Identification of Floristic Diversity and structure in Kurib Forest

A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in General Biology Program under Department of Zoological Sciences

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Identification of Floristic Diversity and structure in Kurib Forest in Kurib Forest, Guagusa shekudad Woreda in Awi Zone of Amhara Region

By

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Thesis is to certify that the thesis prepared by Molla Belay, entitled: Identification of Woody Plant Species Diversity and structure in Kurib Forest and submitted in partial fulfillment of the requirements for the Degree of Master of Science in General Biology Program under Department of Zoological Sciences complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

Identification of Floristic Diversity and structure in Kurib Forest in Kurib Forest, Guagusa shekudad Woreda in Awi Zone of Amhara Region

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The study was conducted in Kurib Forest with the objective of Identification of Floristic diversity and structure in this forest. Systematic sampling method was used to collect data for woody plan species. Sample plot was laid at a long line transacts which are laid horizontally form South to north direction at low, medium and high altitude. A systematic sampling plots of 20m x 20m in each site was established to take samples. A total of 72 sample plots were established. Structural analysis was carried out on the basis of diversity, DBH, height, frequency, and basal area per hectare. The distribution of size classes were evaluated by computing the density of individuals with DBH > 2, >10 and >20cm. the species diversity, species evenness and species richness were analyzed. The result showed that a total of 39 different species of plants were identified in Kurib forest. *Pittosporum viridflorum* was the dominant species followed by, *Maesa lanceolata, Maytenus obscura* and *Acacia abyssinica* and the list dominant woody plant species in Kurib forest were *Maytenus arbutifolia* and *Cupressus lusotanica.* The tallest species were *Pittosporum viridflorum, Maesa lanceolata, Apodytes dimidiate* and *prunus Africana.* The shortest species were *Combretum molle, Phytolacea dodecandera, Solancio gigas* and *Grandinium bullosa.*

Key words: Kurib forest, Species Diversity, Conservation, Sustainable utilization

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List of Abbreviations and acronyms

BA= Basal area

C= climbers

DBH=diameter at breast height

EH= Evenness

FAO= food and agricultural Organization

H`= Sahnnon -Weiner diversity index

ICBP= International Council for Bird Preservation

IVI= Important Value Index

RD= Relative Density

RF= Relative Frequency

RDO= Relative Dominance

S= shrubs

T= Trees

T/S= Tree/shrubs

UNDESA= United Nations Department of Economic and Social Affairs

UNEP=United Nations Environment Programme

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1. Introduction

1.1 Back ground and justification

Ethiopia is an important regional center for biological diversity due to its wide range of altitude, its geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains (Ensermu Kelbessa *et al*., 1992). These helped the emergency of wide range of habitats that are suitable for evolution and survival of various plant and animal species.

As a result the country is regarded as one of the most important country in Africa with respect to endemism of plant and animal species in tropical Africa (EFAP, 1994, EWNHS, 1996). Most of Ethiopia highlands were once covered with dense forest. This is indicated by the numerous isolated mature forest trees or patches of forests (Friis, 1986). Human beings are dependent for their subsistence, health, well being and enjoyment on forests. Forests have been providing raw material for wooden and non wooden products, space for human settlements and agriculture. Forests indirectly influence global climate, serve as wild life habitat, provide genetic pool for biotic diversity and provide ecosystem services for water shed protection and erosion control (Ramirez-Maricial *et al*., 2001).

Historical documents indicate that Ethiopia had experienced substantial deforestation, habitat change, biodiversity loss, soil degradation and an increase in the area of bare land over many years. Deforestation in the highlands of Ethiopia become unstoppable process dating back many hundreds of years resulting patches of forests mainly around religious centers, inaccessible and protected areas (Alemayehu Wassie, 2007).

The major reason for forest degradation, biodiversity loss and an increase the area of bare land are the conversion of forests to farm land shifting cultivation, fire wood, charcoal production, overgrazing, inappropriate investments and lack of viable land use policy (Ramirez-Maricial *et al*., 2001).

The increasing demand for forest products and farm land, together with the alarming rate of population growth has put the remaining few patches of forests on the verge of extinction (Tamrat Bekele, 1994). Reduction in forest cover has a number of consequences including soil erosion, reduction capacity for carbon sequestration, loss of biodiversity and instability of ecosystem and reduced availability of various wood and non-wood forest products and services (Alemu Mekonnen and Stone, 2007). The conversion of natural vegetation and biodiversity loss is currently one of the leading agenda for a number of world conservation organizations, authorities and interest groups (UNDESA, 2004). Those stakeholders establish sustainable forest management for biodiversity conservation and sustainable use of resources. Sustainable forest management has been the main focus of worldwide forest sectors over many years. To minimize the risk, sustainable forest management has been practiced through applying conservation techniques. Among techniques, protecting forest areas with restricted access for local communities which have often been introduced in the forest and increased the awareness of the population helps to tackle deforestation and its effects (Weinberg, 2010).

Kurib forest has been affected by deforestation for timber, charcoal, fuel wood collection and overgrazing. The current study on this forest is important to provide information for the stakeholders to tackle the problem by setting meaningful planning, effective management and giving awareness for the people for conservation and sustainable utilization of the forest and the resources.

1.2 Statement of the problem

Unwise use and excessive utilization of forest products without considering the ecological and economical consequences (EFAP, 1994). There is unwise and excessive utilization of forests for fuel wood, timber, fencing, construction and grazing of animals in the study forest which seriously affect this forest. There is a severe and increasing fuel gap in the country which leads to depletion of the standing stock and hence, for the degradation of the remaining forest stands (EPA, 1997). The energy consumption of the community near Kurib Forest mainly depends on fuel wood collection in the forest to meet their energy requirement for cooking, heating and lightning. This leads to the destruction of woody plants in the study forest.

Lack of proper management, constant and sustainable institutional organization has resulted in total deforestation and degradation of fertile cultivable land and soil fertility, exposing the country to drought and famine, thus the earlier fertile Ethiopia is now on its way changing to `stone desert`(UNEP, 1995). This is also applicable in the study forest. There is lack of proper management, lack of information, constant and sustainable institutional organization and giving awareness for the society about conservation and wise utilization of the forest.

The availability of accurate data on forest resources is an essential requirement on proper management and planning within the context of sustainable development (FAO, 2007). Assessments such as woody species composition and structural analysis are essential in understanding the context of plant diversity in forest ecosystem (WCMC, 1992).

The study of woody plant composition, structure, diversity and evenness to collect appropriate data is very crucial to provide information for the stakeholders to apply proper management and give awareness for the society to reduce unwise utilization of the forest. The present study on Kurib forest aim to identify the problems and recommend possible solutions.

1.3 Significance of the study

Studies on forest biodiversity have been made to provide solutions for the problems imposed on forest biodiversities, woody plant species identification and structural analysis of the study area and document the results will help to give information on the provision of effective management for biodiversity conservation and sustainable use of the resources. Sustainable management and forest biodiversity conservation will help to reduce anthropogenic impacts on different woody plant species diversity in the study area. These anthropogenic impacts which reduce forest biodiversity render significant ecological and socio-economical services to the local community.

1.4 Objectives of the study

1.4.1 General Objectives

The general objective of the study is to assess the woody plant species composition, structure, diversity, evenness and richness in Kurib Forest.

1.4.2 Specific Objectives

- To identify floristic composition in the study area.
- To determine density, DBH, height, basal area, frequency and IVI of woody plant species in the study area.
- To identify species diversity, evenness and richness of woody plant species in Kurib Forest.

2. Literature review

2.1 Overview of Ethiopian forests

Ethiopia is endowed with different forest biodiversity when compared in different countries in Africa. The reason for this is most part of the country consists of high plateau and mountain ranges (Demel Teketay, 2002). The different physical conditions and variation in altitude have resulted in great diversity of climate soil and different vegetation cover of the country which is associated with presence of different forest biodiversity (Zerihun Woldu 1999, Demel Teketay, 2002).

