integrated and participatory watershed development approaches to improve rural livelihoods. Although sustainable natural resource management to ensure sustainable development for present and future generations. Because local farmers ultimately determine the use of area closure practice and SWC measures, clear knowledge of the local (factors that determine farmer's decisions) is an essential part of combating severe soil erosion (Nigatu *et al*., 2017). The Oromia regional state has been desalinating degraded land particularly around east Oromia (Harirage, Rift Valley, and east Shewa). To prevent environmental degradation and combat desertification by regenerating or restoration of soil quality, woody species and biodiversity. Case studies conducted in the highlands of Ethiopia have shown that exclosures can be effective in restoring degraded ecosystems increasing soil carbon content and adapting to climate variability. Other land restoration practices that involve a partial grazing exclusion successfully conducted have been in drylands of Africa (Zucca *et al*., 2013).

Different studies were done to assess the role of enclosures in the recovery of woody vegetation in degraded dryland hillsides of central and northern part in Ethiopia, (Mekuria and Veldkamp, 2012., Mekuria, 2013., Angassa, 2014., Papanastasis *et al*., 2015; Tarhouni *et al*., 2015; Alvarez-Martínez *et al*., 2016). More over other studies conducted by, (Haile and Fetene, 2012; Emiru and Haluf, 2013; Mekuria, 2015; Yosef, 2015; Wolde *et al*., 2016; Dabi *et al*., 2017), to evaluate effect of enclosure on restoration of soil in northwestern and east Shewa, Ethiopia. However, all of these studies conducted have been in only two or three villages and so cannot adequately represent the soil physicochemical properties and diversity of woody species in addition effect of area closure on species regeneration.

Despite many area closure practices in the study area, there is no study done to identify effects of the area closures on soil physicochemical properties and woody species diversity and species regeneration status. In these study areas, there was no high rainfall and good climate condition in case of these high desertification occur more degraded land. Based on this review this study was going to fill the above-mentioned gap by assessing the effect of area closures on physicochemical properties, woody species diversity and regeneration in warja watershed, Adami Tulu Jido Kombolcha woreda east Shewa, Ethiopia.

1.3. Objectives

1.3.1. General objectives

To examine the effects of area closures on selected soil physicochemical properties and woody species diversity in Warja watershed, Adami Tulu Jido Kombolcha district, Ethiopia.

1.3.2 Specific objectives

- To evaluate the effect of area closure on selected soil Physico-chemical properties.
- To identify the effect of area closure on the woody species diversity.
- To measure the effect of area closure on the species regeneration status.

1.4. Research Question

1. What are the effects of area closure on selected soil physicochemical properties in Warja watershed?
2. What are the effects of area closure on the woody species diversity in the study area?
3. What are the effects of area closure on the species regeneration status in Warja watershed?

1.5. Significance of the Study

The findings of this study will be important in providing insight into the importance of area closure for woody species diversity and soil physicochemical properties. Appropriate understanding of these factors in the Warja watershed would assist in the formulation and implementation of the policy interventions designed to induce voluntary continued use of area closure measures in Warja watershed. The knowledge of the effects of area closure on woody species diversity and soil physicochemical properties very crucial for the sustainability of woody species diversity, regeneration and soil physicochemical properties improvement.

The findings help NGO's those directly involved in providing training on the importance of area closure on woody species diversity and soil physico-chemical properties. It also has a great role in contributing the assessment of the problem under consideration and this paper provides the basis for decision-makers in planning, management of the structure, woody species diversity, soil Physico-chemical and to counteract the impact of destroyed on livelihoods of rural households. In addition, the study was used as the baseline for other researchers who want to undertake similar research.

1.6. Limitation of the Study

To assess the effect of area closures on woody species diversity and soil physico-chemical properties baseline data was required. However, due to time and budget limitation, this study focused was only on Warja watershed and used only one period of data to conduct this research. Additionally, there was a lack of access to past-recorded data in the study area regarding this subject before area closure was established and before lands degraded. Therefore, the main limitations of this study were budget, time, and lack of baseline data on woody species diversity and physicochemical properties.

2. LITERATURE REVIEW

2.1. Definitions of Concepts

Area closure. Area enclosures are the type of land management implemented on degraded areas for environmental rehabilitation with a clear biophysical impaction large parts of the formerly degraded commons (free grazing lands) (Mekura, 2001; Betru, *et al.*, 2005). Area enclosure refers to the practice of land management whereby livestock and humans excluded are from accessing a severely degraded area of land. The practice is in line with Ethiopia's Climate Resilient Green Economy Strategy (CRGES, 2010) that calls for "Promoting area closure via rehabilitation of degraded pastureland and farmland. This also leading to enhanced soil fertility and thereby ensuring additional carbon sequestration as one of the strategies for protecting and re-establishing forests for their economic and ecosystem services, including carbon stocks (MANR, 2016).

Regeneration: The reproduction or renewal of tissues and cells, which used up and destroyed have been by the ordinary processes of life as, the continual regeneration of the epithelial cells of the body, or the regeneration of the contractile substance of muscle. The union of parts, which have been severed, so that they become anatomically perfect as, the regeneration of a nerve. Also following the regeneration of vegetation on the degraded lands, particularly emphasizing the benefits gained from reduced soil erosion on the lower slopes of the watersheds. It found has been that the rate at which closed areas regenerate depends on the degree of degradation, climatic factors and the scale of management it receives. (Harmon *et al.*, 1999, Janet *et al.,* 2007). Regeneration is a central component of forest ecosystem dynamics and restoration of degraded forestlands. Sustainable forest utilization is only possible if adequate information on the regeneration dynamics and factors influencing important canopy tree species are available Tropical forests revealed variation in patterns of regeneration both through differences in their constituent species and the environmental variables in which they grow (Teketay 2005; Tesfaye *et al.*, 2010).

Land degradation: Land degradation is the undermining of the quality of soil because of human behavior or severe weather conditions. This process of reducing the quality of soil called land degradation, and it can put stress on the environment, affecting the production of food, as well as the quality of air and water. Drought, flooding and human activities, such as deforestation, agriculture and urbanization, can all put multiple pressures on fertile land, causing the soil to become degraded or polluted (Emiru, 2002 ; WMO,2005).

Rehabilitation: Seeks/search to/try to find to repair damaged ecosystem functions and to active measures (planting, seeding, and watering) are costly and may thus not often be applied. Using and favoring natural processes rather than human inputs. Ecological rehabilitation creates sustainable environment and less destructive relationship between humans and natural systems. If the basic rehabilitation planning done is appropriately while removing ecological stresses, ten or less years may often be enough for nature to recover from damage (Caldwell, 1972; Cairns, 1994).

Restoration: To return a habitat or ecosystem to a condition as similar as possible to its pre-degraded site attempts to re-create the ecosystem structure, functions, diversity and dynamics. Over time, many of the functions and ecological services will closely match those of the original ecosystem restoration deals with the reconstruction of natural or semi-natural ecosystems on degraded or modified lands (Eshetu 2002, Walker and Del Moral 2003).

Watershed: Watershed Management is the process of developing and implementing a series of actions for the management of natural, agricultural, and human resources. Watershed has to provide required and appropriate goods and services to society under the precondition that land and water resources are not negatively affected. Watershed management needs to consider the prevailing socio-economic and institutional factors within and beyond the watershed (FAO, 1987).

Soil: Soil is a natural unit generated interference at the lithosphere and atmosphere under the mutual process of pedogenetic factor and soil binding element between an organic and organic matter live organism in the earth. Soil is unconsolidated mineral or organic matter on the surface of the earth that subjected and shows effects of genetic and environmental factors of climate (including water and temperature effects). Moreover, macro- and microorganisms, conditioned by relief, acting on parent material over a period (CVUT, 1994).

Species diversity: Species diversity is a measurement of biological diversity to found be in a specific ecological community. It represents the species richness or number of species found in an ecological community, the abundance (number of individuals per species), and the distribution or evenness of species. Species diversity refers to species richness and how evenly species' abundance is distributed. Species richness refers to the number of species in an area. Species abundance refers to the number of individuals per species (Kate, 2015).

2.2. Effect of Area Closure on Soil Physicochemical Properties

The vegetation rehabilitation through enclosures was competent measures for soil and water conservation; because they were the best alternative forms of land uses to overcome erosion and deposition (FAO, 2001). Vegetation cover promotes infiltration rate, structure, and permeability of underlying soil. Soil with good structure absorbs water quickly and minimize surface runoff (Wild, 1993). In Ethiopia, the practice of area closure has become an important strategy in rehabilitating degraded hillsides, especially in the highlands due to their remarkable improvement of land productivity and soil erosion reduction (WFP and MoA, 2002). According to Kidane, (2002) establishing intergraded watershed management involving conserving, upgrading and using of the natural resource. In addition, the base of the land, plant, water, animal and human resources through enclosures with effective local people participation is a basis to prevent further ecological imbalance. After implementation, natural regrowth of vegetation occurs; having a positive biophysical impact on formerly, degraded commons graze the land. The ability of these areas to recruit and sustain diverse vegetation and wild fauna is one measure of their contribution to biodiversity and forest resource conservation (Mastewal *et al.*, 2007).

Area closures are determinant ways of rehabilitating severely exploited vegetation has and degraded dryland environments and established due to their advantages in being cheap, quick and lenient to return degraded sites (Bendz, 1986). Studies indicated that enclosures often involve restriction of humans and livestock has and improved biomass production. Additional it improves species composition, density, richness, and diversity as well as soil diversity than the open sites (Kebrome, 1998). The purpose of exclusion of animals and humans was to prevent further degradation of the ecosystems, advance re-vegetation and restore ecology condition (FAO, 2016). Also, according to this enhances the growth of grass and woody vegetation helps to rehabilitate the specified area and improves the microclimate, which is a strong climate adaptation mechanism. Moreover, area enclosure is an intervention measure that boosts land productivity and plays a key role in carbon sequestration, therefore mitigating climate change as well. As various studies, on the value of area closures in Ethiopia, all generally with an indication that the practice has both economic and environmental benefits (resilience and adaptation to climate change). According to Makki and Geisler, (2011) history of enclosures in Africa was associated with the expansion of European overseas missions and its effect in expanding the productive role of capitalism. Area closure practiced has been in seriously degraded watersheds and the rehabilitation activities implemented are (partly) through community mass mobilization efforts.

Local people expressed their opinion that the enclosures had increased grass cover, decreased soil erosion, and increased water availability (CSI, 2015). Area closures promote vegetation coverage, which enhances the amount of accumulated SOM leading to improved physical and chemical properties of soil and overall health of the ecosystem. Soil organic matter often influences soil properties such as soil structure, moisture, diversity and activities of soil organisms (Bot and Benites, 2005). The available water holding capacity of soil increases by 3.7% for every 1% increase in soil organic matter (Hudson, 1994). Soil organic matter is an essential soil component hence it helps to improve soil physical conditions, increase water infiltration, decrease soil erosion, supply available plant nutrients and augment soil's cation exchange capacity (Bandel *et al*., 2002).

Soil loss in Ethiopia due to water erosion was a serious economic and environmental problem. Physical and chemical properties following the establishment of enclosures was understanding would help such as: (1) inform land managers working on the restoration of degraded ecosystem to improve ecosystem services, and (2) maximize carbon sequestration and other ecosystem services from existing enclosures established in degraded ecosystems (Mekuria *et al.*, 2014). Enclosures are playing an important role in conserving remaining soil resources and improving soil fertility. Area closures improve soil fertility by augmenting soil nutrients from decomposed plant remains (Tizita, 2016). Area closures also limit nutrient loss from a site by controlling runoff (vegetation acting as a physical barrier to soil erosion). This eventually improves the capability of the land to support other vegetation types, including exotic plantations, or otherwise support livestock (Tefera *et al.*, 2005).

The relatively large increase in the total soil N and available P storage in the first 5 years after establishing area closure may have resulted from the management rule that restricts grass harvesting for 3 to 5 years (Mengistu, 2011). After enclosure, establishment and subsequent increased organic matter input derived from herbaceous species biomass, from reduced soil erosion through effective ground cover, and from relatively slow decomposition under drier and cooler climate (Mekuria *et al.*, 2011). In addition, it shows the positive correlation of soil nutrient content and soil properties in area closure with woody species biomass, vegetation canopy cover, and enclosure duration. Indicate that enclosures influenced soil nutrient content and soil properties through a higher organic matter input into the soil with time. Other studies also reported increasing soil nutrient retention in the ecosystem along with the number of plant species and aboveground biomass (e.g., Johannes and David, 2000; Loreau *et al*., 2001). Furthermore, the increases in canopy cover with the increase in enclosure duration could decrease sediment-associated soil nutrient losses by reducing the erosive impact raindrop of the sand soil erosion (Tsetargachew, 2008; Girmay *et al*., 2009; Mekuria *et al*., 2009).

According to Yosef, (2015) in the central Rift Valley, Ethiopia area closure brought changes was by rehabilitating degraded lands and eventually brought economic, social and ecological benefits to the local communities. In addition to area closure is good practice, which used rehabilitate species diversity and regeneration while improved soil quality. However, there is a prospect of reverting vegetation degradation by taking proper vegetation restoration measures and incentives schemes to the local communities (Feoli and Zerihun, 2000), since the gene, pool necessary for recovery of natural vegetation is still available in the area (Hengsdijk and Jansen, 2006).

2.2.1. Physical properties of soil

Soil physical properties are important for agricultural land management and soil physical conditions such as moisture storage capacity, rooting condition, and plant nutrients related are to soil physical properties. According to study Talore *et al*., (2015), further explained that such soil properties influence the rate of biomass recycling back to the soil, soil structure, and water holding capacity and turnover and dynamics of soil organic matter. Three main soil physical properties, i.e. texture, bulk density, and soil moistures are consistency reviewed in this paper.

2.2.1.1. Soil moistures

Area closure is an established fact that increasing organic matter increases the soils moisture (Brady and Weil, 2002). The smallest value of water retained in soils under open land, which considerably varied from that of soils under the closed area. Soil moisture content was found to be higher under enclosure than in open grazing land use due to higher soil organic carbon and decreased soil bulk density (Mekuria *et al*., 2016), on the soil restoration after seven years of exclosure management in northwestern Ethiopia. According to Shagufta *et al*., (2017) Soil moisture contents were significantly higher in soils of the protected area as compared to open grazed site. There is a strong positive correlation between soil moisture contents and plant biomass, unmanaged grazing site than the site that protected was for 12 years (Jeddi and Chaieb, 2010). Protection of this rangeland from grazing also caused a change in SOM contents, soil aggregation, and soil moisture. Also suggested that, this rangeland has good potential for rehabilitation when it protected was from grazing and high soil moisture.

2.2.1.2. Soil texture

The texture of the soil in the field is not readily subject to change; textural differences observed were among various land-use types particularly due to the changes in clay and sand fractions (Tizita, 2016). It also shows about closed area soil were dominated by clay fractions whereas open land grazes soils were dominated by sand fractions. So open land graze a place that dominated was by clay fraction these also line of (Tizita, 2016).

It is that management practices generally do not alter the textural class of soil on a field scale; management practices have indirect roles in doing. So Pedologic processes such as erosion, deposition, illuviation, and weathering which shaped are by management practices of area closure can alter the texture of soils (Brady and Weil, 2002). The presence of good vegetation cover in the area closure reduced erosion through the addition of organic matter to reduce the amount of sand parentage and surface litter (Scare, 1991). Under conditions of low vegetation cover as in the open land case, clay fractions are likely to be lost through processes of selective erosion and migration down the soil profile, which ultimately increases the proportion of sand and silt contents in surface soils (Bewket, 2003). This due to the course textural nature of the soil of the study site or due to the age of the area closure. According to Wolde, (2004) found that, coarse-textured soil bulk densities not affected were by grazing intensity but, the slight difference found in this study can be explained by their difference in SOM content and compaction due to livestock trampling effect. That means when the amount of soil organic matter increases, decrease amount of sand fraction. According to Mulugeta and Karl, (2010) and Yihenew *et al*., (2009) also reported that, soil under no conserved treatment found was to exhibit higher soil bulk density than treatments by SWC structures.

