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Full Length Research Paper

Floristic Composition and Structure of Mount Furi Forest, South West Oromia, Ethiopia

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Abstract

Ethiopia is a significant center for biological diversity due to its wide range of altitudes and topographic features though dearth of empirical evidences. Therefore, the main purpose of this study was to determine the floristic composition and vegetation structure of Mount Furi Forest. Floristic data were collected from a total of 50 sample plots of 20 m x 20 m. Frequency, Diameter at Breast Height, density, basal area, and Important Value Index were computed for the floristic composition. In addition, the Shannon Diversity index and Jaccard's similarity index were also computed. Data were analyzed by descriptive statistics using Microsoft excel (2010) and SPSS version 23. A total of 93 species were represented in 62 genera and 48 families were collected of which Asteraceae and Poaceae took the leading class having 7 species each. Lamiaceae and Rosaceae have 5 species each and other 13 have 2 each and 26 have got one species each. Out of the total species, 27 species were identified to be indigenous to Ethiopia of which 8 species are endemic. Plant specimens were collected and identified in the National Herbarium of Ethiopia. The research revealed that though the forest is in good reproduction but low regeneration due to commercial cutting, overgrazing, and land conversion. The forest has a normal invented J-shape indicates the vegetation has good reproduction but low recruitment due to selective cutting of large tree for commercial purposes. Thus, conservation strategies need to be developed to minimize the threats noticed before losing valuable plant species.

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1. Introduction

Ethiopia is among the world's most important biodiversity hotspot areas. Ethiopia encompasses an extraordinary number of the world's broad ecological zones including dramatic geological, history, and broad latitudinal and altitudinal ranges (EBI, 2014). This range of habitats also supports a rich variety of species which contributes to the overall biological diversity of the country. Many authors (Kelbessa et al., 1992; Woldu, 1999; Mengistu; 2003; Kuma and Shibru, 2015) described Ethiopia as an important regional center for biological diversity due to its wide range of altitudes. Its great geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys, and rolling plains helped the emergence of wide ranges of habitats that are suitable for the evolution and survival of various plant and animal species. In the country, there are nearly one thousand endemic plant species (EBI, 2014). Many of these plant species are in danger of extinction because of the rapid conversion of forest to agricultural land and overgrazing (Getahun, 2018). According to Senbeta and Teketay (2003), the loss of forest cover and biodiversity due to human-induced activities is a growing concern in many parts of the world including Ethiopia. Authors also indicates that historical documentation indicated that Ethiopia had experienced substantial deforestation, soil degradation, and an increase in the area of bare land over the years (Tolessa et al., 2017). A substantial proportion of the Ethiopian highlands were once believed to have been covered by forests having wide coverage than at present, but have gradually been cleared (Stevary et al., 2019). It was remarked that the occurrence of isolated mature trees in farmlands and the patches of forests that are seen around churchyards and religious burial grounds indicate the presence of a vast expanse of forests earlier (Bekele, 1994). The need for fuelwood, arable land, and grazing areas have been indicated as the main causes of forest degradation; frequently leading to loss of forest cover and biodiversity, erosion, desertification, and reduced water resources (Girma et al., 2018; Atomsa & Dibbisa, 2019).

Ecological degradation including deforestation and erosion, is widespread, particularly in the northern and central highlands of the country. The highlands of Ethiopia, in contrast to most mountain systems outside Africa, are very suitable for human inhabitation. This population pressure on the highland is accompanied by sedentary agriculture and extensive cattle herding activities that have resulted in heavy deforestation, forest fragmentation, loss of biodiversity, and impoverishment of ecosystems in general (Yirdaw, 2002). The status of species composition and structure of forests are important indicators for understanding the tendencies of threats to plant communities (Chiarucci et al., 2011; Longa et al., 2020). Plant species richness and abundance distribution vary along altitudinal gradients. Species richness decrease with increasing altitude which is connected to decreasing temperatures and precipitation, and also mountain slopes are assumed to correspond reduction in productivity (Didita et al., 2010; Dibaba et al., 2014; Berhanu et al., 2016; Girma et al., 2018). Yet, the highest community diversity and species richness per hectare were reported at relatively high altitudes 3000 meters above sea level and for tree species (Adugna, 2010). The floristic composition of Furi Mountain has not been reordered to date. So the purpose of this study was to assess the floristic composition and structure of plant species in the area.