Ethiopia is also an important regional center of biological diversity. The diversified topographic features such as ragged mountains, flat toped plateaus, deep georges, incised river valleys and rolling plains are some of the reasons for Ethiopia has high biodiversities and regional center of biological diversities (Ensermu Kelbesa et, al., 1992, Tewolde Birhan, 1988). The flora of Ethiopia is very heterogeneous and has reach endemic species of plants due to the diversity in climate vegetation and terrain. It is estimated to contain between 6500-7000 species of higher plants of which 12% are endemic (Tewolde, 1991) as cited in Teshome Soromossa et. al., (2004).

It is believed that substantial portion of the land area in high lands of Ethiopia was covered with forests having wide coverage than at present (Friis, 1986). The presence of a number of isolated forest trees, even on farm lands or patches of forests around church yards and religious burial grounds in this country indicate the occurrence of forests earlier (Tamirat Bekele, 1993).

2.1.1 Socio-ecological significance of forests

Ecological significance of forests

Forests provide a wide range of ecological significance. There are a number of services that forest provides. The major services that forests provide includes regulation of water regions, modulating climate, maintenance of soil quality, carbon sequestration, maintenance of biodiversity and being the habitat for other species (Dail, 1997). As stated by Ramirez-Maricial *et al*., (2001), forests indirectly influence global climate, serve as wild life habitat, provide genetic pool for biotic diversity and provide ecosystem services for water shed protection and erosion control. In addition to this, forests help to maintain the fertility of soil, used as a habitat for wild life, protect water resources and reduce natural disasters, such as land slides and flooding (World Bank, 2004).

Socio- economic significance of forests

Human being are dependent for their substances health well being and enjoyment on forest biodiversity. Forest also have been providing food, recreation, spiritual sustenance, commercially traded products ranging from pharmaceutical to timber and (Murthy *et al.,* 2002 and World Bank 2004). Forests provide a wide range of products and services. The economic values of forest are the basis of a variety of industries including timber, processed wood and paper, rubber and fruits. They also contain products that are necessary for rural communities including fuel, construction materials and medicines (FAO, 2005). Forests play pivotal role as source of energy, for grazing, and non-timber products. The energy consumption of rural Ethiopia is mainly based on biomass source for which fuel wood being the highest component. The rural Ethiopia households entirely dependent on biomass fuel to meet their energy requirement for cooking, heating and lightening.

2.1.2 Causes for Ethiopian forest loss

Historical documents indicate that Ethiopia had experienced substantial deforestation, soil degradation and an increase in the area of bare land over the years. The need for fuel wood, farm land, human settlement, shifting cultivation, grazing area, firewood, lack of viable land policy have been indicated as the main cause for forest biodiversity degradation frequently leading to loss of forest cover and biodiversity loss (Ensermu Kelbessa and Teshome Soromessa, 2008).

Deforestation, natural disasters such as volcanic eruption, logging, and converging of forests to agricultural lands accounts 40% of Ethiopia forest loss (Tewolde Birhan 1988). Particularly, the current contributor factors accelerated the declining of woody plant species diversity in Ethiopia are the size and distribution patters of humans and domestic animal populations, the level of resource consumption understanding woody plant species in narrow sense due to low level of awareness, the attention of woody plant species conservation and sustainable use has so far been inadequate (Tesfaye, 2007).

In Ethiopia, the excessive exploitation of natural pasture and forests without minimum repair, the extension of cultivation to marginal lands by clearing and burning fragile ecosystem, forest fire, lack of proper forest administration and forest management, lack of compatible forest proclamation and other legislation, lack of constant and sustainable institutional organization has resulted in total deforestation and degradation, loss of fertile cultivable land and soil fertility, exposing the country to drought and famine (UNEP, 1995). The country's high forest and wood lands coverage have been decline in both size and quality. This is due to the increased use of forest lands for farm lands, unwise use and excessive utilization of forest products without considering future generation, ecological and economic consequences (EFAP, 1994).

The ever increasing demand for forest products and forest land, together with the alarming rate of population growth has put the remaining patches of forests on the verge of extiniction (Tamirat Bekele , 1994).

2.1.3 Consequences for Ethiopian forest loss

Reduction in forest cover has a number of consequences including soil erosion and production capacity for carbon sequestration, loss of biodiversity and instability of ecosystem and reduced availability of various wood and non-wood forest products and services (Alemu Mekonen and Bluff Stone, 2007). The depletion of natural vegetation in many parts of the country has also lead to the treat and decline in number and area of distribution of many plant species (Tesfaye Bekele, 2000). Loss of forest biodiversity influences vegetation dynamics and tree density at local and regional level. Environmental problems such as soil degradation, erosion, decreasing biodiversity, loss of potential natural resources, a number of valuable medical plants and associated indigenous knowledge are negative effects resulting from forest biodiversity loss. The general destruction of vegetation results in increased soil erosion, loss of soil fertility, loss of plant and animal genetic resources, climate change, increased run off that leads to flooding reduced infiltration to the water table and decreased water supply to rivers during dry seasons (EFAP, 1994).

2.1.4 Measures taken to prevent Ethiopian forest loss

The conversion of natural vegetation and biodiversity loss is currently one of the leading agenda for a number of world conservation organizations, authorities and interest groups (UNDESA, 2004) those stakeholders establish sustainable forest management for biodiversity conservation and sustainable use of resources. Sustainable forest management has been the main focus of the worldwide forestry sectors over many years. It aims to ensure that needs derived from the forest meet present day needs without comprising the ability of future generation. Sustainable forest management also aims at balancing social, economic and environment as objectives. However, only about 5% of the total forest areas in developing countries are managed properly (FAO, 2001), which is very low when compared with developed countries (Girima Amante, 2005)

To minimize the risk, sustainable forest management has been practiced through applying conservation techniques, among techniques, protecting forest areas with restricted access for local communities which have often been introduced in the forest helps to tackle deforestation and its effects (Winberg, 2010).

2.2 Plant biodiversity

Biodiversity (biological diversity), is the variability among living organisms. It includes the diversity within and between species, and ecosystems. Biodiversity is the total variety of life on earth. It includes all genes, species, ecosystems and the ecological process of which they are apart (ICBP, 1992).

2.2.1 The value of plant biodiversity

Various plant species have different uses depending on socio-economic conditions of a given community. Natural forests are important sources of non- timber forest products such as fruits, todders, honony, herbal medicine, a source of tools and construction materials, timber and food for local communities. In Ethiopia the majority of woody plan species have economic uses. This has tended to promote unsustainable utilization of tree and shrub species. Such unsustainable utilization of few species especially, for timber and fuel wood collection put them in the endanger category.

2.2.2 Diversity indices

Floristic description of vegetation involves the analysis of diversity, evenness and similarity. Species diversity is one of the most important indices used for evaluating the sustainability of forest community. Diversity and equitability of species in a given vegetation is used to interpret variations among and within the community and help to explain the underlying reasons for such a difference (Kent and Coker, 1992). Species diversity is described on the basis of two concepts: these are the total number of species in the community /species richness and relative abundance of the species (species evenness) within the sample. Thus, species diversity is the product of species richness and evenness or equitability. Species diversity index provides information about species rarity, endemism, and commonness. Measures of species diversity are usually seen to be key indicators for the well being of ecological system (Heywood, 1995 and Shakelton, 2000).