2.2.1.3. Soil bulk density

The higher soil bulk density under open grazing land use attributed is to the lower SOC and the effect of soil compaction due to livestock trampling (Mengistu, 2011). Also, according to Bewket and Stroosnijder, (2003) indicate that, higher soil bulk density under open grazing land than the enclosure. Soil bulk density was determined using the core method and calculated as the mass of oven-dried soil (105 °C) divided by its volume (Chen *et al.*, 2010). The higher value of bulk density of the open land was due to the trampling effect from the livestock population grazing and the direct impact of raindrops on the area (Mekuria, 2016).

Soil bulk density in the land degradation continues unabated resulting in loss of soil and soil organic carbon and ultimately deterioration the soil quality and poor agricultural performances (Mekuria *et al.*, 2014). According to the result reported by Tizita, (2016) there was a statistically significant difference in bulk density levels between closed areas to open land. The higher value of bulk density of the open land is due to trampling effect from the livestock population grazing and the direct impact of raindrops on the area. Overgrazing led to the degradation of vegetation, soil compaction, and wind and water erosion. Higher bulk density on open land led to a decrease in water infiltration capacity, causing in its turn, a higher surface run-off, which may lead to significant soil erosion.

The soil erosion problem affects the recruitment of new grass seedlings and sapling. There is also soil crusting and sealing in the open land because of lack of vegetation cover, which in turn increases bulk density. The increases in canopy cover within the closure could decrease soil nutrient losses by reducing the erosive impact of raindrops and soil erosion (Mekuria *et al*., 2009). There is also soil crusting and sealing in the open land because of lack of vegetation cover, which in turn increases bulk density. The increases in canopy cover within the closure could decrease soil nutrient losses by reducing the erosive impact of raindrops and soil erosion (Tsetargachew, 2008; Girmay *et al*., 2009; Mekuria *et al*., 2009).

Also, show statistical analysis revealed soil bulk density was significantly improved with the implemented rehabilitation practices where the highest value (1.26g/cm3) was observed at degraded grazing land and lowest at land treated with elephant grass and sesbania. Further, elephant grass and sesbania had similar effects on soil bulk density. Perhaps, the achieved bulk density improvement is due to organic matter addition from the plants, reduction of physical soil loss, and exclusion of grazing practices and human interference (Tamrat *et al.*, 2018).

2.2.2. Soil chemical properties and nutrients

2.2.2.1. Soil organic matter (SOM)

The organic matter content of the soil taken is as a crude measure of fertility status. It is estimated indirectly from the organic carbon determination. Inorganic matter considered is to improve water holding capacity, nutrient release and soil structure (Mekuria *et al.,* 2014). According to Mekuria and Veldkamp, (2005) reported as, the soils of open lands and closed areas differed considerably in the content of soil organic matter (SOM), with significantly higher SOM values found in closed areas than in open lands. So that SOM content in the closed area was the highest and the SOM, content in open land was lowest. Zewudu, (2002) reported that, trees planted for the rehabilitation of degraded sites have improved SOM and this will lead to seedling recruitment and survival. The higher SOM contents in closed areas compared to that of adjacent open land explained could be by the difference in soil erosion and biomass return (Mengistu, 2011). Reduced erosion expected is to occur in well-developed closed areas because of the canopy formed by the mature shrubs and under-story vegetation. The other reason for increment in organic matter in a closed area is the accumulation of litter dominantly from grasses. In addition, less biomass return causes the reduction of SOM and TN in adjacent open lands (Mueller-Harvey *et al.,* 1985).

Moreover, it may be due to improvement in soil qualities like SOM, assisted availability of essential plant nutrients that improved the health and function of environment for the growth and development of woody vegetation stem groups in enclosures than open grazing lands. Tilman *et al*., (1996) support this assumption, research result that states improved soil condition due to proper land management promotes the accumulation of environmental variables like SOM. Furthermore, according to the result, Tilman *et al*., (1996) enhances ecosystem health, species composition, diversity, and land productivity as a whole. Thus, environmental factors mainly SOM (%) had a positive correlation to the improvement of vegetation diversity. The study indicated that an increase in SOM had increased diversity of vegetation categories or it may be due to improvement in vegetation cover accumulated.

The most evident impact of grazing on the ecosystem was the removal of a major part of aboveground biomass by livestock. In general, as the litter covers increases, soil loss decreases exponentially (Coppin and Richards, 1990). Furthermore, Bewket and Stroosnijder, (2003) claim in their finding that many studies examining the effect of deforestation on soil nutrients concluded that after removal of forest vegetation, soils deteriorate in their chemical properties including organic matter content.

According to Dereje *et al*., (2003); Lemma *et al.,* (2015) reported that, inputs from the vegetation can have a positive impact on the organic carbon concentrations into the soil system. Also a study conducted by Wolde *et al*.,(2007) shows soil organic carbon and soil nutrients under area closure are significantly different compared to the adjacent free grazing lands. In addition, studies by Yihenew *et al.,* (2009) and Kebede *et al.,* (2011) on crop field also reported that, the non-conserved fields had lower SOC as compared to the conserved fields with different conservation measures. Show in all conservation or in the protection of soil, soil organic carbon are significant differences. Also according to Mulugeta *et al*., (2005a) this result, reporting the decrease in vegetation cover and disturbance of the natural ecosystem has caused widespread soil degradation, with an attendant decline in concentrations of soil organic carbon. Furthermore, in most of the instances, total organic carbon content is higher in grazing land soils than those soils found under cultivated fields (Dereje *et al*., 2003).

A relatively lower level of disturbance in grazed soils has apparently led to an increase in organic matter content as compared to those cultivated soils. Though the absence of such soil disturbance minimizes rapid loss of soil OM, the export of nutrients and low biomass return after grazing have contributed much to its decline compared to observations made in the forest soils (Emiru and Heluf, 2013). Indicated that temporal change in vegetation diversity and richness from lower to a higher degree can change SOC concentration through the enhanced sediment trapping efficiency. The studies by Wolde and Veldkamp, (2005) in Tigray on a semiarid continental climate indicated significant improvement in SOC an area closed for 5 years.

2.2.2.2. Total nitrogen (TN)

In view of high nitrogen requirements of plants and low levels of available N in virtually all types of soils. It is considered the most important and dynamic nutrient element in managed ecosystems. Soil total N composed of inorganic (NH^{4+}, NO^{3-} and NO^{2-}) and organic forms (OM) are subject to change due to various factors. Management (cropping, erosion, and leaching) and climate (temperature and moisture) determine its level and dynamics (ICARDA, 2001). Management conditions, especially conservation and rainfall generate dominant influence on amounts of nitrogen found in soils. Reduction in organic matter content of a soil is an obvious reason to expect relatively low nitrogen content in the open land (Tsetargachew, 2008). This indirectly suggests that the biological conservation measures on the closed area have contributed to the sustainable management of land through replenishing soil nutrients.

According to Mekuria and Veldkamp, (2005), reported that total nitrogen (%) was significantly higher in closed areas than in open lands. As the grazing intensity increases, higher percentages of mineral soil nitrogen would get more inactive, therefore, fewer amounts of dynamic exchanging nitrogen would be released (Sanadgol *et al*., 2002). On the other hand, areas which non-grazed by animals had higher soil nitrogen content due to their dense vegetation cover, particularly nitrogen stabilizing plants like legumes and large volumes of plant roots in their soils. An addition of a relatively higher plant residue and minimal rate of decomposition might be responsible for a higher amount of total N in natural forest soil as described by (Kreast *et al.,* 2008). Also, Seubert *et al.,* (1977) found that, the topsoil N status remained higher when the soil was cleared by slash and burning than when it was cleared by bulldozing. Furthermore, a minimum of two decades was required to increase the soil nutrient content in the communal grazing lands to the level of soil nutrient content in church forests through area closure establishment (Mekuria and Aynekulu, 2011). Though, in this there could be further potential to restore more total soil N after about 20 years as the studied church forests influenced were by human and domestic grazing animals and not considered areas in climax condition.

According to Tsetargachew, (2008) and Mekuria and Veldkamp, (2005) reported that, total nitrogen (percentage) was significantly higher in closed areas than in open lands. In the case of area closure, it increases the amount of organic in soil. Mean TN under closed area practice was higher compared to the content under adjacent grazing land. The lower TN under open grazing land was due to lower organic matter content. Total N showed a significant correlation with SOM (+0.75, p £ 0.01) (Lemma, *et al*., 2015). A study by Kumlachew and Tamrat, (2002) also reported that, the total nitrogen content of the soil in different communities varies with the amount of organic matter. Similarly, Mulugeta and Karl, (2010) reported that, the land with physical SWC measures has high total nitrogen as compared to the non-conserved land. The mean TN, SOM, and TC were higher under the closed area with and without SWC than in under adjacent open grazing land.

2.2.2.3. Available phosphorus (Av.P) and available potassium (Av.K)

Of all the major plant nutrients, phosphorus possibly the most complicated chemistry in the soil, at least as far as the assessment of P levels and the P fertilizer requirements are concerned (Tizita, 2016). However according to (Bewket, 2003 and Tsetargachew, 2008) found that available phosphorous there is no difference between closed areas to open land. Also in relative terms, available phosphorus levels in soils of the closed areas were generally lower than the open lands, despite the higher SOM contents of the closed areas. The unusual feature here is that the available P contents of these soils did not necessarily increase with increased soil OM. Additional according to Mengistu, (2011) the low available P in the closed area could be due to the presence of P in its unavailable forms. However, the pattern of distribution of available phosphorous among the area closure practice suggests that the establishment of area closure did not bring a significant change in the availability of this vital nutrient (Tizita, 2016). The relatively high content of available phosphorus in the forest soil could be due to the high content of soil organic matter resulting in the release of organic phosphorus, (Gebrelibanos and Mohammed, 2013).

However, according to the finding of the research of mathows *et al*., (2016) available phosphorus were, varied within the land types, slope gradients, and the soil depths. The mean values of Av.P for the un-conserved land were (8.07±2.28) and for the conserved land were (12.12 ± 6.00); this showed that there was a highly significant variation between the land types. The mean value of Av.P in soil under conserved lands was relatively higher than in the non-conserved lands. This could probably be due to higher organic matter content in the conserved plots than in the non-conserved ones. Furthermore, the findings of Worku *et al*., (2012) who stated that Av-K and Av-P concentrations in farm plots with soil conservation structures found were to be significantly higher than in the adjacent non-conserved farm plots. Also according to the ratings of available P by Barber, (1984) there is, medium to the low concentration of available P in the soils of the study area. This might be because of low availability of phosphorus in acidic soil since both the pH of the conserved as well as the un-conserved land were low and found in the range of acidic soil. The significantly higher soil nutrients content in communal grazing land compared with exclosures attributed could be to better vegetation growth in exclosures (Mekuria *et al*., 2015). Also increased vegetation cover and favorable soil properties (i.e. higher soil pH and moisture content; which consequently increased microbial activities, nutrient availability and nutrient uptake by plants. Such higher nutrient uptake results in lower soil nutrient content in exclosures (Mekuria *et al*., 2016).

2.2.2.4. Cation exchange capacity (CEC)

According to Mengistu, (2011) cation exchange capacity (CEC) is higher in closed areas than in open lands that means the CEC under closed area was significantly greater than the open lands. The higher CEC in closed areas compared to the Mengistu land explained could be by the difference in organic matter and clay content among the land use types. It serves for the overall assessment of the potential fertility of the soil, and possible response to fertilizer application. Most studies showed that there are direct relationship between organic matter, clay content and CEC (Mekuria and Veldkamp, 2005). The low CEC in cultivated land was in line with the low clay and organic matter contents of the soils.

The soil CEC values in agricultural land use decreased mainly due to the reduction in organic matter content (Nega and Heluf, 2009). The computed correlation coefficient has indicated a strong and positive association between soil CEC and organic matter contents. Thus, the degradation of organic matter had left the soil of cultivated land with low CEC. Soil CEC is important for maintaining soil fertility as it influences the total quantity of nutrients available to plants at the exchange site (Yitbarek *et al.*, 2013). CEC increased with high clay content. Topsoil chemical properties have improved with continuous cultivation because of fertilizer additions. Soil CEC increased by following the conversion of forest to crop fields (McGrath *et al.*, 2001).

2.2.2.5. Soil pH

Soil pH is sensitive to changes in the natural environment and soil management processes due to human activity. Deforestation of forest resulting loss of basic cations through soil erosion, and leaching due to adequate rainfall, forms the major cause for the change in pH and acidification process in the tropics (Smith *et al*., 1995). Mean soil pH was slightly higher in the enclosure due to the effects of organic matter that trap base cations as compared to the open grazing land (Mekuria, 2016). The soil under enclosure has a higher soil organic carbon than open grazing land, which is effect of organic matter accumulation through liter fall from the trees/shrubs.

Furthermore Mekuria and Veldkamp, (2005) reported that, grazing land and enclosure differ considerably in their soil organic carbon content reflecting the higher amount in enclosures than in open grazing land. Overgrazing led to the degradation of vegetation, soil compaction, and wind and water erosion. According to Landon, (1991) the overall mean pH value of the study site ranges between from (5.42 to 4.52), thus was categorized in moderately acidic to strongly acidic soil pH class. In the general the area closure practice on difference, the study shows the significance of the soil properties (pH).

2.2.2.6. Soil electrical conductivity (EC)

Electrical conductivity (EC) of soil solution shows the indirect measurement of salt content (Brady and Weil, 2002). In their study, Lemma *et al*., (2015) found that, the soil EC under the closed area with SWC were significantly lower than the soil under open grazing land due to relatively higher organic matter content in the closed area. Since pH has a positive correlation with EC, relative increasing of soil pH increases the value of EC in the soil of the conserved land (Mathewos, *et al*., 2016).The higher EC under open grazing land maybe because of higher evaporation rate that increases soil salinity level. In addition, the finding by Seifi *et al*., (2010) report that, an increasing concentration of electrolytes (salts) like calcium salt (calcium carbonate) in the soil will dramatically increase soil EC.

2.2.2.8. Exchangeable of cation

The exchangeable cation of soil hence, the concentration of this cation exchangeable rated was as high for both closed and adjacent open lands where they fully saturated the soil exchange complex (Tizita, 2016). Furthermore, according to the rating set by Landon, (1991) soils having exchangeable Ca less than 4.0, between 4.0 and 10.0 and > 10.0 ($comi_c$ kg_{-1}) were considered as low, medium and high, respectively. The soils of the surface soil samples of both closed area and adjacent open grazing land rated are as high in their exchangeable Ca contents (Mekuria, 2016). The analysis of the exchangeable Na varied significantly between closed area I, adjacent open land I, closed area III, adjacent open land III, closed area II and adjacent open land II) (Tizita, 2016). This was probably low soil erosion in the closed area than the adjacent open land. These show when area closure practice on the land it effects or significant change on the cation exchangeable.

Generally, in both closed and adjacent open lands of composite surface soil, the proportions of the cations were in the order of Ca> Mg > K > Na. According to Havlin *et al*., (1999) the prevalence of Ca followed by Mg, K, and Na in the exchange site of soils is favorable for plant production. This related might be to the parent material from which the soils developed have been from basalt rock and their differential attraction to the soils' exchange complex, which was approximately in that order. Relative to the un-conserved land the conserved one has higher potassium content; this is because soil conservation practices, which applied were on the land, have created a conducive environment for the progress of the nutrient availability in the soil. There was a positive correlation between organic matter and exchangeable cations of a soil (Wild, 1993). Stable SOM pool also improves soil fertility by holding plant nutrients and preventing them from leaching into the subsoil. This might be due to its continuous losses of the cation through lack of proper management, continuous cultivation of crops on the land and free grazing of the land by cattle beyond it carrying capacity as also reported by (Baker *et al.*, 1997). These explain the change of land conserved in the cation exchangeable.