2. Materials and Methods

The Study Area

The study was conducted at Mount Furi Forest which is situated in the latitude and longitude of 8°54′N, 38°41′E and 8°9’N, 38°68’E with an altitude range of 2839-2300 m a.s.l. It covers 180 hectares and located at 19 kilometer away from Addis Ababa, the capital city of Ethiopia, along with Addis to Butajira Road. The forest lies in five kebeles of the Sebeta Awas District. Namely: Furi-Garabulo, Gelanguda, Migira, Gedamba, and Daleti kebeles. The annual rainfall ranges from 866 mm to 1200 mm with the main rainy season ranging from June to September. The annual average temperature lies between 9 ^{0}C and 25 ^{0}C. Preliminary survey was undertaken to identify the sampling area and technique to be used including materials to be used. Systematic random sampling was used to lie the transect line from bottom to top of the mountain based on the altitudinal gradients and plots were laid at a 50 m drop in altitude.

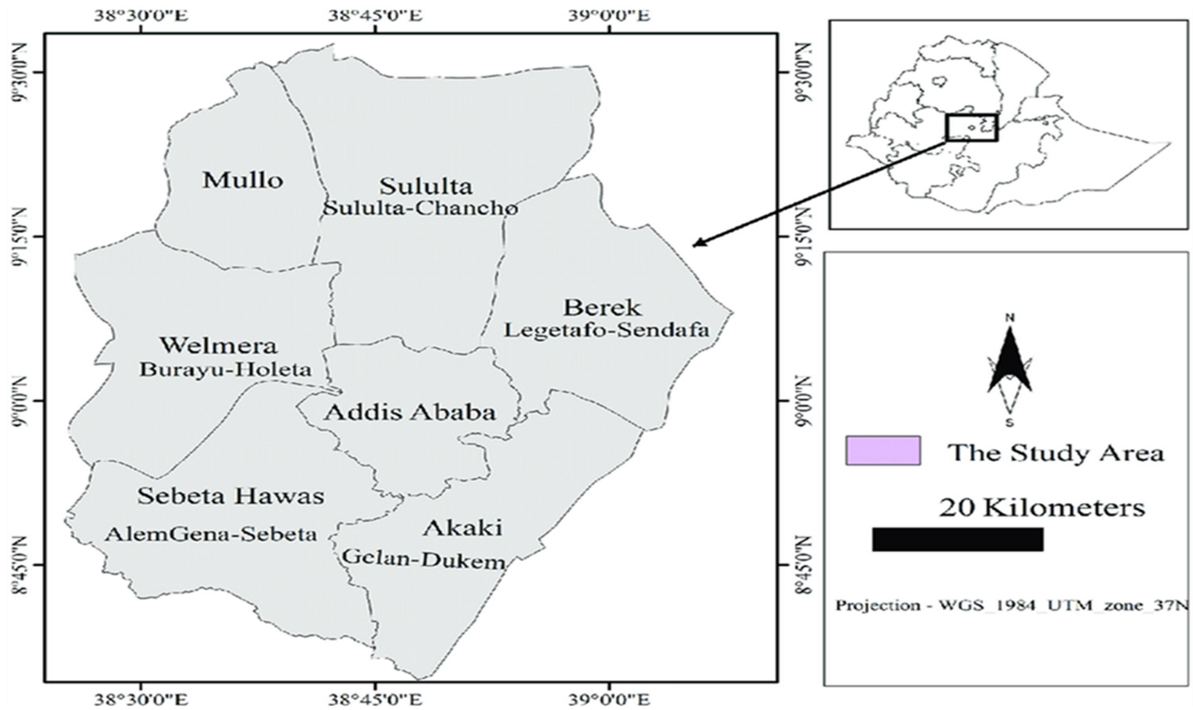

Figure 1:- Map of Oromiya Region Sebeta Awas Wereda showing locations of Furi Mountain Forest Area