3. Materials and Methods

3.1 The Study Area

The study was conducted in Kurib forest, near Tilili capital town of Guagusa Shikudad Woreda which is located northwest of Ethiopia near by the main road of Addis Ababa to Bahir Dar. The study area is approximately at distance of 420 km from Addis Ababa and 130 km from Bahir Dar. The district is bordered with Burie woreda in the east, Wonbera in the south, Sekela in the north, Ankesha in the west and Banja in the North West direction. Guagusa Shikudad woreda in which the study area has two climate conditions, namely Weina Dega (70%) and Dega (30%). But the study area is found in Dega part of the woreda. The minimum and the maximum annual rain fall and temperature ranges from 1140-3572mm and 10-25^{o}c respectively.

3.2 Sampling Technique

Systematic sampling method was used to take samples. Sample plots were laid along line transects which were established horizontally from south to north direction at low, medium and high altitude. Sampling plots of 20m x 20m were established systematically at every 200m interval along 6 transect lines which are 300m apart. A total of 72 sample plots were systematically established to collect information about woody plant species and for documentation of trees, shrubs and lianas following the Braun-Banquet approach (Mueller-Dombois and Ellenberg, 1974, Kent and Coker, 1992, Desalegn Wana and Zerihun Woldu, 2005).

3. 3 Data Collection Methods

3.3.1 Floristic data collection

Floristic data were collected between November 20 to January 30. All wood plant species of trees and shrubs in each sample plots were recorded using vernacular names or local names. Woody plant species identification was done by using flora of Ethiopia and Eritrea for those which cannot be identified in the flora of Ethiopia and Eritrea, fresh specimens were collected and then pressed properly and finally brought to the National Herbarium of Addis Ababa University for species name identification

3.3.2 Structural data collection

Any woody species of trees and shrubs with DBH >2.5cm and the height of trees and shrubs above 2m were measured and recorded for diameter at breast height (DBH), and height. At each of the plot established, diameter of trees and shrubs with diameter at breast height > 2.5m was measured using measuring tape and tree heights was measured by rolling meter, measured sticks and those which can be difficult to measure, the tree height was obtained by visual estimate. Counting of trees and shrubs with DBH >2.5cm and conversion of DBH to basal area was done. Density, frequencies, basal area, dominance and IVI of trees and shrubs were calculated after individual woody plant species were measured and counted.

3.4 Data Analysis

3.4.1 Structural Analysis

Structural analysis was performed on the bases of density, DBH, height, frequency, basal area per hectare and IVI. The distribution of size classes were evaluated by computing the density of individuals with DBH >2cm, >10cm and > 20cm as well as the ratio of DBH class >10cm to DBH class >20cm. According to (Grubb *et al*., 1963), the ratio of density at DBH class >10cm to density at DBH class >20cm can be used as the measure of the distribution of different size classes. The vegetation data were computed and summarized using the following formula according to(Mueller-Dombois and Ellenberg, 1974, Kent and Coker, 1992).

Frequency: the number of plots in which that species occurs/total number of plots x 100.

Relative frequency: frequency of species A/ total frequency of all species.

Density of species: the number of individuals of that species /area sampled.

Relative density: density of species A/ total density of all species x 100

$$\text{Basal area (BA)} = \frac{\pi d^2}{4}$$

Where BA = Basal area in m^2 per hectare

D = diameter at breast height in meter

π:= phi (3.1.4)

Dominance: is a mean basal area per species times the number of species

Relative dominance (RDO): it is a basal area of species / total basal area of all species x 100

Important Value Index (IVI): was analyzed for woody species. IVI of a species was calculated from the sum of relative frequency /RF/ relative dominance (RDO) and relative density (RD) (Kent and Coker, 1992).

IVI = RDO + RD + RF

3.4.2 Diversity analysis

The indices of species diversity, richness and evenness were measured using different indices. Species diversity indices widely used are: Simpson's index, Shannon-Weiner index and Sorenson index of similarity (Mueller-Dombois and Ellenberg, 1974). For this study the Shannon Weiner diversity index was used and it is calculated as follows (Krebs, 1999; Kent and Cocker, 1992 and Jayarman, 2000).

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i)$$

Where: H' = the Shannon diversity index, *pi* is the proportion of the total community abundance represented by the *i*th species and *ln* (*pi*) is the natural log of *pi*, S = numbers of species encountered and Σ = sum from species 1 to species S. The minimum value of H' is 0, for a plot with a single species and H`=1 indicates that the plot with complete evenness. The different value of H` for each plot indicates that the difference in species richness and evenness (Whittaker, 1975). The value of H` increases as species richness and evenness increase and vice versa (Manuel and Molles, 2007).

Equitability or evenness index was calculated from the ratio of observed diversity to maximum diversity using the equation.

$$E = H'/\ln(S) = H'/H_{max}$$

Where: E = Evenness; H' = Shannon-Wiener Diversity Index; Hmax = lnS; S = total number of species in the sample. The value of evenness index falls between 0 and 1.

4. RESULT AND DISCUSSION

4.1 Floristic composition

A total of 39 different species of woody plants were identified in Kurib ferest which is near Tilili town in Awi Zone found between Debre Merkos and Bahir Dar. A total of 4,055 individuals of woody plants were counted. Among the collected plants *Pittosporum viridflorum* was the dominant plant species with recorded value of 450. *Maesa lanceolata, Maytenus obscura* and *Acacia abyssinica* are the second, third and forth dominance with recorded value 400, 366, and 350 respectively. *Maytenus arbutifolia* was the least dominant in Kurib forest (Table1) with recorded value of 3 individuals.

Table 1: Different species of woody plants with their corresponding abundance and average height.

No	*Name of species*	Family name	Habit	Average height (M)	Average height percentage	Their abundance
1	*Acacia abyssinica Hochst.ex Benth.*	Fababaceae	T	18	3.56	350
2.	*Acacia decurrens Willd.*	Fababaceae	T	16	3.16	150
3	*Acacia nilotica (L.) Willd. Ex Del.*	Fababaceae	T	18	3.56	230
4.	*Albizia gummifera (J.F.Gmel.)C.A.Sm.*	Fababaceae	T	12	0.59	30
5.	*Apodytes dimidiate E.Mey.ex Arn.*	Icacinaceae	T	25	4.95	40
6.	*Bersama abyssinica Fresen*	Melianthaceae	T	14	2.77	120
7.	*Buddleja polystachya Fresen.*	Longaniaceae	T/S	6	1.18	50
8.	*Cardia africana Lam.*	Boraginaceae	T	17	3.36	20
9.	*Carissa spinarumL.*	Apocynaceae	S	16	3.16	110
10.	*Clausena anisata (Willd.) Benth.*	Rutaceae	S	14	0.59	160
11.	*Clematis simensis Fresen.*	Ranonculaceae	C	6	2.77	150
12.	*Combretum molle (R. Br.ex Don.) Engl. And Diels.*	Combretaceae	S	3	0.59	179
13	*Croton mocrostachyus P.Del.*	Euphorbiasceae	T	18	3.56	30

14.	*Cupressus lustanica Mill.*	Cupressaceae	T	16	1.18	5
15.	*Discopodium penninervum Hochst.*	Solanacrae	S	5	0.99	20
16	*Dombeya torrid (J.F.Gmel.)P.Bam Ps.*	Sterculaceae	T	18	3.56	50
17.	*Ekebergia capensis Sparrm.*	Miliaceae	T	15	2.97	15
18.	*Embelia schimperi Varke.*	Myrsinaceae	C	5	0.99	30
19.	*Euphorbia abyssinica Gmel.*	Euphorbiaceae	S	13	2.57	100
20.	*Erica arborea L.*	Ericaceae	T	6	1.18	30
21.	*Erythrina brucei Schweinf.*	Fabaceae	T	17	3.36	50
22.	*Ficus sur Forssk*	Moraceae	T	17	3.76	15
23.	*Grandinium bullosa*	Kusha	S	3	0.59	180
24	*Hagenia abyssinica(Brace) J.F.Gmel*	Rosaceae	T	20	3.96	30
25	*Hypericum revolutum Vahl.*	Hypericaceae	S	6	1.18	10
26	*Juniperus procera Hochest.ex Endel*	Cupressaceae	T	20	3.96	20
27.	*Maesa lanceolata Forssk.*	Myrsinaceae	T	29	5.74	400
28	*Maytenus arbutifolia (A. Rich.) Wilczek.*	Celastraceae	T	16	3.16	3
29	*Maytenus obscura (A.Rich.)Cuf*	Kobba	T	13	2.57	366
30.	*Phytolacca dodecandra L. Herit*	Phytolacaceae	C	3	059	12