According to (Mathews *et al.*, 2016) reported show the exchangeable of potassium , in the conserved land was (177.52±43.40) as indicated in this shows that there is a significant difference in potassium content between the two land types. The mean value of the available potassium for the un conserved land was (104.57 ± 18.29). The mean exchangeable K^+ contents of the three factors were significantly different ($p < 0.05$) from each other due to the interaction effects; which is the surface soil of the conserved gentle slope land has higher mean exchangeable potassium content relative to the subsurface soil. The un-conserved steep slope land and the ranges of mean exchangeable K^+ values observed in the study area found were in the range of high to a very high level as the rating of soil nutrients indicated by (Barber, 1984).

Generally, there are lower exchangeable K^+ contents in the un-conserved area than in the conserved area. However, according to Bewekte, (2003) report that, K^+ and Na^+ contents of the soils show statistically there is no differences among the land use types and between the villages. This suggests the absence of any effect that link can be to land-use dynamics in the watershed. These findings on the exchangeable bases content of the soils under the different land-use types with those of (Saikh *et al*., 1998b) who reported, the amount of Ca^{2+} and Mg^{2+}·decrease in land use types. However, K^+ and Na^+ levels after conversion of forest to farmland it might be changed. Soil exchangeable bases (Na^+, K^+; $Ca^{2+;}$ Mg^{2+}) were significantly ($P<0.05$) improved in lands treated elephant grass and sesbania (Tamrat *et al.*, 2018). The highest quantity of exchangeable bases recorded was at land treated with elephant grass and sesbania while the lowest at grazing land.

The presence of high soil organic matter and clay fractions contributed are for better CEC and exchangeable bases at lands treated with elephant grass and sesbania (Tamrat *et al.*, 2018). Gebeyehu, (2007) reported that, deforestation, leaching, limited recycling of dung and crop residue in the soil, declining of fallow periods or continuous cropping. In addition, soil erosion has contributed to the depletion of basic cations (Na^+, K^+, Ca^+, and Mg^{+2}) and CEC on the un-conserved agricultural lands as compared to the adjacent forestland. The exchangeable magnesium content was significantly ($p < 0.01$) affected by the land types, the slope gradient sand the soil depths. Considering the main effects of land types, the higher mean value of exchangeable magnesium (Mg^{2+}) was (6.31 ± 0.99) under the conserved land and the lowest value was (4.20 ± 0.90) on the un-conserved land (Mathews *et al,* 2016).

2.3. Effect of area closure on species diversity

The diversity of tree species is a fundamental component of total biodiversity in many ecosystems because trees are ecosystem engineers that provide resources and habitats for almost all other forest organisms (Huston, 1994). In tropical forests, the diversity of tree species varies by geography, habitat parameters, and levels of disturbance (Whitmore, 1998). The spatial heterogeneity of diversity may be the result of some underlying pattern or process such as environmental heterogeneity, biotic control, and abiotic/biotic coupling process (Pringle, 1990). Spatial patterns of species richness used have been extended to identify biodiversity "hotspots" (Parviainen, *et al.*, 2009).

Species diversity was the number of different species in particular area (species richness**)** weighted by some measure of abundances such as the number of individuals or biomass. However**,** conservation biologists of area enclosure often use the term species diversity even when they are referring to species richness, i.e.to number of present is species (Harrison *et al.,* 2004). According to Noss, (1990) report, species diversity as a composition that refers to the identity and variety of elements in a population includes species lists and measures of species diversity and genetic diversity. Due to the complexity of biodiversity and of forests ecosystems, complete assessments of biodiversity are not practically achievable (Humphrey and Watts, 2004) because, the impossibility to monitor all taxa or features (Linden Mayer, 1999).

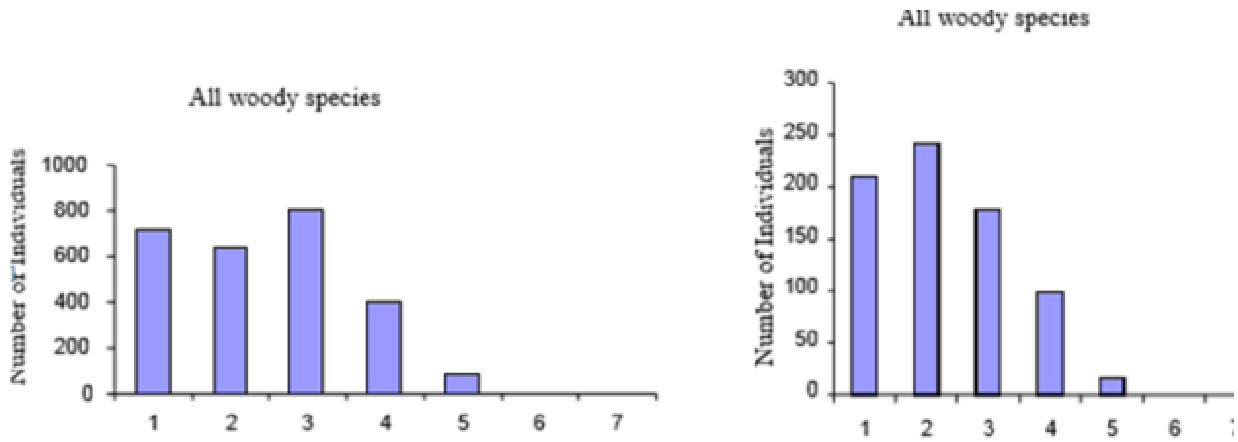
Additional according to Haile, (2012) closed area, 93 individual trees and shrubs and 173 herbs were found whereas in the non-closed area 41 individual trees/shrubs and 149 herbs were found. This shows that the case of the area closed practice had more trees and herbs enriched than the non-closed. Furthermore conduct Yaynishet *et al*., (2008) revealed that, the density of woody species enclosure is more than twice that of adjacent browsed areas. Betru *et al*., (2005) the report also, found the average number of species per plot is higher in closed areas than in open areas indicating that there was more species diversity in the enclosure. This difference could be due to the protection of human beings and domestic animal disturbance and this might be motivated seed germinating and growing up (Demel, 1996).

Higher densities of woody species in area closures compared to open areas supported were by other researches findings (Kindeya, 2003; Kibret, 2008). According to study Ambachew, (2006) reported that, the highest diversity value at seven-year-old area closure explained by the influence of dominant and rare species present in the area. Increasing trend diversity along with increasing age categories of the closures. This might indicate that the existence of variations in species diversity within different age categories of area closures because of the heterogeneous distribution of species due to time factors (Mengistu, 2011). The species evenness also showed a significant difference among age categories of area closures.

The nature of the substrate can also vary depending on the type of enclosure and species held the grass, sand, concrete, bark chipping, and gravel were common substrates in zoos today. In order to prevent claw/hoof/foot problems, it was important to consider the type of substrate best suited for the specific species. According to Haspelag, (2013) elephants are more likely to suffer from foot problems when concrete used as floor substrate in the enclosure. A suitable substrate for elephants was not yet scientifically established and in the current study was found.

The species diversity and composition have been shaped in many ways by human beings, and it is believed no part of its tree and shrub diversity has been shaped was inadequate (Mengistu *et al.,* 2005). The assumption is that managing areas of high species richness equate to improved conservation outcomes. Therefore, richness usually is a positive predictor of places of area closure practice. Understanding species diversity and distribution patterns were important for helping managers to evaluate the complexity and resources of these forests. Quantitative plant diversity inventories if Indian tropical forests are available from various forests of Western Ghats (Jha *et al.,* 2005). A comparison of the species diversity of different vegetation types is difficult because of the dissimilarity of the available data.

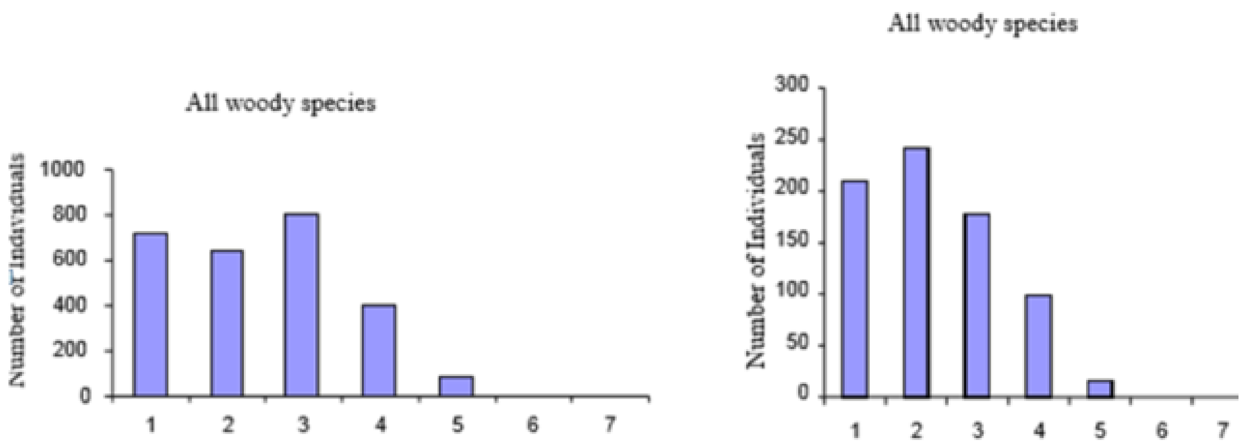
While many have been presented to date for assessing a different aspect of biodiversity in forest ecosystems (Smith *et al.,* 2008; Chirici *et al.,* 2012; Coote *et al*., 2013). However, in a review of NF was from 25 European countries and the United States, Chirici *et al.,* (2012*)* found that data on plant species diversity is limited in many countries. Because, ground layer vegetation is not included or is collected in different ways, making generalization very difficult. Development of an indicator for overall plant species diversity at forest stand level therefore would be of great value. The structural parameters and tree species records collected at the stand level in most NF was to enable growing stock estimations and other variables important for commercial forest management. Also, its important components for biodiversity because both horizontal (spatial) and vertical (stratification) heterogeneity and the array of tree species provide habitats for arranging of plants and animal species (e.g.Lindenmaye *et al*., 2000). Abundance (AB), density (DE), Frequency (FR), basal area (BA) and Importance Value Index (IVI) of woody plants sampled in unprotected grazing land in northeast Ethiopia



Height class heght class

Figure 1: Basal area m^2/ha distribution of woody species.

Recived by Mekuria,(2011) Diamete class 1<5cm,,2=5-10,3=10-15,4=15-20,5=20-25,6=25-30,7=30-35,8=35-40,9=40-45,10=450,11=>50cm



heghit class heghit class

Figure 2: Frequency distribution of height class (m).

for all wood species of enclosures and non enclosures heght1=<0.5m,2=0.5-1,3=1-1.5,4=1.5-2,5=2-2.5,6=2.5-3,7=>3m(recived by mekuria, 2011).

The diversity of woody species was fundamental to total forest biodiversity because woody species provide resources and habitats for almost all other forest species (Whitmore, 1998; Huange, *et al.*, 2003). Human population growth and the demand for natural resources have put great pressure on the biodiversity wealth of the world through deforestation and habitat fragmentation (Terborgh, and van Schaik, 1997; Noss, 1999). Ethiopia owns diverse vegetation resources that include high forests, woodlands, bushlands, plantations, and trees outside forests.

2.3.1. Species richness

According to Mcintosh, (2000) describe the number of species in the Community introduced the term species richness. The number of species in the community was the basic measure of species richness, defined by (Hill, 1973) as diversity number of 0th order, i.e. N0. The basic measurement problem of N0 that it was often not possible to enumerate all species in the population (Krebs, 1989). In addition depends on the sample size and the time spent searching, due to which its use as a comparative index was limited (Yapp, 1979). Hence, the number of other indices independent of the sample size proposed has been to measures species richness. These indices were usually based on the relationship between Sand the total number of find individual observed (Ludwig and Reynolds, 1988).

Species richness was considerably greater in plantation than control plots for grasses, vines, and forbs. Seedlings of several secondary forest species were abundant in the plantation understory but absent in control plots, suggesting an important role for such plantations in accelerating natural regeneration of native forest species (Parrotla, 1992).The most commonly reported pattern of biomass and species richness was the hump-shaped relationship (Grime, 1973a; Mittelbach *et al.*, 2001). The high number of species richness in this attributed to the presence of the high forest that contributes to the growth of many species.

On the other hand, also substrates, often resulting in a reduction in the richness and abundance of wood-inhabiting fungi, including rare species (Abrego and Salcedo, 2013; Halme *et al*., 2013).This general trend however, may not always hold, as the magnitude of the risk depends on harvesting intensity, site exposure and substrate characteristics Grime's work, many studies have argued that this relationship was unusually widespread for an ecological phenomenon (Tilman and Pacala, 1993). Diversity consists of species richness and species evenness where the former implies the total number of species in a community; while the later which also referred as equitability, explains a measure of the relative abundance of the different species making up the richness of the community (Magurran,1988).

2. 4. Effect of area closure on the structure and regeneration status

Regeneration potential is the ability of a species to complete the life cycle. Regeneration is a key process for the existence of species in a community under varied environmental conditions (Khumbongmayum *et al.,* 2005). Regeneration of any species is confined to a specific range of habitat conditions that determine its geographic distribution (Grubb, 1977). Survival and growth of seedlings/saplings determine the successful regeneration (Good and Good, 1972) which is perhaps the single most important step toward achieving long-term sustainability of forests (Saikia and Khan ,2013; Malik 2014; Malik and Bhatt, 2016).

Enclosure showed the potential or the restoration of wood community species and regeneration of species diversity in the area and the lower proportion of seedlings of the same species in the open area were less promising of area closure. (Swamy *et al.,* 2000). Also, according to Swamy *et al.,* (2000) show that the major species in the enclosure such as *Acaciaetbaica* and *Leucasoligocephala* represented were by high seedling proportion. These species could have seeds were easily germinating and match their seed dispersal to the rainy season. The high proportion of seedlings in the enclosure showed the potential for the restoration of a woody community. A lower proportion of seedlings of the same species in the open area were less promising species diversity experimental research (Demel, 2005). Enclosures are units in which living beings confined are, for instance, to reveal competitive relationships between different animal species (Manor and Saltz, 2008). Area closure to create a controlled environment for plant pollination studies (Jauker and Wolters, 2008).

Enclosures were a powerful tool in aquatic community studies, where they are used to manipulate environmental conditions or communities in ponds (Cottennie and De Meeste, 2004; Louette.*et al.,* 2006). Most seeds typically fall and establish less than 100 m from their parent plants for most tree and shrub species (Nathan and Muller, 2000; Meurk and Hall, 2006). This has two important implications for native restoration projects in urban environments. First, if a desirable goal was to increase wild native plant biodiversity in urban gardens, parks, and waste areas. Many small patches of native vegetation needed were throughout the urban environment to provide seed sources (Robinson and Handel, 2000). Indeed, seed dispersal limitation may explain the absence or rarity of many native species in New Zealand urban environments, with the notable exceptions of hand fully of weedy' natives such as *Cordyline australis, Coprosmarobusta, and ittosporumtenuifolium*, all of which are now widely established (Stewart *et al.,* 2004).

Seedling densities in forest under stories are dynamic and rates may vary among species and in gap and shade environments (Bazzaz, 1991). The rates also vary due to mortality, which could include abiotic stresses such as light, drought and biotic factors that include herbivory, disease or competition (Augspurger, 1984). Information on tree seedling ecology can provide options for forest development through improvement in recruitment, establishment and growth of the desired species (Swaine, 1996). According to studies Tesfaye *et al*., (2010) report that, regeneration studies have significant implications on the management, conservation and restoration of degraded natural forests. Production of seeds from adult trees, seedling survival and growth into saplings are also ecological characteristics of forests that determine successful regeneration in the forests (Khumbongmayum *et al*., 2006; Pokhriyal *et al.*, 2010; Saikia and Khan, 2013). Tree species are fundamental to the overall maintenance of forest biodiversity because trees provide resources and habitats for almost all other forest species (Rahman *et al*., 2011).