Vegetation Data Collection

Data was collected from 50 sample plots of 20 m x20 m (400 m^2) for trees and shrubs, 5 m x 5 m for saplings, and 1 m x1 m for herbs in each sample plot. The five subplots of 5 m x 5 m were located at the four corners and one at the center of the main plot of 400 m^2 following the transect line. Furthermore, five subplots of 1 m x 1 m were used to sample herbaceous species as described in Mueller- Dombois and Ellenberg (1974). All trees and shrubs within the sample plots were recorded. The diameter at Breast Height (DBH) of all trees and shrubs was measured at 1.3 m above ground using diameter tape.

Vegetation Data Analysis

The structural data analysis was computed using the species density, DBH, Basal area, frequency, and Important Value Index (IVI). The percentage density and basal area for each species in addition to frequency and relative frequency were calculated on a hectare basis.

Frequency

According to Silvertown and Doust (1993) cited in Eshete et al. (2005), frequency measures reveal the uniformity of the distribution of the species in the study area, which again tells about the habitat preference of the species. It indicates the approximate homogeneity of the stand under consideration (Kent & Coker, 1992). The frequency value obtained reflects the patterns of distribution as well as the diversity of species.

$$frequency = \frac{Number\ of\ quadrants\ in\ which\ a\ species\ occur}{Total\ number\ of\ quadrants\ throughout\ the\ study\ area} \times 100 \ldots\ldots\ldots 1$$

Density

Based on Hutchings (1997), density is defined as the number of plants of a certain species per unit area. Population density refers to a count of the number of all individual plants per species within the quadrants, i.e., the total number of individuals in the species per unit area (Kent and Coker, 1992). In other words, it is the number of individuals of size class in the stand. It is important to characterize vegetation. Density is determined by counting the number of individuals of each size class of each sample plot. Tree density was computed by converting the count from the total quadrats on a hectare basis. It is calculated in 50 total plots of 20 m x 20 m which is 2 ha.

Basal area

Basal area provides a better measure of the relative importance of the species than a simple stem count (Bekele, 1994). Therefore, the species with the largest contribution in the basal area can be considered the most important woody species in the forest. Basal Area is the horizontal (cross-sectional) area occupied by the trunk of a species or size class. Basal area calculations were made based on the diameter measurements of woody species having DBH 2 cm and above. It is expressed in square meters/ hectare.

$$\mathbf{BA} = \pi \mathbf{d}^2/4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Importance Value Index

The importance value index (IVI) permits a comparison of species in a given forest type and depicts the sociological structure of a population in its totality in the community. It often reflects the extent of the dominance, occurrence, and abundance of a given species in relation to other associated species in an area (Kent and Coker, 1992; G/Hiwot, 2003; Shibru & Balcha, 2004). It is also important to compare the ecological significance of a given species. Therefore, IVI analysis is used for setting conservation priorities. Those species which receive lower IVI values need high conservation efforts while those with higher IVI values need monitoring management.

$$\mathbf{IVI = RF + RD} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{.3}$$

$$\mathbf{where\ RF = Relative\ Frequency, RD = Relative\ Density, and\ RBA = Relative\ Basal\ Area}$$

For all individuals of a tree having greater than or equal to 2 cm DBH, Relative Density, Relative

Frequency, Relative Basal Area, and Importance Value Index (IVI) was calculated using the following formula:

$$RD = \frac{Number\ of\ individuals\ of\ species\ A}{Total\ number\ of\ individuals\ of\ all\ species} \times 100 \ldots 4$$

$$RF = \frac{Frequency\ of\ species}{Sum\ frequency\ of\ all\ species} \times 100 \ldots 5$$

Frequency is the chance of finding a species in a particular area in a particular trial sample. The frequency value obtained reflects the pattern of distribution as well as diversity:

$$RBA = \frac{Total\ basal\ area\ of\ all\ individuals\ of\ a\ species}{Total\ basal\ area\ of\ all\ species} \times 100 \ldots 6$$

Basal area is the cross-sectional area of the tree at a point 1.3 meters above the ground. The data were computed using Microsoft Office Excel (2010) spreadsheet using the formula of Mueller-Dombois and Ellenberg, (1974) and Kent and Coker (1992) and SPSS version 23.0. Descriptive statistic was used to organize, summarize and describe the collected data.