31	*Pittosporum viridiflorum Sims.*	Pittosporaceae	T	30	5.94	450
32	*Prunus africana (Hook.F.)Kalkm.*	Rosaceae	T	25	4.95	40
33.	*Rhus natalensis Krauss.*	Euphorbiaceae	S	4	0.79	40
34.	*Rubus steudneri Schweinf*	Rosaceae	T/S	5	0.99	130
35.	*Rosa abyssinica Lindley.*	Rosaceae	T/S	4	0.79	180
36.	*Schefflera abyssinica (Hochst.ex A. Rich.)Harms.*	Araliaceae	T	20	3.96	30
37.	*Solanecio gigas (Vatke)C.Jeffrey*	Asteraceae	S	3	0.59	50
38.	*Vernonia amygdalina Del.*	Asteraceae	T/S	6	1.18	10
39.	*Vernonia urticifolia A. Rich.*	Asteraceae	S	3	0.59	170
	Total			**508**	**100**	**4055**

Key T= tree, S= shrub, T/S= Tree shrubs, C=climber

The life forms of the study forest were trees, tree/shrubs, shrubs and climbers. The tree has the largest proportion of life forms of the species, trees with 22 (56.41%) species, Tree/shrub with 4 (10.25) species, shrub with 10(25%) species and climber with 3(7.69%) species.

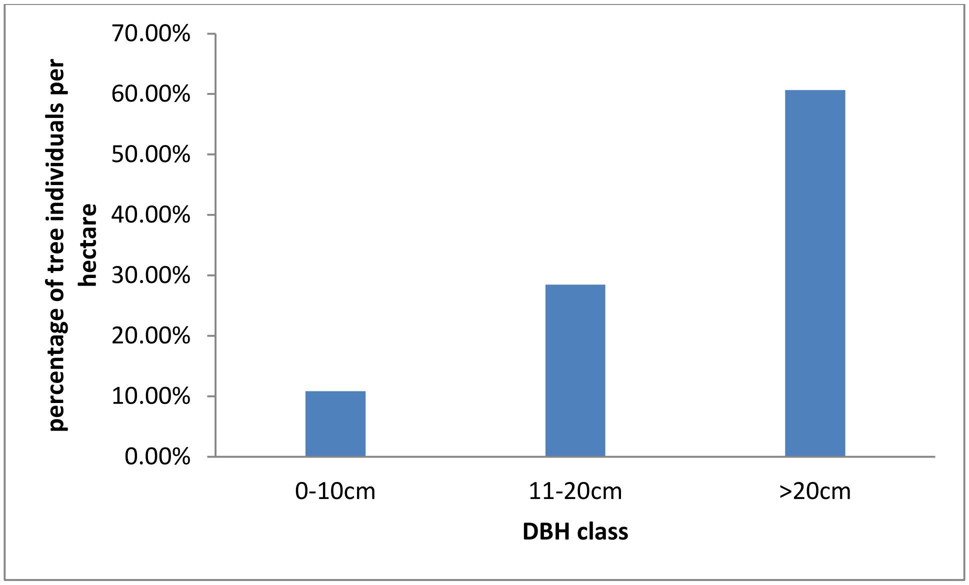
4.2 Analysis of vegetation structure

4.2.1 Density of trees

The density of tree is expressed as the number of trees per area sampled. It is the crucial parameter for sustainable forest management. The density of tree individuals in Kurib Forest was analyzed. According to the data analysis the density of tree individuals of Kurib forest with DBH greater than 2.5cm was 152.53 individuals per hectare, those with greater than 10 cm was 400.88 individuals per hectare and those greater than 20cm was 853.95 individuals per hectare. The data analysis of Kurib forest woody plant species showed that *Pittosporum viridflorum* is the most dominant tree species followed by *Maesa lanceolata, Maytenus obscura* and *Acacia abyssinica* respectively (Appendix I). The data analysis from figure 1 showed that the majority of woody plant species were distributed in DBH class > 20cm and the least woody plant species distributed in DBH class > 2cm.

The ratio of density of trees with DBH greater than 10cm to DBH greater than 20cm for Kurib forest is 0.469. This indicates that the predominance of large sized individuals.

The ratio of density at DBH class greater than 10cm to density at DBH class greater than 20 cm has been compared with Angada forest (Shambel Alemu, 2011) and Gedo forest (Birhanu Kebede *et al*., 2014). The ratio of density at DBH class greater than 10cm to density at DBH class greater than 20 cm for the study forest is 0.469, Angada forest is 1.47 and Gedo forest is 1.79. The ratio of Kurib forest is less than the above mentioned forests. This indicates that there is predominance of large sized individuals in the study forest. This is because small sized individuals are affected by grazing animals, fire wood collection and fencing by communities (information from field observation and community elders).

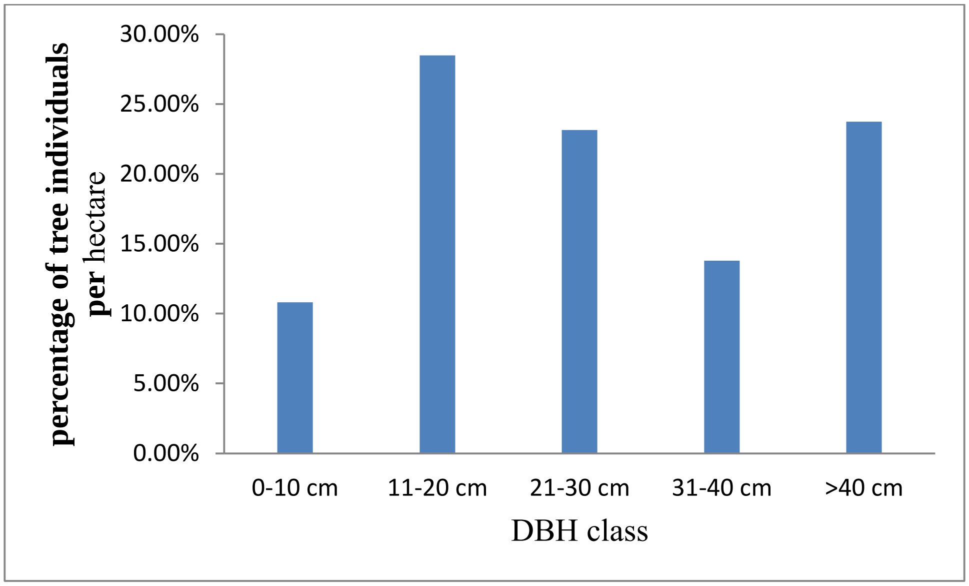


Key: >2cm = 10.82%, >10cm = 28.48%, >20cm = 60.68%

Figure 1: percentage of tree densities per hectare with DBH .2cm, >10cm and >20cm in Kurib forest

4.2.2 Diameter at Breast Height (DBH)

The distribution of woody plant individuals in different DBH classes was analyzed. The DBH was classified into five classes 1 (2.5-10cm), 2 (11-20cm), 3(21-30cm), 4(31-40cm) and 5 (>40cm). The DBH analysis showed that the majority of woody plant species distributed in the second class (11-20cm) which has a total of 1155 individuals with 401.04(28.48%) individuals per hectare. The least woody plant species distributed in the first class 0-10 cm. The least woody plant species distributed in the first class (0-10). The distribution of woody plant species in DBH class 1(0-10cm) has a total of 439 individuals with 152.43(10.82%) individuals per hectare, the third class has a total of 939 individuals woody plant species with 326.04(23.15%) individuals per hectare, the fourth DBH class has a total of 559 individuals of woody plant species with 194.09 (13.78) individuals per hectare and the fifth DBH class has a total of 963 individuals of woody plant species with 334.37(23.74%) individuals per hectare. The DBH analysis showed that more number of individuals were distributed in the middle class and decrease in the DBH class 1 and 4, then slight increase in DBH class 5(Fig. 2).