Restoring native vegetation in urban environments obviously involves more than filling space quickly. Using an adverse mix of native species in restoration projects will likely benefit frugivorous and insect rigorous birds by providing a food supply at all times of the year (Lucas *et al.,* 2004). While did not detect an increase in native seedlings in the plots of bird-dispersed species relative to the plots with wind-dispersed species, seedlings of several bird-dispersed native species did colonize the experimental plots. For trees and shrubs, their diameters were measured using diameter tape or caliper, while their heights were measured using graduated wooden rod or hypsometer as finding appropriate. No measurement made was for seedlings except counting. Plant species encountered in the plots were entities on spot using vegetation identification guides or manuals (Hedberg and Edwards, 1997, 2000; Hedberg *et al.,* 1995; Hedberg *et al*., 2006).

Trees form the major structural and functional basis of tropical forest ecosystems and can serve as robust indicators of changes and stressors at the landscape scale (Khan, 1997). Earlier studies of tropical tree regeneration have focused mainly on seedlings, which are usually more abundant than other life stages (Scholl and Taylor, 2006; Tripathi and Khan, 1997). Parameters of seedling stands are crucial components of tree population dynamics and composition of species structure (Clark, 1986). As floristic and structural composition changes from one community to another, there are concomitant changes in the competitive abilities of seedlings that depend on shifting opportunities for regeneration (Barker and Kirkpatrick, 1994). Recruitment, growth, and survival are influenced by a range of microclimatic and edaphic factors, which vary the amount of different tropical forest formations (Augspurger, 1984). MEF, (2012) analyzed tree turn over in 67 mature forest sites representing most of the major tropical forest regions of the world; across the sites, tree turnover had significantly increased since the 1950s. Increased tree turnover has positive impacts on atmospheric quality and biodiversity (Huston, 1994).

The woodlands typically comprise an upper canopy of umbrella-shaped trees; a scattered layer, often absent, of sub-canopy trees; a discontinuous understory of shrubs and saplings; and a patchy layer of grasses (Campbell, 1966). Differences in species composition, diversity and structure are more apparent at a local scale. The origin of these differences was unclear: geomorphic evolution of the landscape edaphic factors, principally soil moisture and soil nutrients and past and present land use and other anthropogenic disturbances have all been implicated (Cole, 1986;Chidumayo, 1987c;Campbell *et al.*, 1988). According to (Chidumayo, 1989a), anthropogenic activities play a big role in the dynamics of miombo woodlands.

3. MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Geographical location

Adami Tulu Jido Kombolcha (ATJK) district lies between 7^{o} 0’35”–8^{o}0’5” north and 38^{o} 0’20”- 38^{o} 0’55” east in the northern part of the Rift Valley. It is bounded by Dugda Bora Woreda in North, Southern Nations Nationalities Peoples Region (SNNPR) in the west, Arsi Negele in the south and Arsi zone to the east. Batu is the capital of the Woreda, which is 160 km away from Addis Ababa and 40 km Abjata Shalla Lakes National Park (ASLNP). (ATARC profile, 2004), and the Warja watershed is located in Adami Tulu Jido kombolcha woreda which lies between 7^{o} 0’56”–7^{o} 0’58” N to 38”0’40 ^{o} E occurred. This watershed area covers about 694.42 ha in which 54.4 ha is area closure, 473.87 ha is cultivated land, 23.26 ha is conservation structure and 142.85 is open grazing land. There is a watershed association the Warja watershed and the association was formally registered and given legal power over the use and management of natural resources. The Warja watershed association was also responsible for the management, protection, and use of area closures and other land rehabilitation efforts in the watershed. The association also ensures the sustainable management of area closures and protection of the SWC structures the watershed. In the Warja watershed, the area closure was established in 2004 EC (2011/12 GC). Accordingly, this area closure and adjacent open grazing land as a control treatment were selected for this study assuming that before the establishment of area closure and the adjacent open grazing lands was in similar condition (biophysical properties such as topography, climate, vegetation, and soil fertility). Because the area closure was established on the same adjacent open grazing land that was used for livestock grazing.

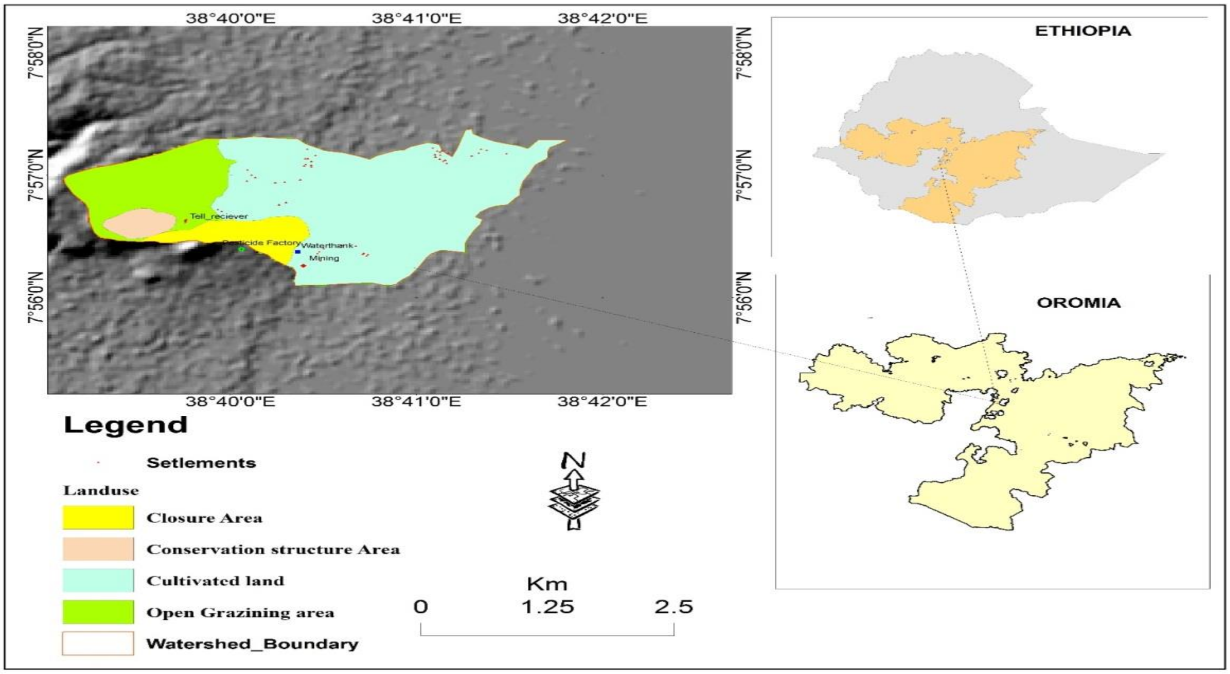


Figure 2: Map Warja watershed in Adami Tulu Jido Kombolcha District, Rift Valley,

Oromia reginal state.

3.1.2. Topography and climate

The area is characterized by plain and flatlands of volcanic origin with small mountains, hills, and gorges extending from the most northern part of Central Rift Valley. The altitude ranges from 1500-2300 m above sea level. The woreda has semi-arid and arid agro-climate zones. It receives an average annual rainfall of 760 mm. The mean monthly temperature varies from 18.5 ^{o}C to 21.6 ^{o}C with a mean annual temperature of 20 ^{o}C. Rainfall extends from February to September with a dry period from May to June, which separates the preceding short rains from the following long rains (ATARC profile, 2004**)**.

3.1.3. Vegetation, soil and land uses

The vegetation of the woreda is characterized by scattered acacia woodland which is categorized as tropical savannah. Acacia species were dominant trees and important means of livelihood for the local people. Most of the flat areas in the woreda are dominated by sandy loam soil types (Kasahun and Tesfaye, 2014). The pH of the soil is 7.8 (ATARC profile, 2012). The three dominant land-use systems in the woreda includes:(a) croplands under smallholder subsistence farming system (b) controlled grazing lands with closed areas and (c) communal open access grazing land exist in the study area.

3.1.4. Population

According to the woreda agriculture and rural development office, the total population of the woreda was estimated at 164,321 for the year 2006 EC of which 14.5% urban and 85.5% rural dwellers. The population growth rate it 3 percent. The average household size was 4.6 with 4.9 and 4.2 for rural and urban areas, respectively. The population density was 99 persons per square kilometer. With regard to ethnic and religious composition 78.7% are Oromos, 21.3% were other ethnic groups. Muslims was 72.4%, 27.4% Christian and 0.2% others (CSA, 2016)

3.2. Methods

3.2.1. Site selection

Before sample collection, site selection was carried out by field observation to identify area closure. Two stage sampling techniques were employed for study site selection; first Adami Tulu Jido Kombolcha district was randomly selected from the east Shewa zone, Oromia National regional state. Then, the specific study site (Warja watershed) was purposely selected depending on availability of area closure practice. Apart from this, availability of adjacent open grazing land was considered for the selection of the area closure. Accordingly, land managed under area closure practice since 2004 EC (2011/12 GC) and adjacent open grazing land in the watershed were identified for this study. After that, depending on the land topography relatively similar system and slope gradient (high, middle and low slope) were delineated by GPS from both the area closure and the adjacent open grazing lands.

3.2.2. Data collection and sampling method

Field observation and transect walk were done from February to March 2019 before data collection to obtain an overview of the study site. Detailed preliminary survey on biophysical component and topographical site observation also employed before actual data collection. Both undisturbed and disturbed soil samples were collected to determine soil physico-chemical properties. Also were collected seedling, sapling and mature tree to evaluated Species richness, Shannon index, species evenness index, and Simpson's diversity Index were used to evaluate regeneration status of the woody species in the study area.

The following three sampling framework of data collection and analysis were done to evaluate effects of area closure on soil physicochemical properties, woody species diversity and regeneration status.

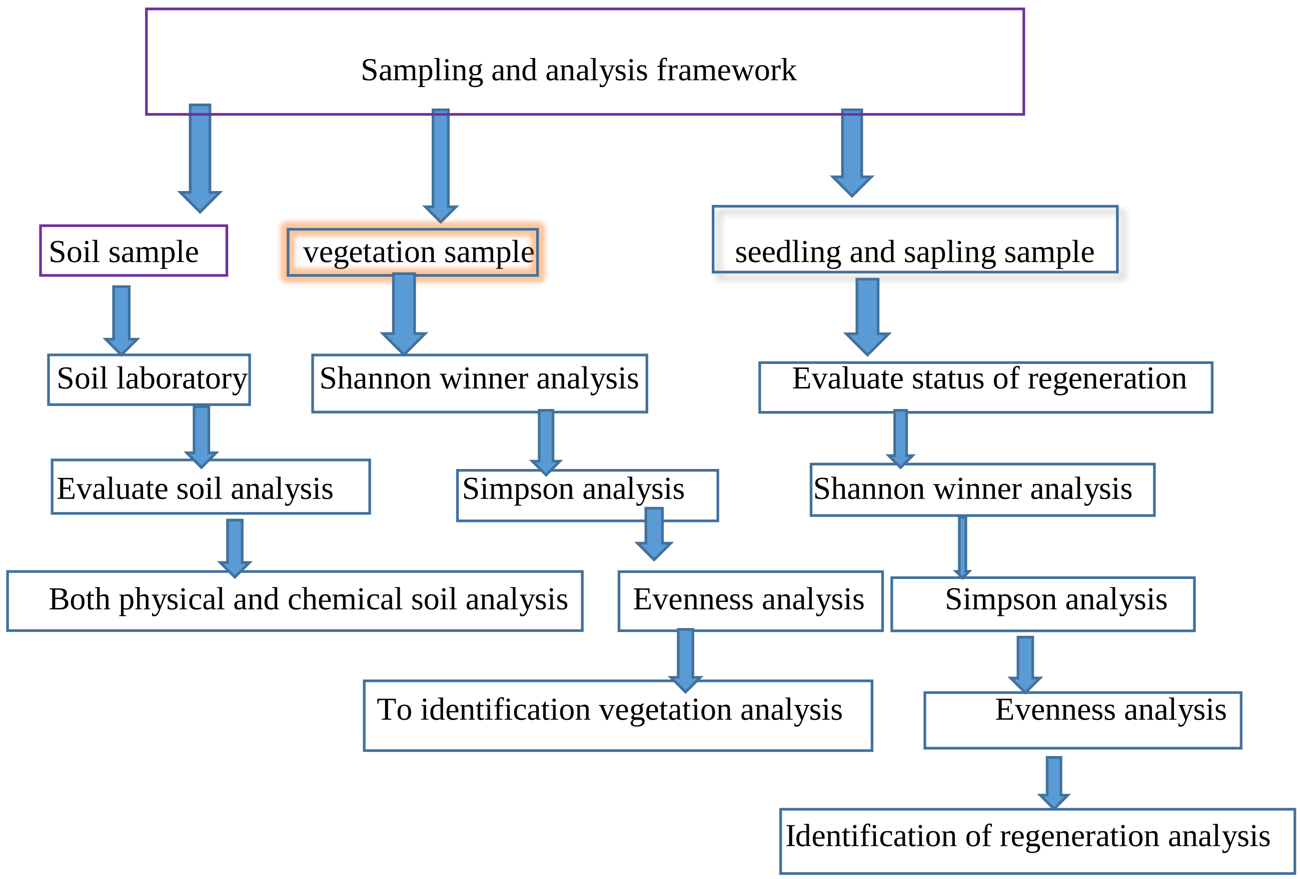


Figure4: sampling and analysis frame work

3.2.2.1. Soil sampling

To investigate the effect of area closure practice on soil physico-chemical property, a composite soil sample were collected from both area closure and adjacent open grazing land.. Quadrants with 20 m x 20 m were used as a sampling center for both sites in each slope. The composite soil sample was collected in a random cris cross manner (X) or diagonal form. The collected soil samples were mixed thoroughly to form a composite soil sample. The soil samples were taken from topsoil at a depth of 0-30 cm with a soil auger with sharp-edged and closed, circular auger pushed down for soil part. The soil samples were collected from two-site (from area closure practices and adjacent open grazing land) * 3 slope gradient*3 replications while sampling center point having 20 m x 20 m quadrant for each slope. Therefore, depending on the detailed soil survey (high-intensity soil map scale) 18 total soil samples were taken (9 samples for each site). The Collected soil samples were air-dried at room temperature, homogenized and passed through 2 mm sieve before laboratory analysis.

3.2.2.2. Vegetation Sampling

The vegetation sampling was undertaken systematically by using quadrant measuring techniques, for woody species diversity and their regeneration were recorded. Woody species and regeneration of species in the area closure and adjacent open grazing land of these sites were classified into equal transect. The number of transects per site were based on vegetation density, spatial heterogeneity of vegetation and the distance between every plot was 50m (Tefera *et al.*, 2005). Transects were parallel to each other and to the topography of the landscape. In each transect, three landscape positions were delineated (upper slope, mid-slope, and foot slope/low slope), and in each landscape position, a sampling plot of 20m x 20 m was established for quantitative vegetation inventory. All seedlings with a height below 0.3m were counted and used for regeneration data and all tree with 0.3 up to 1.3 m used for sapling. Trees were measured at breast height (1.3 m above the soil) to identify regeneration and woody species (Otsamo, 2000; Tefera *et al.*, 2005). The encountered woody species in each plot was also identified to local name or scientific name and, to the abundance, density, relative frequency (Pi) and importance value index to determine its significance.

3.3. Soil laboratory Analysis

The soil physical and chemical analysis were carried out at the laboratory of Adami Tulu agricultural research center. The parameters were analyzed for soil moisture content, bulk density, soil texture, pH, organic carbon (OC), Av.P, Av.K, total nitrogen, Cation exchangeable(CE) such as (K^+, Na^+ ,Mg^{+2} and Ca^{+2}), Electrical conductivity(EC) and cation exchange capacity (CEC) by the following step. For soil moisture, fresh soil sample were taken in china dishes and its weights was recorded. The soil sample were dried in the oven at 105^0C overnight. Then samples were removed from the oven after 24 hours and weights were recorded. Then soil moisture contents was determined by gravimetric method (Hess, 1971. The following formula was used to determined soil moisture.

$$Moisture\ content\ (\%) = \frac{Weight\ of\ fresh\ soil - Weight\ of\ ovn\ dry\ soil}{Weigt\ of\ oven\ dry\ soil} \times 100$$

The particle analysis was done using the hydrometer method (Gee and Bauder, 1986) and soil texture classification was by USDA texture triangle. Bulk density was determined by Gravimetric method and by the core method (FAO, 2007), using the ratio of solid mass to total volume after dried by using this formula ρs (g/cm^3) = Ms/Vb.