3. Results

Species composition

As depicted in Table 1 below, from the study site, 93 species belonging to 49 families were encountered and specimens of these plants (tree, shrubs, climbers, and herbs) were collected and deposited in the National Herbarium, Department of Plant Biology and Biodiversity Management, Addis Ababa University and Herbarium of the Ethiopian Institute of Biodiversity. Out of the total species, 24.7% were trees, 20.4% were shrubs, 44.1% were herbs, and the remaining 10.8% were climbers.

Table 1. List of plant species and local names of the Furi Mountain Forest

Species name	Family	Local name	Habit
Acacia mellifera (Vahl) Benth	Fabaceae	Girar /Lafto	T
Acanthus eminens C.B Clarke	Acanthaceae	Keskeso	H
Alchemilla kiwuensis Engl.	Rosaceae	-	H
Aloe macrocarpa Tod.	Aloaceae	Ret	H
Anthospermum herbaceum Linn. f.	Rubiaceae	-	H
Artemisia abyssinica Sch., Bip. ex A.Rich.	Asteraceae	Chanchi	H
Asparagus africanus Lam.	Asparagaceae	Sariitii	Cl
Bersama abyssinica Fresen.	Melianthaceae	Lolchisa	T
*Caesalpinia decapetala (*Roth) Alston.	Fabaceae	-	T
Carissa spinarum L.	Apocynaceae	Agam / Agemsa	Sh
*Cassipourea malosana (*Baker) Alston.	Rhizophoraceae	Danshute	Sh
Casuarina cunninghamiana Miq.	Casuarinaceae	Shewshawe	T
Celtis africana Burm F.	Ulmaceae	Chari	H
Cenchrus pennisetiformis Steud.	Poaceae	Ketema	H
Cladostigma dioicium Radlk.	Convolvulaceae	Kemete	Cl
Clematis longicauda Steud.ex A.Rich.	Ranunculaceae	Eda fiti	Cl
Conyza aegyptiaca L. Dry and ex Ait.	Asteraceae	-	H
Crotalaria spinosa Hochst ex. Benth.	Fabaceae	Gufte	H
Croton macrostachyus Huchst.ex Del.	Euphorbiaceae	Bisana/ Bekenisa	T