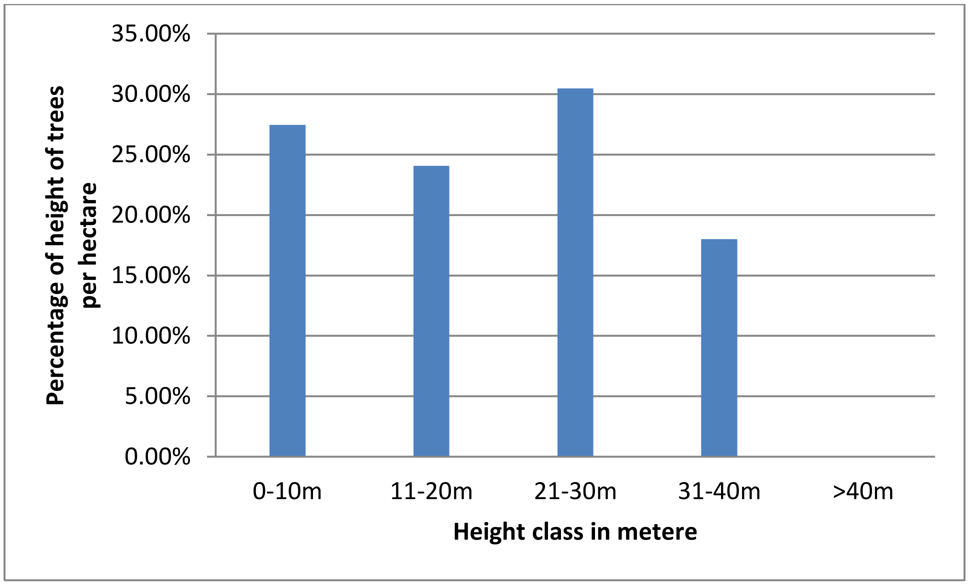


Key: 0-10cm = 10.82%, 11-20cm = 28.48%, 21-30cm = 23.15%, 31-40cm =13.78% >40cm = 23.74%.

Figure 2: DBH classes and percentage of numbers of individuals per hectare in Kurib Forest

4.2.3 Height of trees

Individual woody plant species recorded in Kurib forest were classified in to five height classes. 1. 0-10m, 2. 11-20m, 3. 21-30m, 4. 31- 40m, 5. > 40m. As the data analysis showed, there is higher number of woody plat species in height class three (21-30m) which has 1236 individuals with 429.16(30.48%) individuals per hectare, followed by height classe 1(0-10m) which has 1113 individuals with 386.45 (27.45%) individuals per hectare, second and fourth height classes have 977 individuals with 339.23(24.06%) individuals per hectare and 729 individuals with 253.12(18%) individuals per hectare and there is less number of woody plant species in height class 4 (31-40m)(figure 3). The tallest species in the study forest id *Pittosporum viridiflorum* with average height 30m (5.94%) followed by *Maesa lanceolata*, *Apodytes dimidiata* and *Prunus africa* with average height 29m (5.74%), 25m (4.5%) and 25m (4.95%) (Table 1) respectively.



Key: 0-10m = 27.45%, 11-20m =24.06%, 21-30m = 30.48%, 31-40m = 18% >40m = 0%

Figure 3: Percentage distribution of height classes per hectare of woody plant species in Kurib Forest.

4.2.4 Basal area

The basal area of Kurib forest was analyzed. The data analysis showed that. The total basal area of all woody plant species in Kurib forest was 105.7 m^2 per hectare (Table 2). As shown from the table *Pittosporum viridflorum* has the highest basal area which is 23.28% followed by *Maesa lanceolata*, *Maytenus obscura, Acacia nilotica* and *Acacia abyssinica* which has basal area of 19.75%, 14.32%, 9.78 % and 4.59% respectively. Basal area provides a better measure of relative importance of the species than simple stem count (Cain and Castro, 1959) as cited in Tamirat Bekele (1994). Species with the largest contribution in basal area can be considered the most important woody species in the forest. The data analysis showed that the most, important trees species in Kurib forest were *Pittosporum viridiflorum, Maesa lanceolata, Maytenus obscura, Acacia lilotica* and *acacia abyssinica* (Table 2).

Table 2: Basal area (m2/ha) of woody plant trees species and their percentage contribution in Kurib forest.

No	*Name of species*	basal area /ha	%
1	*Acacia abyssinica Hochst.ex Benth.*	4.861	4.59
2.	*Acacia decurrens Willd.*	2.326	2.19
3.	*Acacia nilotica (L.) Willd. Ex Del.*	10.357	9.78
4.	*Albizia gummifera (J.F.Gmel.)C.A.Sm.*	0.673	0.63
5.	*Apodytes dimidiate E.Mey.ex Arn.*	0.991	0.99
6.	*Bersama abyssinica Fresen*	0.699	0.69
7.	*Buddleja polystachya Fresen.*	0.697	0.65
8.	*Cardia africana Lam.*	0.041	0.03
9.	*Carissa spinarumL.*	0.90	0.85
10.	*Clausena anisata (Willd.) Benth.*	1.144	1.07
11	*Clematis simensis Fresen.*	1.437	1.35
12	*Combretum molle (R. Br.ex Don.) Engl. And Diels.*	1.202	1.13
13	*Croton mocrostachyus P.Del.*	1.100	1.03
14.	*Cupressus lustanica Mill.*	0.309	0.28
15.	*Discopodium penninervum Hochst.*	0.140	0.13
16	*Dombeya torrid (J.F.Gmel.)P.Bam Ps.*	1.197	1.12

17.	*Ekebergia capensis Sparrm.*	0.357	0.33
18.	*Embelia schimperi Varke.*	0.012	0.011
19.	*Euphorbia abyssinica Gmel.*	1.812	1.71
20.	*Erica arborea L.*	0.242	0.22
21.	*Erythrina brucei Schweinf.*	3.381	3.19
22.	*Ficus sur Forssk*	1.236	1.16
23.	*Grandinium bullosa*	1.579	1.48
24.	*Hagenia abyssinica(Brace) J.F.Gmel*	0.671	0.67
25	*Hypericum revolutum Vahl.*	2.520	2.38
26	*Juniperus procera Hochest.ex Endel*	0.035	0.33
27	*Maesa lanceolata Forssk.*	1.111	1.04
28.	*Maytenus arbutifolia (A. Rich.) Wilczek.*	20.902	19.75
29	*Maytenus obscura (A.Rich.)Cuf*	0.0322	0.030
30	*Phytolacca dodecandra L. Herit*	15.156	14.32
31.	*Pittosporum viridiflorum Sims.*	0.0092	0.006
32	*Prunus africana (Hook.F.)Kalkm.*	24.638	23.28
33	*Rhus natalensis Krauss.*	1.919	1.80
34.	*Rubus steudneri Schweinf*	0.838	0.59
35.	*Rosa abyssinica Lindley.*	1.631	1.54
36.	*Schefflera abyssinica (Hochst.ex A. Rich.)Harms.*	2.239	2.10
37.	*Solanecio gigas (Vatke)C.Jeffrey*	0.906	0.85
38.	*Vernonia amygdalina Del.*	0.232	0.21

39.	*Vernonia urticifolia A. Rich.*	0.197	0.17
	Name of species	**105.77**	

The basal area of Kurib Forest which is 105.77 is compared with the basal area of Mengesha Ambamariyam Forest (Abiyu Tilahun, 2009) with basal area of 84.17, Angada Froest (Shambel Alemu, 2011) with basal area of 79.8 and Dindin Forest (Simon Shibiru and Girma Balcha, 2004) with basal area of 49.00. The study forest has the highest basal area than the other compared forests. This is because the studied forest has higher DBH individuals of woody plant species than the other compared forests. The result of basal area was found based on the DBH. Woody plant species which have the highest DBH also have the highest basal area.