Where ρs = soil bulk density (g cm-3), Ms = mass of soil after oven-dry (g), Vb = bulk volume of the soil. The Soil pH was determined by 1:2.5 soil: water suspension, soil organic carbon (SOC) was determined by the Walkley-Black oxidation method and organic matter was derived from the organic carbon (OM%=1.72 X% OC) (Tilman *et al*., 1996).Total Nitrogen (TN) was determined by using the Kjelda digestion method, (Mueller-Harvey *et al.*, 1985). Cation Exchange Capacity (CEC) was determined by extraction with Ammonium acetate method. The available (Av. P) were determined both bray-II and Olsen method.

Available potassium and exchangeable cations (Na^+ and K^+) were determined by Flame photometer and $Ca^{2+}$and Mg^{2+} were determined by atomic absorption spectrophotometer. On the other hand, electrical conductivity (EC) was determined by 1:5 soil: water suspension. Hydrogen peroxide was used to destroy organic matter, cementing agents was detached with sodium hexametaphosphate $(NaPO_3)_6$ and sodium carbonate (Na_2CO_3), to reduce foaming problem a drop of amyl alcohol was used.

3.4. Vegetation data analysis

Data analysis was carried out by quantitative methods were to determine species richness of each slope and total number of tree species were counted, tree density and Shannon index (S) were calculated. The density of woody species was also calculated by summing up all stem crosses of samples from all plots and converted to hectare basis (Mulelleir-Dombosis and Ellenberg, 1974).

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Sample area (ha)}}$$

This index does not indicate the relative proportion or abundance of a particular species in the land. Hence, models that incorporate both richness and the evenness of relative abundance were required. Hence, Shannon index (Shannon and Wiener, 1949) and Evenness measure (E) were used. Statistical analysis SPSS 20.0 version software was employed to compete t-test and significant level was determined. It was calculated using the formula, $H' = - \Sigma\, pi \ln pi$), where, pi was the proportion of individuals composed of species. The regeneration diversity also measured with Shannon's index. Shannon diversity index (H') was high when the relative abundance of the different species in the sample was even and, reduced when few species were more abundant than the others. Simpson's diversity index was often used to quantify the biodiversity of a habitat (measures the evenness of species from 0 to 1) (Begon *et al.*, 2006). According to them, the greater value of (1-D) was the greater evenness. Its value increases with the increase in the number of species and the distribution of the individuals among the species become even. And, Simpson's diversity was calculated using the following formula: Cd = $\mathbf{D\text{-}1\sum \boldsymbol{Pi}2}$ Pi described above. So Simpson's diversity were calculated woody species diversity and species regeneration in both area closure and adjacent open grazing land.

In addition the other measurement species diversity was evenness index of woody species and species regeneration in both area closure and adjacent open grazing land. The measure of evenness (*E*) was the ratio of observed diversity to maximum diversity and calculated as, **E = H'/Hmax, = H' /ln S**. Formula were **H'**= -SUM [(pi) * ln (pi)], $\mathbf{E=H/H_{max}wa}$, SUM = Summation, pi= Number of individuals of species i=total number of samples S = Number of species or species richness H_{max} = Maximum diversity possible (Shannon and Weaver, 1963

Species richness (the number of species) was determined by summing up the number of species identified (Whittaker, 1975). Community quantitative parameters such as diversity, richness, and abundant plant species were calculated according to the formula given by (Cottam and Curtis, 1956). Moreover, t-tests analysis was made to test variations of different vegetation parameters and the different between area closures and adjacent open grazing land.

The regeneration status of species was determined based on the population size of seedlings and saplings (Chauhan *et al.*, 2008b).We can take as good regeneration status if, seedlings >saplings >adults and, fair regeneration if seedlings ≥or ≤ saplings ≤ adults. Also poor regeneration is when the species survives is only in sapling stage, but no seedlings (saplings may be <, > or = adults) and no regeneration if a species was present only in adult form. In addition new regeneration if the species has no adults but only seedlings or saplings.

3.5. Statistical Analysis

The collected data were analyzed using Statistical package for social science (SPSS) version 20 software. T-test was used to determine the differences in selected soil physicochemical properties collected from area closure and adjacent open grazing land. As well as to identify the effect of area closure on the woody species diversity and to measure the effect of area closure on the regeneration of plant species in both area closure and adjacent open grazing land. The independent t-test at ($P \leq 0.05$) was used to performed means separation for significant difference parameters.

4. RESULTS AND DISCUSSIONS

4.1. Effect of Area Closure on Soil Physiochemical Properties

4.1.1. Effect of area closure on soil physical properties.

This study came up with the evidence that the establishment of area closure could improve soil physical properties of degraded lands of the study area. In area closure, there were improvements on soil physical properties when compared with the adjacent open grazing land (table 1).

Table 1: The result of t-test analysis the effect of area closure on the physical properties of soil.

Soil parameter	Open area	Area closure	T-test	P-value
	Mean ±St D	Mean ± St D		
Moisture content %	4.12±1.193	5.09±0.88	-1.97	0.042
Bulk density g/cm-3	1.34±0.166	1.19± 0.064	-2.38	0.038
%sand	62.00±2.96	59.33±7.28	1.85	0.324
%silt	34.91±2.80	38.34±6.43	-1.93	0.170
%clay	2.98±.36	2.99± 0.426	-0.060	0.953

The result of the soil moistures independent t-test of soil analysis was showed a significant difference ($p \leq 0.05$) in the soil moisture (p=0.042). The highest soil moisture (6.68%) was recorded from area closure while, the lowest value was (3.78%). The highest value (5.13 %), of soil moisture was recorded from adjacent open grazing land and the lowest was 2.10% (appendix 5). In similar study, Mekuria *et al*., (2011) indicated that, lower soil moisture conditions could restrict the decomposition of organic matter, which consequently may favor the accumulation of soil carbon.

In this study, the mean value of soil moisture in area closure was 5.09% and from the adjacent open grazing land was 4.12%. Depending on those results, the mean value of area closure was more than that of open grazing land upon each result of the sample. This might be due to the area closure increases the soil moisture through improving soil infiltration and decrease runoff. Similarly Mengistu, (2011) reported that, the effect of area closure on biodiversity in that, the largest numerical values were associated with soils under closed area surface layer (0-30 cm) while smallest in adjacent open grazing land soils; which was the least in its soil moisture content. The observed trends were consistent and high soil moisture values associated with increasing organic matter content and vice versa. It was an established fact that increasing organic matter increases the water-holding capacity of soils (Brady and Weil, 2002). On the other hand, Tizita, (2016) shows that, reduction in vegetation cover reduces the capacity of soil to retain moisture or water holding capacity for plant productivity. This, in turn, leads to increased soil loss and loss of soil fertility, which causes land degradation. Changes in woody species diversity especially those leading to a loss in vegetation structure affect the potential of soil to replenish its nutrients particularly soil moisture.

As it indicated in the above table, the results of the study revealed that there were no soil textural differences between area closure practice and adjacent open grazing land (table 1). Sandy particle in area closure was ranges from 44% to 68%, silty were from 29.2% to 52.2% and clay from 2.5% to 3.8%. While in the adjacent open grazing land, sandy Soil ranges from 56% to 68%, silty were from 29.4% to 41% and clay from 2.4% to 3.34% (appendix 5). The non-significant result might be dealing with be age establishment of area closure practice which has no effect on the soil textural, in case low organic matter decomposition. However, there were slight variations among the absolute values of sand, silt and clay contents of the soils between area closure and adjacent open grazing land. Generally, all sand, silt and clay contents ranged from low to moderate rate for both area closure and adjacent open grazing land.

The result of soil bulk density on the other hand, showed a significant difference between area closure and adjacent open grazing land (table1). Thus, the bulk density of the area closure ranges from 0.98 to 1.37 g/cm-3 while the adjacent open grazing land range from 1.27 to 1.41 g/cm-3 (appendix 5). In addition, the mean value of bulk density in the area closure was 1.19 g/cm-3 while that of the open grazing land was 1.34 g/cm-3. The highest bulk density observed might be due to variation in clay content, organic matter and total porosity of the adjacent open grazing land and area closure. The possible reasons for the presence of higher bulk density at grazing land include livestock trampling, removal of organic matter or vegetation via grazing and soil erosion. Other authors reported that, the presence of intense grazing practices leads to soil compaction and increase erosion (Fatunbi and Dube, 2008; Abinet, 2011). Perhaps, the achieved bulk density improvement is due to organic matter addition from the plants, reduction of physical soil loss, and exclusion of grazing practices and human interference (Tamrat *et al*., 2018).

According to Werner, (1997) because, greater pore space associated with high OM and clay, that lower soil bulk density implies greater pore space and improved aeration, creating a favorable environment for biological activity. Whereas, the lower total porosity under the area closure of the land corresponds to the higher bulk density value, the relatively lower organic matter and clay content of the adjacent open grazing land. Similarly Wakene, (2001) reported that, the low total porosity was the reflection of the low organic matter content. Bohn *et al*., (2001) stated that, the acceptable range of bulk density in the enclosure area is 1.3 to 1.4 g/cm-3 for mineral agricultural soils. In view of this, bulk density values of the soils in the study area was optimum for proliferation and ramification of plant roots.

4.1.2. Effect of area closure on soil chemical properties

The soil parameters obtained from laboratory analysis were entered to SPSS and computed by independent t-test analysis to assess either significant or not. The result of statistical analysis on soil chemical properties were shown in the below table 2.

Table 2: T-test analysis of result on the effect of area closure on soil chemical properties

Soil parameter	Open area	Area closure	T-test	P-value
	Mean ±St D	Mean±St D		
EC mhos/cm at 25 ºC	3.6± 0.488	2.75± 0.51	3.603	0.002
pH H2O	5.81±.227	6.6±0.44	-5.29	0.000
% T.N	0.25±0.092	0 .32±0.84	-1.86	0 .042
Av.p ppm	3.25±.801	5.35± 0.439	-6.89	0.000
Av.K mg/Kg of soil	342.71±16.62	446.37±69.88	-2.34	0.032
CECmeq/ 100 g soil	21.59±4.22	25.6±3.91	-2.140	0.048

OC %	2.75±.431	3.65±.74	-3.134	0.006
Ca meq/100 g soil	14.02±2.48	31.91±9.55	-5.44	0.000
Mg meq/100 g soil	2.95±.98	3.59±1.41	-1.12	0.278
Exch.Na meq/ 100g soil	2.38±.56	1.33±.43	4.44	0.000
Exch. K meq/ 100 g soil	1.41±.578	1.43±.48	-0.082	0.936
Soil organic matter%	4.741±.745	6.29±0.43	13.66	0.000

The result shown that area closures considerably promoted soil conditions; especially improvement in SOM content was a key indicator of soil quality. In these results except exchangeable potassium and exchangeable magnesium, all parameters of soil chemical properties indicated a significant different between area closures and adjacent open grazing land (table 2).

The mean average value of organic carbon (3.65%) on area closure was greater than the adjacent open grazing land (2.75%). The value of soil organic carbon might be increased when the soil protected or conserved from erosion and other any damage. With similar study, Dereje *et al*., (2003) and Lemma *et al*., (2015) reported that, inputs from the vegetation can have a positive impact on the organic carbon concentrations into the soil system. Therefore, area closure practices plays significant role in the restoration of soil organic carbon and reduce nutrient depletion. Different study also stated that, soil carbon can be parity explained by reduced livestock flattening effect change in vegetation structure, higher rate of biomass recycling back to the soil and reduced runoff and soil erosion (Taboada *et al*., 2011; Mekuria *et al*., 2011; Sarah and Zonana, 2015).

The mean of organic matter in area closure was more than in the adjacent open grazing land. The recorded average value of soil organic matter in area closure was range from (4.65 to 7.82%) while the value of organic matter in the adjacent open grazing land was from (3.72 to 6.24%) appendix 5. In addition, the mean values of soil organic matter 6.291% recorded while the adjacent open grazing land 4.741% (table 2). The SOM content in the closed area was highest than in adjacent open grazing land. The relatively low organic matter in the open area was possibly a manifestation of vegetation succession, of the partial removal of organic matter input through harvesting of grass. Also, for removal of biomass and the existence of conducive environment for decomposition and mineralization. Similar idea for instance, Wolde and Edzo, (2005) reported as, higher SOM values found in closed areas than in open lands. Descheemaker *et al*., (2006) also suggest that, closed area improve the hydrology and soil inside the forested land in several ways.

On these results of analyzed data, the total nitrogen in area closure was more than in the adjacent open grazing land and it was a significant difference between area closure and adjacent open grazing land. Depending on the result of soil laboratory analyze, the value of total nitrogen was occurred between 0.21% and 0.52%. While the value in adjacent open grazing land was between 0.15% to 0.42 (appendix 5). As well, the t-test analysis of mean value of area closure was recorded 0.32% and adjacent open grazing land 0.25% (table 2). This may be because of area closure to improve soil fertility, which could enhance biomass accumulation and thereby, increased OC and N contents. Improvement in soil qualities would promote the capacity of the land to support higher species composition, especially grasses (that accumulate large residues) and leguminous plants (due to their rapid decomposition) enrich the soil with OC and N, (FAO, 2005).

In addition, the significant difference of total nitrogen between area closure and adjacent open grazing land was due to the difference in SOM content and intensities of soil erosion. In contrast, reduction in organic matter content of the soil was an obvious reason to expect relatively low nitrogen content in the adjacent open grazing land. This indirectly suggests that the biological conservation measures in closed area. According to Havlin *et al.,* (1999), soil total N contents of less than 0.15%, 0.15-0.25% and > 0.25% are categorized as low, medium and high respectively depending on the rate of total nitrogen.

In area closure the highest soil pH value was 7.4 and the lowest 6.5 pH result values was recorded while in adjacent open grazing land the highest pH value 6.1 and the lowest pH value was 5.4. Similar Mekuria, *et al.*, (2016) report that, the observed differences between enclosures and communal grazing land in soil pH, CEC, soil moisture, and bulk density could indicate the potential of enclosures to improve key soil properties. In addition, it reverses land degradation in the long-term and thereby support the regeneration of indigenous shrub and tree species. Because, the improvements in such soil properties could enhance root and shoot growth, infiltration, transport of water and air in the soil system, and water and nutrient holding capacity of soils (Taboada *et al*., 2011; Talore *et al*., 2015).The soil pH was one of the parameters of the soil that was most important identifying characters of soil between alkaline and acid soil. This indirectly suggests that the biological conservation measures on the closed area have contributed to the sustainable management of land through replenishing soil nutrients. The low pH value of soil in the closed area might be due to the accumulation and decomposition of leaf litter. Also leaching of bases down the soil profile (the vegetation cover of the closed area was higher than that of the adjacent open grazing land in which infiltration was higher in the former land use, thus, facilitates the topsoil acidic).

The average mean value of available phosphors in the area closure was 5.35 ppm. While in the adjacent open grazing land was 3.25 ppm (table 2). According to result laboratory analysis of available P, the highest concentrations was (6.25 ppm) recorded in area closure while the lowest recorded was (4.75 ppm). Also, in the adjacent open grazing land highest available phosphors concentration was (4.51 ppm) while the lowest recorded was (2.25 ppm) (appendix table 5). Those were a significant difference between closed area and adjacent open grazing land at ($p<0.05$). That the similar result of (Tizita, 2016), report on the dynamics of soil physicochemical properties in area closure at Harn watershed. Furthermore, the studies conducted Tamrat *et al*., (2018) the highest amount of Av. P observed was under lands treated with sesbania (3.85 ppm) and lowest at grazing land (2.86 ppm). That where pH soil increases the amount of P in the soil also increases the same to the available of P also increase. This variability due to area closure practices, which was, amount and type of organic or inorganic fertilizers utilized, fallowing, and crop rotation. In addition, the high available P could be due to the increase of the soil pH and soil organic carbon. Birru, (1999) reported that, availability of P varied considerably with land use pattern, soil reaction, total preserves and the particle size distributions of the soils.