Cucumis prophetarum L.	Cucurbitaceae	Yemder-inbuayi	H
Cupress lusitanica Mill.	Cupressaceae	Yefereng Tid	T
Cyperus fischerianus A.Rich.	Poaceae	Engicha/ Kuni	H
*Cyphostemme cyphopetalum (*Fresen.*)*	Vitaceae	-	H
Digitaria abyssinica (Hochst.ex A.Rich.)Stapf.	Poaceae	Senbelet/ Merga Gogori	H
Dodonaea angustifolia L.f.	Sapindaceae	Kitkita	T
Dovyalis abyssinica (A.Rich.) Warb.	Salicaceae	Koshim	Sh
Echinops kebercho Mesfin	Asteraceae	Sokoru/Kebercho	H
Ehretia cymosa Thonn.	Boragiaceae	Ulaga	T
Eragrostis pilosa (L.) P. Beauv.	Poaceae	Chefe	H
Erica arborea L.	Ericaceae	Asti/ Gedira	Sh
Eucalyptus camaldulensis Dehnh.	Myrtaceae	Bargamo-diima	T
Eucalyptus globulus Labill.	Myrtaceae	Bargamo-adi	T
Evolvulus fugacissimus A.Rich.	Canvovulaceae	Areertii	Cl
Ficus sur Forssk.	Moraceae	Harbu/ Shola	T
Geranium elamelatum Kokwaro.	Geraniaceae	-	H
Geranium ocellatum Cambess.	Geraniaceae	-	H
Gomphocarpus integer (N.E.Br.) Bullock.	Asclepiadaceae	Shishi	H
Gomphocarpus purpurascens A. Rich	Asclepiadaceae	Kinchib	Sh
Grevillea robusta R.Br.	Proteaceae	Grevillea	T
*Helichrysum horridum (*Sch. Bip.) A. Rich.	Asteraceae	-	T
Helichrysum schimperi (Sch.Bip.ex A.Rich.) Moeser	Asteraceae	-	H
Hyparrhenia multiplex (Hochst. ex A. Rich.) Andress. ex Stapf.	Poaceae	-	H
Hypericum revolutum Vahl	Hypericaceae	Ine/ Eddera	T
Jasminum abyssinicum Hochst. ex DC.	Oleaceae	Yedibir Hareg/Eda	Cl
Jasminum grandiflorum L.	Oleaceae	Bilu	H
Juniperus procera Hochst.ex Endle.	Cupressaceae	Yehabesha Tid	T
Justicia schimperiana (Hochst.ex Nees) T. Anders	Acanthaceae	Tumuga	Sh
Laggera tomentosa (Sch.Bip.ex A.Rich.)	Asteraceae	-	H
Lantana camara L.	Verbenaceae	Toma shimbiro	H
Leuras tomentosa Gurke.	Lamiaceae	-	H
Lippia adoensis L.	Verbenaceae	Suke	H
Lippia javanica Burm.f.	Verbenaceae	Kusaye	H
Maesa lanceolata Forssk.	Primulaceae	Abeyi	Sh
Maytenus addat Loes. Sebsebe.	Celastraceae	Zegnit	Sh
Monocymbium cerosiiforme (Nees) Stapf.	Poaceae	-	H
Myrsine africana L.	Primulaceae	Kechemo	Sh
Mystroxylon aethiopicum (Thunb.) Lods.	Celastraceae	Atat	Sh
Nuxia congesta R.Br. ex Fresen.	Loganiaceae	Kewisa	T

Ocium forsholei Benth.	Lamiaceae	Hulegeb	H
Ocium lamiifolium Hochst. ex Benth.	Lamiaceae	Darguu	H
*Olea europaea sub-sp.cuspidate (*Wall.ex G.Don) C.f.	Oleaceae	Ejersa	T
Osyris quadripartita Decn.	Santalaceae	Watto / Kero	T
Pavetta abyssinica Fresen.	Rubiaceae	-	H
Pennisetum thunbergii Kunth.	Poaceae	Kecha/Gicha	H
Pimpinella hirtella (Hochst.) A. Rich.	Apiaceae	-	H
Pittosporum abyssinicum Del.	Pittosporaceae	Shole	T
Plantago albicans L.	Plantaginaceae	Kulegeb	H
Podocarpus falcatus (Thunb.) R.B.ex Mirb.	Podocarpaceae	Birbirsa/ Zigba	T
Prunus africana (Hook.f.) Kalkm.	Rosaceae	Tikur Enchet	T
Pteris cretica L.	Pteridaceae	Anu jira Gubedhu	H
Pterocephalus frutescens Hochst.ex.A.Rich.	Dipsacaceae	-	H
Rhamnus prinordes L'Herit.	Rhamnaceae	Gesho	Sh
Rhamnus staddo A. Rich	Rhamnaceae	Kededa	H
Rhus natalensis Krauss.	Anacardiaceae	Debobesa	Sh
Rhus retinorrhea Oliv.	Anacardiaceae	Debelucha	Sh
Rhus vulgaris Meikle.	Anacardiaceae	Kemo	Sh
Ricinus communis L.	Euphorbiaceae	Kobo/Gulo	T
Rosa abyssinica Lindely	Rosaceae	Kega	Sh
Rubia cordifolia Gand.	Rubiaceae	Lalesa/ Enchibir	Cl
Rubus apetalus Poir.	Rosaceae	Arenkula	Cl
Rubus volkensii Engl.	Rosaceae	Arenkula	Cl
Rumex abyssinicus Jacq.	Polygonaceae	Mekmeko	H
Rumex nervousus Vahl.	Polygonaceae	Enbuacho	H
Salvia nilotica Jacq.	Lamiaceae	Shokoksa	Cl
Scolopia theifolia Gilg.	Salicaceae	-	Sh
Senecio ochrocarpus Oliv. and Hiern.	Asteraceae	-	Cl
Smilax asperi L.	Smilacaceae	Kebkebo	Sh
Solanum marginatum L.f.	Solanaceae	Inbuay/ Hidi	H
Thunbergia ruspolii Lindau.	Acanthaceae	-	Sh
Thynmus shimperi Ronniger.	Lamiaceae	Tosign	H
Verbascum sinaiticum Benth.	Scrophulariaceae	-	Sh
Verbena officinalis L.	Verbenaceae	Gura Hare	H
Vernonia congolensis De. Wild. and Muschl.	Asteraceae	-	T