4.2.5 Frequency

Frequency is the number of quadrants in which a given species found in an area. It gives an approximate indication for homogeneity and heterogeneity of vegetation. Lamprecht (1989), pointed out that high value in high frequency and lower value in lower frequency classes indicate vegetation homogeneity. Conversely, high percentage of number of species in the lower frequency classes and lower percentage of number of species in the higher frequency classes indicate high degree of floristic heterogeneity (Simson Shibru and Girma Balcha, 2004).

According to Appendix II, the most frequent species was *Pittosporum viridflorum* with the percentage frequency value 97.22 % which is occurred in 70 quadrates followed by *Maesa lanceolata, Acacia nilotica* and *Maytenus obscura* with percentage frequency value of 83.33%, 69.49% and 62.25% respectively which are found in 60, 50 and 45 quadrates respectively.

Based on the percentage frequency values, the woody plant species of Kurib forest were classified into five frequency classes 1.(0-20%), 2.(21-40%), 3.(41-60%), 4.(61-80%), 5.(81-100%) which is expressed in their percentage value. In frequency class 1, 24 species with 61.53% distributed, in frequency classes 2,3,4 and 5:5,4,4 and 2 species with 12.82%, 10.25%, 10.25% and 5,12% distributed respectively (Figure 3).

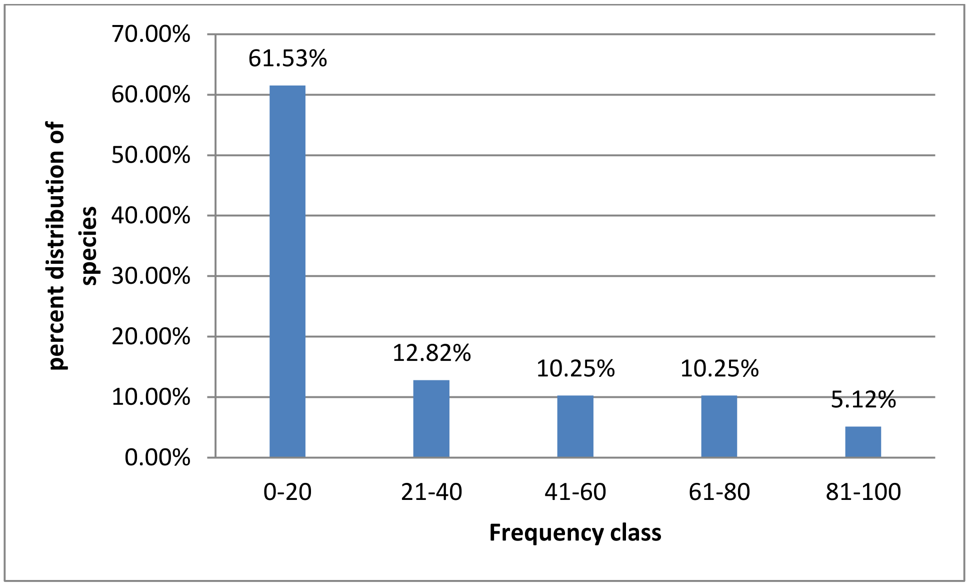


Figure 4: Frequency distribution of woody plant species in Kurib Forest

The present study in Kurib forest indicate that high percentage of number of species in lower frequency classes and relatively low percentage of number of species in higher frequency classes. This result revealed that the presence of high degree of floristic heterogeneity in Kurib forest.

4.2.6 Important Value Index (IVI)

Important value index indicates the structural importance of a species with mixed species and it is calculated by the sum of relative frequency (RF), relative density (RD) and relative dominance (RDO). It is used to compare ecological significance of species in which high IVI value indicates that the species sociological structure in the community is high as indicated by Lamprecht, (1989). The species with greatest importance value are the most dominant of particular vegetation (Simon Shibru and Girma Balcha, 2004). The IVI of Kurib Forest was analyzed and the importance value index of Kurib forest is given in table 3. As shown in the table *Pittosporum viridflorum* was found to have the highest IVI, followed by *Maesa lancrolata, Maytenus obscura* and *Acacia nilotica* have the second, third and fourth IVI value respectively The IVI analysis showed that *Pittosporum viridflorum* is the most important species followed by *Maesa lancrolata, Maytenus obscura* and *Acacia nilotica* (Table 3).

Table 3: The Important Value Index of woody plant species in Kurib Forest.

No	*Name of species*	RD	RF	RDO	IVI
1	*Acacia abyssinica Hochst.ex Benth.*	8.08	6.46	3.74	18.28
2.	*Acacia decurrens Willd.*	0.35	2.42	1.79	4.56
3.	*Acacia nilotica (L.) Willd. Ex Del.*	5.31	8.08	7.97	21.36
4.	*Albizia gummifera (J.F.Gmel.)C.A.Sm.*	0.69	2.42	0.51	3.62
5.	*Apodytes dimidiate E.Mey.ex Arn.*	0.92	0.96	0.74	2.21
6.	*Bersama abyssinica Fresen*	9.07	1.61	0.53	11.21
7.	*Buddleja polystachya Fresen.*	1.15	0.58	0.53	2.26
8.	*Cardia africana Lam.*	0.46	0.64	0.64	1.74
9.	*Carissa spinarumL.*	2..54	2.74	0.69	5.97
10.	*Clausena anisata (Willd.) Benth.*	3.69	1.59	0.88	6.16
11.	*Clematis simensis Fresen.*	3.46	4.85	1.10	9.41
12.	*Combretum molle (R. Br.ex Don.) Engl. And Diels.*	4.13	1.39	0.92	6.44
13	*Croton mocrostachyus P.Del.*	0.69	2.10	0.84	3.63
14.	*Cupressus lustanica Mill.*	0.11	0.32	0.23	0.66
15.	*Discopodium penninervum Hochst.*	0.46	0.58	0.10	1.14
16	*Dombeya torrid (J.F.Gmel.)P.Bam Ps.*	1.15	1.77	3.45	6.37

17.	*Ekebergia capensis Sparrm.*	0.34	0.80	0.27	1.41
18.	*Embelia schimperi Varke.*	0.69	4.85	0.09	5.63
19.	*Euphorbia abyssinica Gmel.*	2.31	1.29	1.39	4.99
20.	*Erica arborea L.*	0.69	0.80	0.18	1.67
21.	*Erythrina brucei Schweinf.*	1.15	1.93	2.60	5.68
22.	*Ficus sur Forssk*	0.34	0.64	0.95	1.93
23.	*Grandinium bullosa*	0.41	6.46	0.51	7.38
24	*Hagenia abyssinica(Brace) J.F.Gmel*	0.69	0.64	1.94	3.27
25	*Hypericum revolutum Vahl.*	0.23	0.64	0.27	1.14
26	*Juniperus procera Hochest.ex Endel*	0.46	0.88	0.85	2.19
27.	*Maesa lanceolata Forssk.*	9.24	9.70	16.09	35.03
28	*Maytenus arbutifolia (A. Rich.) Wilczek.*	0.06	0.32	0.07	0.45
29	*Maytenus obscura (A.Rich.)Cuf*	8.45	7.27	11.67	27.39
30.	*Phytolacca dodecandra L. Herit*	0.27	0.80	0.003	1.07
31	*Pittosporum viridiflorum Sims.*	10.39	11.31	18.97	40.67
32	*Prunus africana (Hook.F.)Kalkm.*	0.92	2.33	1.47	4.72
33.	*Rhus natalensis Krauss.*	0.92	1.61	0.49	3.02
34.	*Rubus steudneri Schweinf*	3.00	2.10	1.72	6.82
35.	*Rosa abyssinica Lindley.*	0.41	2.26	1.25	3.92
36.	*Schefflera abyssinica (Hochst.ex A. Rich.)Harms.*	0.69	2.58	0.69	3..96
37.	*Solanecio gigas (Vatke)C.Jeffrey*	1.15	0.58	0.17	1.90
38.	*Vernonia amygdalina Del.*	0.23	3.22	0.15	3.60