On the other hand, the availability of phosphorus in the soil increases where rehabilitation of the vegetation in case of area closure practice. However, in relative terms, available phosphorus levels in soils of the closed area and adjacent open grazing land were a generally low amount of P. The low level of available phosphorus in the soil reflected was in the low content of active phosphorus forms (Haque and Kamara 1988; Dubale 1996). Also according to the finding saikh *et al.*, (1998); woldamlak, (2003) and Abiy, (2008) P absorption capacity varies widely in Ethiopian soils, despite the higher SOM content of the closed area) of insignificant change in available phosphorous following deforestation was reported by a study in tropical India.

Available potassium in both area closure and adjacent open grazing land was range between (389 to 469 meq/100g of soil) and 227.5 to 454.0 meq/100 g of soil separately (appendix 5). The mean values of the Av.K both in area closure and open graze land were (446.37 meq/100 g) and (342.71 meq/100 g soil) respectively (table 2). The t-test indicated that, it was significantly different at (P=0.032) between closed area and the adjacent open grazing land. This probably, due to management of area closure which have effect on these soil improvement in the study area. Additional it might be due to the reduced selective removal of this vital macronutrient from the land by accelerated erosion on the adjacent open grazing land. Because of its high in the soil, potassium was most susceptible to leaching losses (Alfaro *et al.*, 2004 cited in Mekuria, 2005). Therefore, the higher soil leaching rates in the adjacent open grazing land of study might be caused lower potassium content.

As indicated above table2, the result of cation exchangeable capacity was shown significant difference ($p<0.05$) between area closure and adjacent open grazing land. The result CEC of the soils in area closure was ranged between 17.46 to 30.26 meq/100 g of soil and the mean value was, 25.69 meq/100 g of soil while a range of adjacent open grazing land was recorded between 14.54 to 27.35 meq/100 g of soil (appendix5) also the mean value analysis variance was 21.59 meq/100 g of soil (table2). The rated as high to very high according to (Landon, 1991), who rated CEC values as very low (<5), low (5 to 15); medium (15 to 25), high (25 to 40), and very high (>40). Depending on this, the CEC in the area closure was indicated higher rates and in the adjacent open grazing land indicated the medium rate. The very high CEC values were obtain from the enclosure area as both clay and colloidal OM have the ability to absorb and hold positively charged ions (Foth, 1990). Thus, soils containing high clay and organic matter contents have high cation exchange capacity. CEC represents the primary soil reservoir of available K, Ca, Mg and several micronutrients. The larger the CEC, the more nutrients the soil supply and it related was directly to the inherent fertility (exchangeable nutrient contents).

Result of electronic conductivity in the study area was revealed significant difference ($p<0.05$) between area closure and adjacent open grazing land. The mean value of electrical conductivity in adjacent open grazing was 3.6 mhos/cm and the mean value of the area closure was 2.75 mhos/cm. The highest result value of electrical conductivity in area closure was 3.51 mhos/cm while, the lowest value was 2.15 mhos/cm. Also the highest value of electrical conductivity in the adjacent open grazing land was 4.34 mhos/cm while the lowest value of was 3.15 mhos/cm (appendix 5). The amount of electrical conductivity from the adjacent open grazing land was more than area closure. This might be because of sodium exchangeable or amount of salt reduced from the soil due to rehabilitation of the land by area closure practice. Similarly study of Mekuria, (2017) reported as area closure improve soils restoration due to the accumulation and decomposition of leaf litter. In addition, leaching of bases down the soil profile and diversity of vegetation cover of the area closed in which enhance infiltration higher in the former land use that facilitates leaching of bases down the profile soil. That means the salt soluble and exchangeable sodium was the observed generally low EC value in all the area closure of this study.

In addition, a non-saline condition despite the aridity of the climate and limited rainfall to leach away base-forming cations from the surface soil in the area in general and the study site in particular. This could be due to the addition of soluble salt with irrigation water or water runoff. The water flow or runoff water more occurred in the adjacent open grazing area because, there was no species diversity in the adjacent open grazing land.

The result of t-test analysis on exchangeable calcium shown significant different ($p<0.01$) between area closure and adjacent open grazing land (table 2).The highest result value of exchangeable calcium (44.65 meq/100 g of soil) was recorded from area closure while, the lowest value was 22.80 meq/100 g of soil. On the other hand, the highest value of exchangeable calcium in adjacent open grazing land was 19.0 meq/100 g of soil and the lowest value was 11.40 meq/100 g of soil (appendix 5). The exchangeable Ca, followed by Mg, was the predominant cation on the exchange sites of surface soil colloidal materials.

These were probably due to the better clay content, grasses and shrub cover in closed area than the adjacent open grazing land.

The analysis of independent t-test of the exchangeable sodium significantly ($P<0.01$) varied between closed area and the adjacent open grazing land area at ($p=0.00$) table 2. The highest value of exchangeable sodium was 2.52 meq/100 g of soil and the lowest values was 0.89 meq/100 g of soil in area closure. From adjacent open grazing land, the highest value of exchangeable sodium was 3.23 meq/100 g of soil whereas the lowest value was 1.28 meq/100 g of soil. (Appendix 5). That area closure was under categories of very low rate but, adjacent open grazing lands was under low rate because (>2) low and (2 to 8 were medium rate widely used measure of the deleterious effects of high sodium level. This result was describing that, probably there was low soil erosion in the closed area than in the adjacent open grazing land). Furthermore, Tamrat *et al.*, (2018), stated that, soil cation exchange capacity (CEC) and exchangeable bases (Na^+, K^+, $Ca^{+2,}$ and Mg^{+2}) were significantly improved in lands treated by elephant grass and sesbania. The presence of high soil organic matter and clay fractions contributed were for better CEC and exchangeable bases at lands treated with elephant grass and sesbania (Tamrat *et al*, 2018). Additionally, the studies conducted by Abiy, (2008) indicate, the presence of higher CEC and exchangeable cation under vegetated and low at degraded lands. Sachs, (199); Havlin *et al*., (2004) also reported that, improvement in soil organic matter and clay contents contributes to better soil nutrient status and exchangeable base.

The result of exchangeable potassium shown that, there was no significant difference between area closure and adjacent open grazing land. The recorded highest value of exchangeable potassium in area closure was 2.03 meq/100 g of soil and the lowest value was 0.65 meq/100 g of soil. In adjacent open grazing land area, the highest value of exchangeable potassium was 2.26 meq/100 g of soil but, the lowest value was 0.78 meq/ 100 g of soil (appendix 5). The mean values of exchangeable potassium in the area closure was 1.43 meq/100 g of soil while the value recorded from adjacent open grazing land was 1.41meq/100g of soil. This might be due to more removal of macronutrient and micronutrient and leaching of OM in case accumulation rock and leaching of organic matter decomposition. In addition, due to the time of area closures establishment and the agro climate of local area attributed that could be the difficulty in detecting the changes that occurred during a short period of time (Lal, 2004).

The statistical analysis of exchangeable magnesium was shown insignificant different between closed area and adjacent open grazing land. Based on the classification set by Landon, (1991) soils containing exchangeable magnesium greater than 4.0 is considered as high, between 0.5 and 4.0 is as medium and less than 0.5 is as low rate ($cmol_c$ kg_{-1}). Therefore, the Mg^{+2} in both closed and adjacent open grazing land were considered as medium rate.

4.2. Effect of Area Closure on Species Diversity and Regeneration Status

4.2.1 Effect of area closure on woody species diversity

In this objectives of the study, the gathered data were entered into excel spreadsheet and filtered. Then it was entered into SPSS to compute independent t-test analysis to assess either significant difference or not between area closure and adjacent open grazing land. The result of statistical analysis indicated that, the woody species diversity in the study area showed a significant different between area closure and adjacent open grazing land indicated.

The densities (individual numbers of tree /hectare) of woody species in the area closures were higher than the adjacent open grazing land (indicated table 6). That means the total density of woody species of mature tree per hectare both area closure and adjacent open grazing land were 1291.5 in this the species in area closure was 938.75 while species density in adjacent open grazing land was 352.5 see table 6. The density of woody species measured in the area closures was more than that of adjacent open grazing land browsed areas reflecting the lack of recruitment of woody species in the heavily browsed and trampled areas. Also it might be probably a result of the establishment of area closure and protection of land from animal and human interference. Suggesting rehabilitation of the degraded areas in relatively short periods by simply avoiding or minimizing interference of people and domestic animals in the degraded areas, i.e. establishing enclosures (Mengistu *et al*., 2005). The high diversity measured in the area closures might be explained by the increased litter accumulation (Descheemaker *et al.*, 2006; Mekuria *et al.*, 2007) improved soil organic matter and other nutrients inside the area closures. A higher density of woody species total individual species per hectare has resulted in increased browsing capacity of the exclosures without adversely affecting the grass layer. Similarly finding Mengistu, (2011) report the role of area closure on woody and soil rehabilitation enhancing plant succession and ecosystem development compared to open degraded sites. On other hand, the establishment of area closure as a strategy to reverse land degradation, rehabilitation of natural resource and fragmentation of habitats has gained great acceptance due to its efficiency in improving land productivity and reducing soil erosion in the areas enclosed (WFP and MoA, 2002).

Table 3: List of woody species recorded in the study area.

No	Vernacular or name or local name	Family name	Scientific Name	Life form
1	Doddoti	Leguminosae	*Acacia etbaica. Schweinf*	Tree
2	Qarxafaa	Leguminosae	*Acacia senegalvar Senegal L. Wild*	Tree
3	Waaccuu	Leguminosae	*Acacia seyal*	Tree
4	Ajoo	Leguminosae	*Acacia tortilis (forssk.) Hayne*	Tree
5	Qaraaruu	Apocynaceae	*Acokanthera schimperi (A.D C.) Schweinf*	Shrub
6	Baddana	Balanitaceae	*Balanitesaegyptiaca*	Tree
7	hagamsa	Apocynaceae	*Carissa spinarum (C. edulis)*	Shrub
8	Geetoo	Mimosaceae	*Dichrostachyscinera (L.) Wight and Arn*	Tree
9	Harooressa	Tiliaceae	*GrewiabicolorJuss*	Tree
10	Qurquraa	Rhamnaceae	*Ziziphusmauritiana*	Tree
11	Xaaxessaa	Anacardiaceae	*Rhus natalensis Benth. Ex Krauss.*	Tree shrub
12	Gorta	Leguminosae	*Pterolobiumstellatum (Forssk.) Brenan*	Shrub
13	Qarxaaxummee	Verbenaceae	*PremnaschimperiEndle*	Shrub
14	Ejersa	Oleaceae	*Oleaeuropea var. Africana*	Tree
15	Kombolcha	Celastraceae	*Maytenussenegalensis (Lam) Exell*	Tree
16	Hidii	Solanaceae	*Solanumincanum*	Shrubs
17	Ceeka	Fabaceae	*Calparina ourera*	Tree
18	Argama	Asteraceae	*Vernonia* sp.	Tree
19	Barzafii	Myrtaceae	*Eucalyptus globulus*	Tree

On the above table1 show, the number of woody species in area closure was similarly, in the adjacent open sites of species and families encountered but the abundance species was the difference. The species evenness showed a significant difference between area closures and adjacent open grazing land. That means evenness index values in area closures significantly exceed the species in open sites (P=0.001) table5. The higher evenness index in the area closures indicate that there was better species diversity in the area closures than in the adjacent open grazing land. However, low evenness of woody species in adjacent open grazing lands reveals that the areas dominated were with few species. According to Alemayehu finding, (2002) resulted show, that low evenness could be due to attribute the excessive disturbance and selective cutting of some species by humans in the dominance of few species in adjacent open grazing land. According to the result obtained from data analysis of species diversity, the area closure revealed higher evenness index than that of open grazing land which was 2.27 as described in table 4. But, in the adjacent open grazing land, the occurrence of evenness index was lower than that of area closure which was about (2.018).

Shannon diversity index t-test show that there was a significant difference between in area closure of woody species diversity and adjacent open grazing land. In addition, the Shannon diversity index (H') values of woody species in area closure sites was higher than adjacent open grazing lands. The result of mean excels spreadsheet of species diversity value was 2.907 recorded in area enclosure and in adjacent open grazing lands was (2.17) indicated on table 4. The high diversity value of Shannon diversity index said if (H>3) (Cavalcanti and Larrazabal, 2004 and Kibret, 2008). However, in this study area, both area closure and adjacent open grazing land was Shannon diversity index (H') were less than three (H<3), but, in area closure was the approach to these the highest diversity. These may be a case of lands very degraded and time of established area closure of watershed. Therefore, it may after a long time it is more diverse and high regenerated of wood species diversity.

Table 4: The diversity index value of woody species.

Index diversity	Area closure	Open land grazing
Shannon index	2.907	2.17

Simpsons index	0.08	0.029
Evenness index	2.27	2.018
Richness	19	18

The relatively high diversity and evenness index indicate the need to conserve the species diversity of the study sites and protect the woody vegetation from human disturbances and animals. The increases in the species diversity within increase Shannon index diversity, increase evenness index and Simpson index. Similarly, other studies Asefa *et al., (*2003); Mengistu *et al*., (2005) reported greater plant species diversity in area closures than in the open grazed areas. Species diversity were the most widely used criterion to assess the conservation potential and ecological value of a site line from thesis result (Magurran, 1988). In the Sahel and Hiernaux, (1998) reported that, protection from grazing increased herbaceous species richness only in the short-term. The similar result of Yosef, (2015) reports on the effect of area closure among categories of age and attitudes and perceptions of the local people towards benefits and conflicts they get from conservation.

Table 5: T-test analysis result of the effect of area closure on woody species diversity.

Index value	Area closure Mean ± St D	Adjacent open land Mean ± St D	t-test	p-value
Shannon	0.153±0.59	0.144±0.65	0.408	0.002
Richness	5.30±1.036	6.54±2.23	2.18	0.215
Simpson	0.056±0.0041	0.0043±0.005	0.117	0.023
Evenness	0.1195±0.046	0.118±0.526	0.49	0.001

The other measurement species diversity Simpson's index analysis in study area significant difference between area closure and adjacent open grazing land at (p=0.023) indicated above table5. Simpson index of diversity showed increasing trend diversity along with accruing area closure practice and increasing categories of species in the area closures. The Simpson's index value in area closure was (0.08) and in adjacent open grazing land was

(0.029) revealed on (table 4). These higher Simpson's index indicated that, there was better species diversity in warja watershed was forest protection from human and animal disturbance helped individual plant species abundance than the open site were there repeated human and livestock interference. Similar findings have also been reported in the Kondoa region in Tanzania (Mwalyosi, 2000) a central and northern Ethiopia (Asefa, *et al* 2003, Mengistu *et al*, 2005) showing that, the relative increase in herbaceous biomass in were closures reflected the effects of resting during the previous growing season.

However according to show t-test analyze there was no significant difference between species richness in both area closure and adjacent open grazing land in the study area. There was low species richness or an individual number of species in the study area. These cases due to the much-degraded area before area closure and the area also very desertification. But there was little difference richness of tree species between area closure and adjacent open grazing land. Those highest in area closure while lowest in the adjacent open area according to show a number of species below the table 6. So there was no new plant species or no difference number of family species only additional *Eucalyptus globulus* occurred in area closure. The vegetation types sampled in the study area, there were 19 richness these numbers of species richness species happened and in the adjacent open grazing land all occurred except *Eucalyptus globulus* plant. Similar to Rosen, (1996) reported that, the suggesting of biomass was not affected by resting from adjacent open grazing land. The patterns of herbaceous biomass and species richness between the area closures and adjacent open grazing areas in the current study was comparable to show report on the herbaceous species biomass the findings from northern Kenya (Oba *et al.*, 2001) and in the Queen Elizabeth National Park in Uganda (Lenzi *et al.*, 1996).