NB: H= Herbs, G= Grasses, S= Shrubs, T/S= Trees or Shrubs, and T= Trees

Source: Identified using Flora of Ethiopia

The family Asteraceae and Poaceae were the most dominant families having 8 and 7 species, respectively and followed by Lamiaceae and Rosaceae comprised five species each. The family Verbenaceae and Rubiaceae comprised four species each while other families like Acanthaceae, Anacardiaceae, Fabaceae, Oleaceae, and Rubiaceae have three species. However, species such as Vitaceae, Ulmaceae, Polygonaceae, Euphorbiaceae, Salicaceae, Geraniaceae, and Myrsinaceae were found to be the least family species with only one or two species each. Mount Furi Forest contributes 19 species that are indigenous to Ethiopia and belongs to 22 families and 25 genera as shown in Table 2. Anacardiaceae family contributes 3 species belonging to 2 genera and two families, Rhamnaceae and Rosaceae have two species each.

Table 2:- List of indigenous plants of Mount Furi Forest

Local name	Species name	Family	Habit
Ret	*Aloe macrocarpa* Tod.	Aloaceae	H
Lolchisa	*Bersama abyssinica* Fresen.	Melianthaceae	T
Agam / Agemsa	*Carissa spinarum* L.	Apocynaceae	Sh
Chari	*Celtis africana*	Ulmaceae	H
Bisana/ Bekenisa	*Croton macrostachyus* Huchst.ex Del.	Euphorbiaceae	T
Kitkita	*Dodonaea angustifolia* L.f.	Sapindaceae	T
Koshim	*Dovyalis abyssinica* (A.Rich.) Warb.	Salicaceae	Sh
Sokoru/Kebercho	*Echinops kebericho* Mesfin	Asteraceae	H
Asti/ Gedira	*Erica arborea* L.	Ericaceae	Sh
Harbu/ Shola	*Ficus sur* Forssk.	Moraceae	T
Ine/ Eddera	*Hypericum revolutum* Vahl	Guttiferae	T
Yehabesha Tid	*Juniperus procera* Hochst.ex Endle.	Cupressaceae	T
Tumuga/ sensel	*Justicia schimperiana* (Hochst.ex Nees) T. Anders	Acanthaceae	Sh
Abeyi	*Maesa lanceolata* Forssk.	Myrsinaceae	Sh
Kewisa	*Nuxia congesta* R.Br. ex Fresen.	Loganiaceae	T
Ejersa / Weyra	*Olea europaea* L. subsp.cuspidata (Wall.ex G.Don) Ciferi.	Oleaceae	T
Birbirsa/ Zigba	*Podocarpus falcatus* (Thunb.) R.B.ex Mirb.	Podocarpaceae	T
Gesho	*Rhamnus prinoides* L'Herit.	Rhamnaceae	Sh
Kega	*Rosa abyssinica* Lindely	Rosaceae	Sh

Sh= Shrub, T= Tree, H= Herb

Vegetation structure

The structural data were computed using the species density, DBH, basal area, frequency, and IVI. The percentage density and basal area for each species in addition to frequency and relative frequency were calculated on a hectare basis. The data was computed using Microsoft Office Excel (2010) spreadsheet using the formula of Mueller-Dombois and Ellenberg (1974) and Kent and Coker (1992).