39.	*Vernonia urticifolia A. Rich.*	3.92	1.28	1.21	6.41
	Name of species				

4.3 Woody Plant species diversity and equitability analysis

Woody plant species diversity and equitability in the study forest was analyzed by Shannon-Weiner diversity index and equitability (evenness) index. It is the most applicable index of diversity (Greg-Smith, 1983). It accounts both abundance and evenness of the species present. The Shannon-Weiner diversity index varies between 1.5 and 3.5 and rarely exceeds 4.5. Shannon-Weiner diversity is high when it is above 3.0, medium when it is between 2.0 and 3.0, low when it is smaller than 1.0 (Kent and Cocker, 1992). The woody plant species and evenness of Kurib forest was analyzed. According to the data analysis in table 4, the species diversity increase when we go from the base of the forest to the middle and decrease when we go from the middle to the top. The first 24 plots were taken from the base of the forest and the next 24 plots taken from the middle of the forest and finally the last 24 plots taken from the top of the forest. The overall Shannon-Weiner diversity index of the study forest is 1.86. The study forest has low diversity. This can be attributed by social and environmental influence according to (Espinosa and Carbrera, 2011).

The species evenness value ranges between 0 and 1. When it is 0, the area is dominated by single species and when it is 1, the species are evenly distributed in the area. The data analysis showed that the average evenness value of the study forest is 0.91. This indicates that the species in the study forest are more or less evenly distributed.

The study was compared with Woynwuha Natural Forest (Temesgen Mekonen *et al*., 2015) with the average diversity and evenness value. The study forest has 1.86 and 0.91 average Shannon Weiner diversity index value and average evenness value respectively. Woynwuha Natural Forest has 3.24 and 0.76 average Shannon Weiner diversity index and average evenness value respectively. When the study forest was compared with the above forest, it has low diversity but high evenness value.

Table 3: The diversity of the species evenness and richness in Kirub forest

Plots	Species richness	Total abundance in each plot	H`	EH(Evenes s)
1	7	58	1.64	0.84
2	6	47	1.51	0.84
3	5	39	1.41	0.87
4	6	41	1.63	0.90
5	5	47	1.52	0.94
6	5	40	1.15	0.71
7	6	49	1.69	0.94
8	5	43	1.51	0.93
9	5	42	1.48	0.91
10	6	51	1.55	0.86
11	6	62	1.58	0.88
12	5	42	1.47	0.91
13	8	41	1.72	0.82
14	7	38	1.72	0.88
15	7	34	1.76	0.90
16	6	36	1.72	0.95
17	9	95	1.75	0.79
18	8	77	1.76	0.84
19	8	42	1.75	0.84
20	8	44	1.78	0.85
21	8	55	1.72	0.82
22	8	22	1.62	0.78
23	8	49	1.79	0.86
24	7	61	1.47	0.75
25	13	68	2.31	0.90
26	11	74	2.23	0.92
27	11	78	2.20	0.91

28	12	76	2.21	0.88
29	13	106	2.23	0.86
30	13	58	2.43	0.94
31	13	71	2.27	0.88
32	14	78	2.27	0.86
33	12	65	2.29	0.81
34	12	65	2.29	0.92
35	13	65	1.94	0.75
36	10	79	2.27	0.98
37	10	82	2.09	0.90
38	9	84	2.04	0.92
39	11	72	2.08	0.86
40	9	45	2.04	0.92
41	10	66	2.13	0.92
42	9	62	2.02	0.91
43	10	64	2.04	0.88
44	9	119	2.09	0.96
45	10	50	2.21	0.95
46	10	119	2.09	0.96
47	9	46	2.06	0.93
48	10	64	2.11	0.91
49	10	79	2.01	0.87
50	8	46	2.06	0.99
51	9	61	1.86	0.84
52	8	73	1.88	0.90
53	7	44	1.86	0.93
54	7	45	1.84	0.94
55	7	36	1.81	0.93
56	7	39	1.82	0.93
57	7	41	1.87	0.96

58	8	43	1.91	0.91
59	8	63	1.90	0.91
60	8	54	1.91	0.91
61	8	41	1.89	0.90
62	9	58	1.84	0.83
63	8	46	1.82	0.87
64	8	54	1.86	0.89
65	8	43	1.90	0.86
66	9	54	1.88	0.85
67	9	54	1.88	0.85
68	8	49	1.81	0.87
69	8	40	1.87	0.89
70	8	45	1.85	0.88
71	7	33	1.84	0.94
72	8	40	1.96	0.94
Total			133.92	65.55
Average			1.86	0.91

Key H`= Shannon Weiner diversity index, EH= Evenness or Equitability

5. Conclusion and Recommendation

5.1 Conclusion

The woody plant species composition, structure and diversity of Kurib Forest have been studied. The study showed that a total of 39 species of woody plants were identified in the study forest. From 39 different species, a total of 4055 individuals of woody plants were collected *Pittosporum viridflorum* is the most dominant tree in the study forest followed by *Maesa lanceolata, Maytenus obscura* and *Acacia abyssinica* which are second, third and fourth dominant tree species in the study area. On the other hand *Hypericum revolutum, Vernonia amygdolina, Cupreseeus lostanica and Maytenus arbutifolia* are the least domint woody plant species in Kurib Forest

From the structural analysis, the density of tree individuals of Kurib Forest with DBH greater than 2cm was 152.35 individuals per hectare, those with greater than 10 cm was 400.88 individuals per hectare and those with greater than 20 cm was 853.95 individuals per hectare. The density of trees increases with increase DBH class. This indicated that the predominance of large sized individuals in higher DBH class than the lower DBH class. The total basal area of woody plant species in Kurib forest is 105.7 m^2 per hectare. *Acacia abyssinica* has the highest basal area followed by *Maesa lanceolata, Maytenus obscura* and *Acacia nilotica* which have the highest basal area when compared to the other woody plant species in the study forest, therefore these are the most important tree species in the forest.

From frequency analysis, *Pittosporum viridflorum* is the most frequent species followed by *Maesa lanceolata* and *Acacia nilotica.* On the other hand the least frequent species are *Maytenus arbutifolia, Vernonia amygdolina* and *Cupressus lustanica.* There is high percentage of number of species in lower frequency classes and low percentage of number of species in higher frequency class. This indicated that the presence of high degree of floristic heterogeneity in the study forest.

5.2 Recommendation

Forest provide many importance such as forest products, homes for plants and animal species, protects soil erosion, conserve water resources and control ecological climate. Cattle putt heavy pressure on the forest in the study area. Animal rearing is a very serious problem in Kurib forest followed by fuel wood collection and timber cutting. It needs serious attention for conservation and implements effective management for sustainable use and continues the forest for future generation. Therefore, the following recommendations are forwarded to meet the above objectives:

- It is important to create awareness for the local community about forest conservation and wise utilization by intensive education of the local community.
- Creating awareness for local community about the value of forest resources and ecological consequences of declining of forests by educating them.
- Encourage the community to plant trees to reduce pressure put on the forest
- Encourage local community to use alternative materials for fuel consumption by using cow dung and biogass.
- Reducing of grazing of animals on the forest which allows the small sized plants to grow
- Extension program and forest management should be practiced to create awareness for conservation and wise utilization of the forest resources.