4.2.2. Effect of area closure on woody species regeneration status.

The regeneration in the study area was depending on the results of analyze by excel spreadsheet diversity of Shannon index, evenness index and Simpson's index in the area closure was more than adjacent open grazing land. Depending on the result of regeneration species in the study area showed a significant difference between area closure and adjacent open grazing land. In abundant of regenerating species (saplings+seedlings) were maximal in area closure compared to open grazing land (caused by fuelwood collection, cattle grazing and protect from all human interference. The total individual density of regeneration species (both seedlings and sapling per hectare in the study area were recorded 1,056.5/ha. Out of this in area closure regeneration were 875.75/ha (both seedling and sapling) while the density of regeneration in adjacent open grazing land of both sapling and seedling were 198.75/ha show table 6. In this the density of species regeneration in area closure was more than adjacent open grazing land. The most abundant (highest density) species regeneration in area closure were *DichrostachyscineaeLwightarea*, *Acokanthera schimperi (A.D C.) Schweinf and Vernonia* sp. might be favored by the disturbance.

Regeneration of species and reduction of soil erosion considered the major positive changes were observed after the establishment of area closures. Similar findings were reported by (Ambachew, 2006; Emmiru, *et al*. 2006; Yosef, 2015) the comparison of results made between the area closures and adjacent open grazing land area in terms of woody species. As well, natural regeneration involves deliberately managing land to enhance and accelerate the natural processes of ecological succession in order to reestablish vegetation and resilient ecosystem (Mengistu, 2011).

Table 6: Regeneration status of woody species in area closure and adjacent open grazing land.

		Area closure				Adjacent open grazing land			
No	Species name	Mature tree D/ha	Seedling (no) D/ha.	Sapling/ ha.	Status	Mature treed/ha	Seedling (no)D/ha	Sampling D/ha	Status
1	*Acacia etbaica.Schwenf*	90	18.75	25	Fair	42.5	6.25	5	Fair
2	*Acacia tortilis (forssk.) Hayne*	95	22.5	22.5	Fair	27.5	8.75	6.25	Fair
3	*Rhus natalensis Benth. ex Krauss*	68.75	17.5	18.75	Fair	38.75	16.25	8	Fair
4	*Acacia senegalvar Sene gal L. Wild*	98.75	23.75	22.25	Fair	30	21.5	0	Fair

5	*Eucalyptus globulus*	90	27. 5	22.5	Fair	0	0	0	No
6	*Acacia seyal*	20	22.5	20	Good	17.5	0	8.75	Poor
7	*Balanitesaegyptiaca*	21.25	23.75	22.5	Good	17.5	0	10	Poor
8	Ziziphusmauritiana	33.75	28.75	23.75	Fair	0	0	0	No
9	*Acokanthera schimperi (A.D C.) Schweinf*	35	66.25	62.5	Good	25	6.25	15	Fair
10	*Oleaeuropea var. Africana*	16.25	37.5	33.75	Good	7.5	0	0	No
11	*PremnaschimperiEndle*	21.25	35.75	33.75	Good	11.75	8.75	0	Fair
12	*Pterolobiumstellatum (Forssk.) Brenan*	33.75	0	5	Fair	18.75	0	0	No
13	*Solanumincanum*	25	0	0	No	33.5	0	6.25	Poor
14	*Maytenussenegalensis (Lam) Exell*	33.75	0	0	No	6.25	0	0	No
15	*Carisa Spinarum(C.edu lis)*	60	16.75	45	Fair	26.25	13.75	8.75	Fair
16	*Grewiabicolorjus*	70	22.5	20	Fair	18.75	12.5	5	Fair
17	*Calparina ourera*	12.5	22.5	20	Good	10	0	0	Poor
18	*Vernonia* sp.	37.5	41.25	0	Good	10	12.5	6.25	Good
19	*DichrostachyscineaeLw ightarea*	76.25	43.75	18.75	Fair	11.25	8	5	Fair
	Total	**938.75**	**471.25**	**396.5**	**Fair**	**352.75**	**113.5**	**84.25**	**Fair**

The regeneration status of area closures was greater than adjacent open grazing land. While the matured tree were greater than seedling, seedling greater than sapling (938.75>471.25>396.5ha^{-1}) and 352.75>113.5>84.25ha^{-}1) indicated above the table 6. In area closure higher densities of woody species than adjacent open grazing land as compromise open areas supported were by other researches findings (Kindeya, 1997 and 2003; and Kibret, 2008). The fair regeneration status in area closure more in adjacent open grazing land and well regenerating for the seedling and sapling per hectare show. Whereas, the highest diversity in the saplings found was in the area closure followed by protected (management) and less in the adjacent open grazing land. In addition in the below the figure 4 indicated the regeneration and matured tree in area closure more than adjacent open grazing land. Similarly, the study result agrees to this studies that state regeneration of natural habitats increase biomass production and plant species diversity, thereby resulting in more diverse soil biota and other associated beneficial organisms (FAO, 2005; Yosef, 2015).

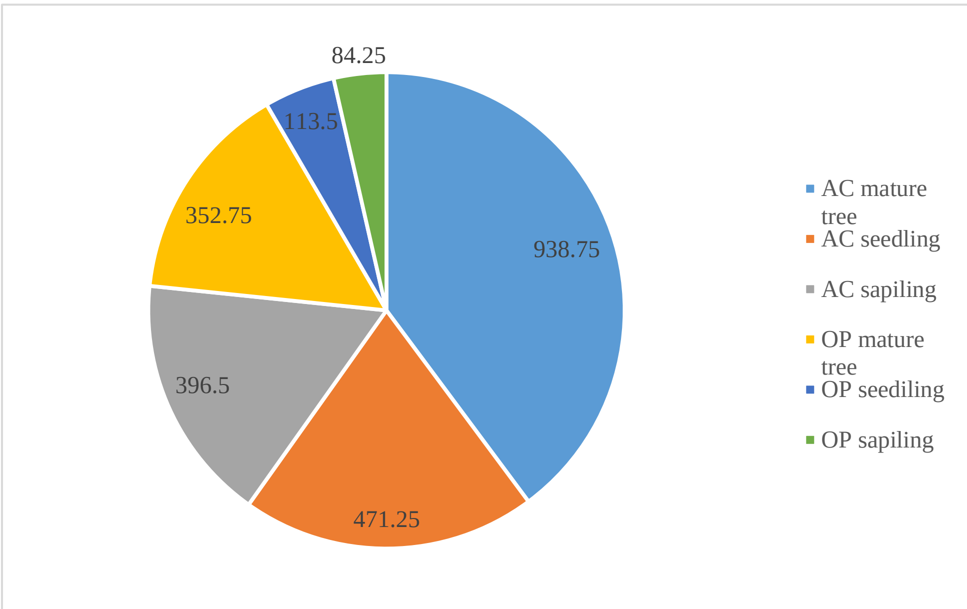


Figure 5: The total regeneration species in area closure and adjacent open grazing land.

Where AC was represented area closure and OP was represented adjacent open grazing land.

In the figure5 indicated the status of regeneration in area closure were high fair and good while in area closure there was low no regeneration status species and there was no poor regeneration status. However in adjacent open grazing land there were high fair and no regeneration species status and good status of regeneration species showed very low.

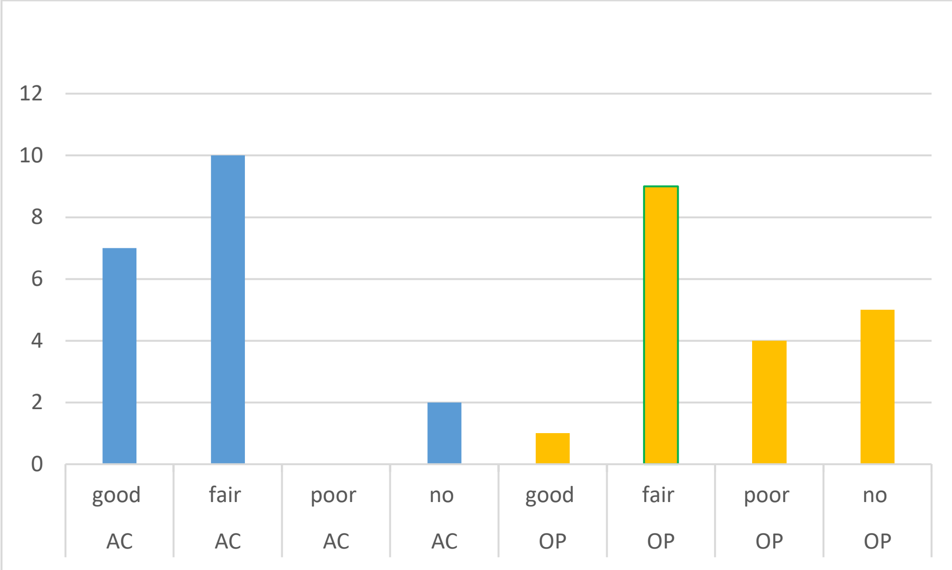


Figure 6: Status of regeneration in area closure and adjacent open grazing land

On other hand the regeneration status of both area closure and adjacent open grazing land when show in the percent. In this study 18%, tree species exhibited „good" regeneration status in area closure, 26%, showed „fair" regeneration condition, 5% total of tree species were „not regenerating" at all and poor regeneration status was not present. While the percent of adjacent open grazing land was 3% species exhibited „good" regeneration status, 24% exposed „fair" regeneration condition, 11% indicated „poor" regeneration status and 13% total of tree species were „not regenerating" in adjacent open grazing land. In these the area closure good was high percent than adjacent open grazing land means seedling were greater than sapling and sapling were greater than mature tree. However in the adjacent open grazing land fair has highest percent means sapling greater than seedling and mature tree indicated below figure 6.

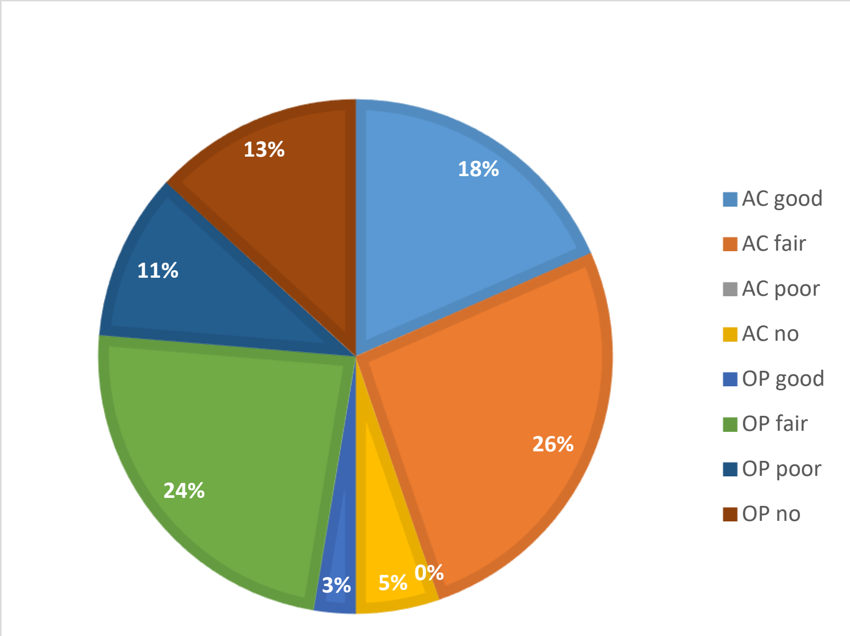


Figure 7: percent status of regeneration species in area closure and adjacent open grazing land**.** Were AC was represented area closure and OP was represented adjacent open grazing land.

The highest diversity for seedlings and sapling found were in the area closure and the lowest diversity of seedling and sapling in adjacent open grazing land show above the figure 6. However, still, the density of more plant category, especially seedlings in enclosed sites, was fair more than the open grazing lands indicating the effect of area closure practice to promote woody vegetation density. It supported was by a study that states disturbance especially overgrazing causes reduction in palatable species leading to a reduction in plant density and impairs natural regeneration including the development of seedlings (Bot and Benites, 2005).

Additionally, the relatively high diversity at sites was attributed to low disturbance, habitat conditions and species characteristics that similarly conducted (Demel *et al.*, 2015) report on the seedling population and regeneration of woody species in dry Afro mountain forest of Ethiopia**.** Those depending on the regeneration density that means area closure protected was from human and animal interference and reduce overgrazing of the land degradation. In open sites, human disturbance, particularly grazing, was usually the major reason for hampered or poor regeneration.

Table 7: Diversity index value of regeneration species in area closure and adjacent open grazing land.

Index diversity	Area closure	Open land grazing
Shannon index	2.85	1.06
Evenness index	2.316	1.04
Simpsons index	0.081	0.0218
Richness	17	14

Analysis of Shannon diversity index of regeneration showed high value for area closures than the adjacent open grazing land. The Shannon diversity index of regeneration species was according to show excel spreadsheet from area closure was 2.85 and in the adjacent open grazing land recorded was 1.06 (table 7). That the Shannon diversity of regeneration species was area closure greater than adjacent open grazing land. The Evenness index of the regeneration in area closure was 2.32 while the evenness index in the adjacent open grazing land recorded was 1.40. In addition, the regeneration of the Simpson index in area closure was 0.081 while the adjacent open grazing land was 0.0218 (table 7).

Table 8: T-test analysis result of the effect of area closure on regeneration species.

Index value	Area closure	Adjacent open land	T-test	P-value
	Mean ± St D	Mean ± St D		
Shannon	0.167±.045	0.094±0.058	3.21	0.000
Evenness	0.136±.037	0.082±0.051	2.48	0.001
Simpsons	0.0046±.005	0.0012±0.0014	1.26	0.019

Richness	5.4±.69	4.61±2.47	3.52	0.221

Depending on those t-test analyze area closure has more evenness regeneration species than adjacent open grazing land (p=0.001). Similar to that result Simpson's analyze recorded was the p-value (0.019) that show significant difference (table 8). In addition, the result of Shannon index diversity species regeneration in the site was the significant difference at (p =0.000). So, depending on the result t-test analysis show significant difference in all Shannon diversity index, evenness index and Simpsons index.

The other species richness was one measurement parameter, which determined woody species diversity in one recovered area. The species richness in the regeneration were no more differences between area closure and adjacent open grazing land area. That the total number of regeneration species in area closure were recorded 17 and the number of species in adjacent open grazing land were recorded 14 recurred during data collecting. So depending on the excel spreadsheet analysis species richness in regeneration in the study area was little difference between them that was approximate to species richness in species diversity. So, this study shows the species richness of regeneration, there was no significant difference between area closure and adjacent open grazing land. On other hand, studies reported that successful regeneration promotes seed dispersal by attracting disseminating agents resulting in seed development under tree crowns than in open sites (Blay, 2002).

5. CONCLUSION AND RECOMMENDATION

5.1. SUMMARY AND CONCLUSION

This study focused on the evaluated effect of area closure on selected soil physicochemical properties and woody species diversity in warja watershed, Adami Tulu jido kombolcha district, east Shewa, and Oromia regional state of Ethiopia. The specific objectives of the study include to evaluate the effect of area closure on selected soil Physico-chemical properties, to identify the effect of area closure on the woody species diversity and to measure the effect of area closure on the species regeneration status in study area.

The data was collected from primary sources including soil, vegetation, seedling and sapling sample were collected through field measurement by using different materials like GPS, measuring tape, auger, spatula and core sampler. Systematic sampling method were employed to take vegetation and soil sample. In this, quadrant measuring techniques was used to record all data. A sampling plot of 20mx20m was established for quantitative data for both vegetation and soil samples. The composite soil and vegetation samples were taken from 9 plots for each site. Soil laboratory analysis for soil organic carbon, organic matter Av. P, Av. K, total N, Soil texture, soil moisture, soil pH, bulk density, CEC, $Mg^{+2,}$ K^{+}, $Ca^{+2,}$ $Na^{+,}$ and EC were done from the collected composite soil sample. These data were analyzed by using Excel spreadsheet and 20 SPSS software. Independent t-test were employed to evaluate the significance level at ($P<0.05$). The analyzed data of all Soil physicochemical properties were shown significant differences except soil texture, $Mg^{+2,}$ and K^{+}. The in these study the total density of individuals woody species in the study area were 1291.5. Out of these in area closure were 938.75/ha and in the adjacent open grazing land were 352.75/ha respectively. The diversity of all woody species in area closure was greater than in the adjacent open grazing land.

The total density of regeneration in study site was 1,056.5/ha. Out of this, the density of regeneration species in area closure were 867.75/ha. While the density of regeneration in adjacent open grazing land were 197.75/ha. The results of this study confirm that the establishment of area closures on degraded adjacent open grazing lands in the warja watershed can effectively restore degraded ecosystems or degraded land. Area closure was a system of management, protecting, improving natural resources and improving soil physio-chemical properties sites. As a result, it promotes land productivity, resilience, and sustainability of the ecosystem ensuring food security and alleviating poverty as well. The soil physio-chemical properties approved and the soil fertility increased was in case of area closure.

The diversity of woody species and regeneration of species in area closures better than an adjacent open grazing area. Management, among other factors, has enhanced woody species composition /richness/ and diversity, regeneration of species reduced soil erosion and improved the land productivity as a whole. It was plausible to conclude that area closures could be possible options to rehabilitate degraded. Based on the increased vegetation cover and improved soil conditions of the area closure, it was possible to conclude that the establishment of area closures in the degraded lands was a viable option for species woody diversity, regeneration improvement and biodiversity conservation. Additional results of this study clearly indicated that area closure could contribute to the rehabilitation of degraded areas in a relatively short period while contributing to improved regeneration species (seedling and sapling). The status of species regeneration in area closure was better than adjacent open grazing land. That means area closure had more percent of good status than adjacent open grazing land (seedling > sapling > mature tree) and the area closure was no poor status. Generally, higher species diversity was considered to signify a complex and healthier community since a greater variety of species facilitate more species interactions, leading to greater stability of the system and indicates good environmental conditions.

5.2. RECOMMENDATION

From the research findings, the following recommendations were drawn. Establishment of area closure very important to improve soil physico-chemical properties, woody species diversity and regeneration status. Therefore, careful design of management strategy that needed for ecological rehabilitation should be implemented for the sustainability of area closures. Free grazing or adjacent open grazing land was a major threat to soil quality. This study did not assess the impact of area closure on plant structures, plant standard characteristics and soil seed bank. Additional this studies not asses on the soil micro nutrient and soil biological properties. Other researchers can study the effect of area closure on these characteristics to verify whether the effect is significant or not. So as to achieve the expected ecological, environmental and socioeconomic objectives.

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7. APPENDIX

Appendix Table 1: Species diversity for area closure

For Area closure	S(Number of species)	N(Number of individual in sample	LN Of N	SR(Species richness =(S-1)/LN(N)	pi=n/N	Lnpi	H'(Shannon Index)	Simpsonis index(CD) =pi 2	Evennes index(e) =H'/logS
Acacia etbaica. Schweinf	19	71	4.263	4.22	0.101	-2.294	0.231	0.010	0.181
Acacia tortilis (forssk.) Hayne	19	76	4.331	4.16	0.108	-2.226	0.240	0.012	0.188
Rhus natalensis Benth. ex Krauss	19	50	3.912	4.60	0.071	-2.645	0.188	0.005	0.147
Acacia senegalvar Senegal L. Wild	19	79	4.369	4.12	0.112	-2.187	0.245	0.013	0.192
Eucalyptus globulus	19	64	4.159	4.33	0.091	-2.398	0.218	0.008	0.170
Acacia seyal	19	30	3.401	5.29	0.043	-3.156	0.134	0.002	0.105
Balanites aegyptiaca	19	17	2.833	6.35	0.024	-3.724	0.090	0.001	0.070
Ziziphus mauritiana	19	27	3.296	5.46	0.038	-3.261	0.125	0.001	0.098
Acokanthera schimperi (A.D C.) Schweinf	19	28	3.332	5.40	0.040	-3.225	0.128	0.002	0.100
Olea europea var. Africana	19	13	2.565	7.02	0.018	-3.992	0.074	0.000	0.058
Premna schimperi Endle	19	17	2.833	6.35	0.024	-3.724	0.090	0.001	0.070
Pterolobium stellatum (Forssk.) Brenan	19	27	3.296	5.46	0.038	-3.261	0.125	0.001	0.098
Calparina aurera	19	20	2.996	6.01	0.028	-3.561	0.101	0.001	0.079
Vernonia *spp.*	19	27	3.296	5.46	0.038	-3.261	0.125	0.001	0.098
Carisa Spinarum (C.edulis)	19	48	3.871	4.65	0.068	-2.686	0.183	0.005	0.143
Grewia bicolorjus	19	56	4.025	4.47	0.080	-2.531	0.201	0.006	0.157
Maytenus senegalensis (Lam) Exell	19	10	2.303	7.82	0.014	-4.254	0.060	0.000	0.047
Solanum incanum	19	30	3.401	5.29	0.043	-3.156	0.134	0.002	0.105
Premna schimperi Endl	19	61	4.111	4.38	0.087	-2.446	0.212	0.008	0.166
Sum		751	66.59	100.8484	1.067	-57.986	2.907	0.078	2.273

For Open land	S(Number of species)	N(Number of individual in sample	LN Of N	SR(Species richness =(S-1)/LN(N)	pi=n/N	Lnpi	H'(Shannon Index)	Simpsonis index(CD)=pi 2	Evennes index(e) =H'/logS
Acacia etbaica. Schweinf	18	34	3.526	4.821	0.122	2.101	0.257	0.015	0.205
Acacia tortilis (forssk.) Hayne	18	22	3.091	5.500	0.079	2.537	0.201	0.006	0.160
Rhus natalensis Benth. ex Krauss	18	31	3.434	4.951	0.112	2.194	0.245	0.012	0.195
Acacia senegalvar Senegal L. Wild	18	24	3.178	5.349	0.086	2.450	0.211	0.007	0.168
Eucalyptus globulus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acacia seyal	18	10	2.303	7.383	0.036	3.325	0.120	0.001	0.095
Balanitesaegyptiaca	18	14	2.639	6.442	0.050	2.989	0.151	0.003	0.120
Ziziphusmauritiana	18	8	2.079	8.175	0.029	3.548	0.102	0.001	0.081
Acokanthera schimperi (A.D C.) Schweinf	18	20	2.996	5.675	0.072	2.632	0.189	0.005	0.151
Oleaeuropea var. Africana	18	6	1.792	9.488	0.022	3.836	0.083	0.000	0.066
PremnaschimperiEndle	18	9	2.197	7.737	0.032	3.430	0.111	0.001	0.088
Pterolobiumstellatum (Forssk.) Brenan	18	12	2.485	6.841	0.043	3.143	0.136	0.002	0.108
Calparina ourera	18	22	3.091	5.500	0.079	2.537	0.201	0.006	0.160
Vernonia sp.	18	5	1.609	10.563	0.018	4.018	0.072	0.000	0.058
Carisa Spinarum(C.edulis)	18	21	3.045	5.584	0.076	2.583	0.195	0.006	0.155
Grewiabicolorjus	18	15	2.708	6.278	0.054	2.920	0.158	0.003	0.125
Maytenussenegalensis (Lam) Exell	18	8	2.079	8.175	0.029	3.548	0.102	0.001	0.081
Solanumincanum	18	8	2.079	8.175	0.029	3.548	0.102	0.000	0.081
PremnaschimperiEndl	18	9	2.197	7.737	0.032	3.430	0.111	0.008	0.088
	18	278	46.529	124.373	1.000	124.37	2.17	0.078	2.087

Appendix Table 2: Species diversity from adjacent open grazing land are

Name of species	S(Number of species)w	N(Number of individual in sample	LN Of N	SR(Species richness =(S-1)/LN(N)	pi=n/N	Lnpi	H'(Shannon Index)	Simpsonis index (CD)=pi 2	Evennes index(e) = H'/logS
Balanitesaegyptiaca	17	47	3.85	3.71	0.077	-2.919	0.158	0.0029	-0.128
Ziziphusmauritiana	17	41	3.71	3.91	0.065	-2.728	-0.178	0.0043	-0.145
Acokanthera schimperi (A.D C.) Schweinf	17	50	3.91	3.33	0.082	-2.496	-0.206	0.0068	-0.167
Oleaeuropea var. Afri cana	17	28	3.33	5.77	0.045	-3.091	-0.141	0.0021	-0.114
PremnaschimperiEndl e	17	30	3.340	3.40	0.048	-3.030	-0.146	0.0023	-0.119
Pterolobiumstellatum(Forssk.) Brenan	17	37	3.61	3.61	0.040	-3.225	-0.128	0.0016	-0.104
Acacia tortilis (forssk.) Hayne	17	23	3.17	3.13	0.051	-2.973	-0.152	0.0026	-0.124
Vernonia sp.	17	40	3.69	3.69	0.054	-2.919	-0.158	0.0029	-0.128
Rhus natalensis Benth. ex Krauss	17	29	3.67	3.67	0.040	-3.225	-0.128	0.0016	-0.104
Carissa spinarum (C. edulis	17	53	3.69	3.97	0.151	-1.893	-0.285	0.0227	-0.232
Acacia seegalvar Senegal L. Wild	17	35	3.67	5.43	0.054	-2.919	-0.158	0.0029	-0.128
Eucalyptus globulus	17	40	3.97	3.89	0.063	-2.773	-0.173	0.0039	-0.141
Dichrostachyscineae(L)Wight Aren	17	35	3.55	3.55	0.099	-2.308	-0.230	0.0099	-0.187
Calparina ourera	17	49	3.89	3.50	0.094	-2.367	-0.222	0.0088	-0.180
Maytenussenegalens is (Lam) Exell	17	35	3.55	3.96	0.028	-3.561	-0.101	0.0008	-0.082
Acacia etbaica. Schweinf	17	33	3.50	5.91	0.043	-3.156	-0.134	0.0018	-0.109
Acacia seyal	17	40	3.67	5.54	0.051	-2.973	-0.152	0.0026	-0.124
Total	17	612	51.124	91.91068	1.063	48.55	-2.85	0.08	2.316

Appendix Table 3: Regeneration specie from area closure

Appendix Table 4: Regeneration of species from adjacent open grazing land area

For Open land	S(Number of species)	N(Number of individual in sample(F)	LN Of N	SR(Species richness =(S-1)/LN(N)	pi=n/N	Lnpi (RF)	H'(Shannon Index)	Simpsonis index(CD)=pi 2	Evennes index(e) =H'/logS
Acacia etbaica. Schweinf	14	9	1.609	8.077	0.028	3..561	0.101	0.00081	0.088
Acacia tortilis (forssk.) Hayne	14	10	1.946	6.681	0.040	3.225	0.128	0.00158	0.112
Rhus natalensis Benth. ex Krauss	14	12	1.386	9.378	0.023	3.784	0.086	0.00052	0.075
Eucalyptus globulus	0	0	0.000	0.000	0.000	0.000	0.000	0.00000	0.000
Acacia senegalvar Senegal L. Wild	14	9	1.609	8.077	0.028	3.561	0.101	0.00081	0.088
Acacia seyal	14	15	2.079	6.252	0.045	3.091	0.141	0.00207	0..123
Balanitesaegyptiaca	14	12	1.386	9.378	0.023	3.784	0.086	0.00052	0.075
Ziziphusmauritiana	0	0	0.000	0.000	0.000	0.000	0.000	0.00000	0.000
Acokanthera schimperi (A.D C.) Schweinf	14	5	1.609	8.077	0.028	3.561	0.101	0.00081	0.088
Oleaeuropea var. Africana	14	17	2.197	5.917	0.051	2.973	0.152	0.00261	0.133
PremnaschimperiEndle	14	7	1.946	6.681	0.040	3.225	0.128	0.00158	0.112
Pterolobiumstellatum (Forssk.) Brenan	0	0	0.000	0.000	0.000	0.000	0.000	0.00000	0.000
Calparina ourera	14	10	2.303	5.646	0.057	2.868	0.163	0.00323	0.142
Vernonia sp.	14	13	2.565	5.068	0.074	2.606	0.192	0.00546	0.168
Carisa Spinarum(C.edulis)	14	7	1.946	6.681	0.040	3.225	-0.128	0.00158	0.112
Grewiabicolorjus	14	2	0.693	24.526	0.007	4.934	-0.035	0.00005	0.031
Maytenussenegalensis (Lam) Exell	14	4	1.386	12.263	0.014	4.241	-0.061	0.00021	0.053
		132	24.662	122.700	0.499	48.639	1.605	0.02182	1.400

Appendix Table 5: Soil parameter analysis from area closure and adjacent open grazing land

No	PH	Moisture	OM	BD	OC	AV.K	Av.P	TN	Na^{+1}	Mg^{+2}	Ca	K^{+}	CEC	Sand	Silt	Clay	EC
01	6.5	6.68	4.65	1.01	2.7	460	5.4	0.286	1.07	6.65	41.50	1.68	24.25	44.00	52.20	3.80	2.52
02	7.2	3.78	5.95	1.25	3.5	430.0	5.8	0.310	1.34	3.8	44.65	1.65	17.46	62.00	35.40	2.60	3.20
03	7	4.2	4.99	0.98	2.9	448.0	6.25	0.52	2.31	3.25	38.10	1.82	28.50	55.00	42.40	2.60	3.12
04	7.4	5.93	6.72	1.32	3.9	453	5.35	0.31	1.45	4.75	42.75	2.03	26.19	54.00	42.60	3.40	2.45
05	6.3	4.12	7.82	1.31	4.54	469	5.26	0.336	1.37	2.85	26.60	1.46	29.68	59.00	37.9	3.01	3.51
06	6.1	5.31	7.82	1.12	4.55	430	4.75	0.332	.89	3.80	22.80	1.45	30.26	67.00	33.80	3.20	2.23
07	6.8	4.56	6.55	1.01	3.8	420.0	5.3	0.21	.95	2.85	23.75	1.25	23.09	64.00	35.20	2.80	2.15
08	6.4	5.10	7.5	1.37	4.36	445	5.08	0.294	1.09	3.52	23.75	.85	26.58	64.00	33.00	3.00	2.31
9	6.45	4.23	5.5	1.36	3.21	389.0	5.05	0.28	2.52	2.52	23.25	.65	26.58	65.00	32.50	2.50	3.25
10	5.9	2.94	4.67	1.36	2.71	454.0	3.2	0.280	2.32	4.75	15.20	1.25	23.09	64.00	33.40	2.60	3.23
11	5.8	3.21	5.2	1.41	3.01	425.0	3.2	0.31	1.28	3.02	13.10	1.80	24.02	66.00	31.00	3.00	3.21
12	5.9	4.76	6.24	1.4	3.62	410.0	2.89	0.42	2.34	1.90	11.40	2.26	25.22	68.00	29.40	2.60	4.23
13	6.1	4.19	4.34	1.37	2.52	342.5	2.95	0.182	2.25	3.80	19.00	2.15	27.35	62.00	35.00	3.00	3.15
14	5.5	4.01	4.53	1.3	2.63	428.0	3.4	0.212	2.35	2.30	14.00	1.68	24.63	63.00	34.50	2.50	4.34
15	5.8	5.13	5.13	1.31	2.98	273.5	2.38	0.224	2.31	1.90	11.40	1.02	18.82	64.00	32.80	3.20	4.12
16	5.4	4.8	3.99	1.27	2.32	227.5	2.25	0.252	2.26	2.30	12.10	.89	17.52	63.00	33.50	3.50	3.24
17	6.0	2.10	3.72	1.33	2.16	281.0	4.51	0.154	3.23	2.85	13.80	.78	14.74	60.00	36.60	3.40	3.56
18	5.9	5.9	4.86	1.37	2.82	250.4	4.5	0.182	3.12	3.75	16.20	.78	18.90	56.00	41.00	3.00	3.34

NB: Number 1-9 for area closure 9-18 for adjacent open grazing land.