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Appendices

Appendix 1: Density per hectare for woody plant species with DBH > 2 cm, >10 cm, and >20 cm individuals in Kurib Forest.

No	*Name of species*	>2	%	>10	%	> 20	%
1	*Acacia abyssinica Hochst.ex Benth.*	2.43	1.59	23.95	5.97	95.13	11.13
2.	*Acacia decurrens Willd.*	15.13	8.92	23.61	5.88	28.47	3.33
3.	*Acacia nilotica (L.) Willd. Ex Del.*			9.37	2.33	70.13	8.21
4.	*Albizia gummifera (J.F.Gmel.)C.A.Sm.*			3.47	0.86	6.94	0.81
5.	*Apodytes dimidiate E.Mey.ex Arn.*			5.55	1.38	8.33	0.97
6.	*Bersama abyssinica Fresen*	9.02	5.69	22.56	5.62	10.41	1.21

7.	*Buddleja polystachya Fresen.*			10.41	2.59	6.94	0.81
8.	*Cardia africana Lam.*			0.62	0.19	6.94	0.81
9.	*Carissa spinarumL.*	7.98	5.23	22.22	5.54	7.96	0.93
10.	*Clausena anisata (Willd.) Benth.*	17.01	11.16	24.65	6.14	13.88	1.62
11.	*Clematis simensis Fresen.*	13.54	8.88	21.87	5.45	16.66	1.95
12.	*Combretum molle (R. Br.ex Don.) Engl. And Diels.*	35.76	23.47	23.26	8.86	3.12	0.36
13	*Croton mocrostachyus P.Del.*			2.08	0.51	8.33	0.97
14.	*Cupressus lustanica Mill.*					1.73	0.20
15.	*Discopodium penninervum Hochst.*	0.34	0.22	4.86	1.21	1.73	0.20
16	*Dombeya torrid (J.F.Gmel.)P.Bam Ps.*			3.47	0.86	13.88	1.62
17.	*Ekebergia capensis Sparrm.*			1.38	0.34	3.81	0.44
18.	*Embelia schimperi Varke.*	3.81	2.50	5.20	1.29	1.38	0.16
19.	*Euphorbia abyssinica Gmel.*			14.23	3.54	20.48	2.39
20.	*Erica arborea L.*	2.43	1.59	4.86	1.21	3.12	0.36
21.	*Erythrina brucei Schweinf.*					17.36	2.03
22.	*Ficus sur Forssk*	8.68				5.20	0.60
23.	*Grandinium bullosa*	28.81	18.91	27.43	6.84	2.77	0.32
24.	*Hagenia abyssinica(Brace) J.F.Gmel*	12.84	8.42	27.08	6.75	22.56	2.64
25	*Hypericum revolutum Vahl.*					10.41	1.21
26	*Juniperus procera Hochest.ex Endel*	0.69	0.45	1.38	0.34	1.38	0.18
27	*Maesa lanceolata Forssk.*			0.34	0.08	6.59	0.77
28.	*Maytenus arbutifolia (A. Rich.) Wilczek.*			10.41	2.59	12847	15.04
29	*Maytenus obscura (A.Rich.)Cuf*					1.04	0.12
30	*Phytolacca dodecandra L. Herit*			3.81	0.95	123.26	14.43

31.	*Pittosporum viridiflorum Sims.*	4.16	2.73				
32	*Prunus africana (Hook.F.)Kalkm.*	1.04	0.68	24.30	6.06	130.90	15.32
33	*Rhus natalensis Krauss.*			2.77	0.69	11.11	1.30
34.	*Rubus steudneri Schweinf*			5.90	1.47	7.98	0.93
35.	*Rosa abyssinica Lindley.*	2.77	1.81	23.26	5.80	19.09	2.23
36.	*Schefflera abyssinica (Hochst.ex A. Rich.)Harms.*	3.12	2.04	35.06	8.74	24.30	2.84
37.	*Solanecio gigas (Vatke)C.Jeffrey*			2.08	0.51	8.33	0.97
38.	*Vernonia amygdalina Del.*	6.94	4.55	8.68	2.16	1.73	0.20
39.	*Vernonia urticifolia A. Rich.*			1.38	0.34	20.08	0.24
	Name of species	**152.35**		**400.88**		**853.95**	

Appendix 2: The frequency and percentage of woody plant species in Kurib forest.

No	***Name of species***	**No of plots the**	**Total number**	**% of**

		species found	of quadrates	frequency
1	*Acacia abyssinica Hochst.ex Benth.*	40	72	55.55
2.	*Acacia decurrens Willd.*	15	72	20.83
3.	*Acacia nilotica (L.) Willd. Ex Del.*	50	72	69.44
4.	*Albizia gummifera (J.F.Gmel.)C.A.Sm.*	15	72	20.83
5.	*Apodytes dimidiate E.Mey.ex Arn.*	6	72	8.33
6.	*Bersama abyssinica Fresen*	10	72	13.88
7.	*Buddleja polystachya Fresen.*	4	72	5.55
8.	*Cardia africana Lam.*	4	72	5.55
9.	*Carissa spinarumL.*	17	72	23.61
10.	*Clausena anisata (Willd.) Benth.*	10	72	13.88
11.	*Clematis simensis Fresen.*	30	72	41.66
12.	*Combretum molle (R. Br.ex Don.) Engl. And Diels.*	9	72	12.50
13	*Croton mocrostachyus P.Del.*	13	72	18.05
14.	*Cupressus lustanica Mill.*	2	72	2.77
15.	*Discopodium penninervum Hochst.*	4	72	5.55
16	*Dombeya torrid (J.F.Gmel.)P.Bam Ps.*	11	72	15.27
17.	*Ekebergia capensis Sparrm.*	5	72	6.94
18.	*Embelia schimperi Varke.*	30	72	41.66
19.	*Euphorbia abyssinica Gmel.*	8	72	11.11

20.	*Erica arborea L.*	5	72	6.94
21.	*Erythrina brucei Schweinf.*	12	72	16.66
22.	*Ficus sur Forssk*	4	72	5
23.	*Grandinium bullosa*	40	72	55.55
24	*Hagenia abyssinica(Brace) J.F.Gmel*	4	72	5.55
25	*Hypericum revolutum Vahl.*	4	72	5.55
26	*Juniperus procera Hochest.ex Endel*	5	72	6.94
27.	*Maesa lanceolata Forssk.*	60	72	83.33
28	*Maytenus arbutifolia (A. Rich.) Wilczek.*	2	72	2.77
29	*Maytenus obscura (A.Rich.)Cuf*	45	72	62.5
30.	*Phytolacca dodecandra L. Herit*	5	72	6.94
31	*Pittosporum viridiflorum Sims.*	70	72	97.22
32	*Prunus africana (Hook.F.)Kalkm.*	15	72	20.83
33.	*Rhus natalensis Krauss.*	10	72	13.88
34.	*Rubus steudneri Schweinf*	13	72	18.05
35.	*Rosa abyssinica Lindley.*	14	72	19.44
36.	*Schefflera abyssinica (Hochst.ex A. Rich.)Harms.*	16	72	22.22
37.	*Solanecio gigas (Vatke)C.Jeffrey*	4	72	5.55
38.	*Vernonia amygdalina Del.*	2	72	2.77
39.	*Vernonia urticifolia A. Rich.*	8	72	11.11
	Name of species			