Frequency

Based on the frequency values, the plant species were classified into five frequency classes: A) 0-20, B) 20.1-40, C) 40.1-60, D) 60.1-80 E) 80.1-100 which is expressed in percentage. The frequency and percentage frequency values of each species were analyzed. The species that distributed in the fifth frequency class (Class E) were *Eu-*

calyptus globules, Celtis africana, Thymus schimperi, Carissa spinarum, Myrsine africana, Asparagus africanus, Crotalaria spinosa, Rhus retinorrhea, Rosa abyssinica, Pennisetum thumbergi, Osyris quadripartite and *Jasminum abyssinicum* having the highest frequency values in between 81% and 100% for each. Whereas the first frequency class (Class A) have got the highest species population with 52 species which is 56% of all. The remaining species were distributed in frequency classes B, C, and D consisting of 15% and 8% each as indicated in figure 2 below. From the figure and description, it can be concluded that there is high heterogeneity in the forest without undermining the good homogeneity due to the above thirteen species having nearly 100% frequency.

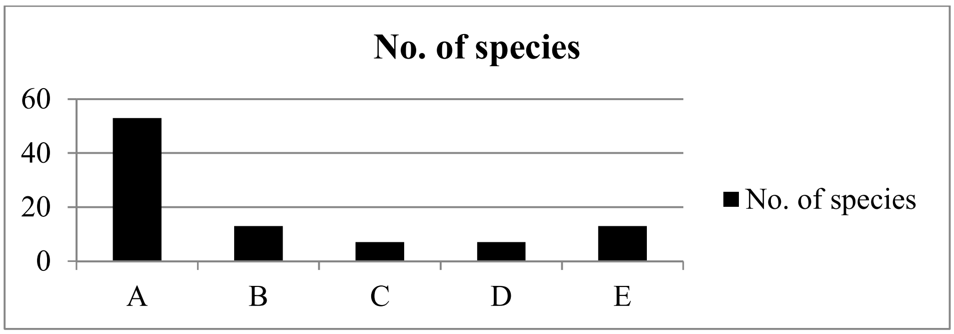

Figure 2:- Frequency classes with a number of species in Mount Furi forest (A: 0-20, B: 20.1-40, C: 40.1-60, D: 60.1-80 E: 80.1-100)

Density

Tree and shrub density expressed as the number of individuals with DBH between 2 cm and 5cm was 1853.5 individuals/ha and those individuals with DBH between 5 and 10 cm was 159 individuals per hectare and with DBH greater than 10 cm but less than 15 cm were 61 individuals per hectare. The last two classes were 90.5 individuals per hectare for the fourth class and 668.5 individuals/ha for the fifth class as indicated in the table below. The ratio described as a/b, is taken as the measure of size class distribution (Grubb *et al.,* 1963). Accordingly, the ratio of individuals with DBH between 2-5 cm (a) and DBH > 20 cm (b) was 2.77 for Furi Forest. This indicates that the proportion of small-sized individuals is larger than the large-sized individuals.

Basal Area

The basal area for each tree and shrub species of the area was measured in m^2. Since the basal area is calculated using the DBH/DSH measure, its correlation is given in Table 4.

Table 4:- DBH Vs Basal Area

DBH Class	Class	No of tree & shrub	DBH (%)	BA (m^2)	BA (%)	D/ha	a/b	% of Tree/Shrub individuals/ha
1	2-5	22	56.4	200.22	7.06	1873.5	2.8	66.0
2	5.1-10	5	12.8	240.38	8.48	154	0.2	5.4
3	10.1-15	7	17.9	801.79	28.28	54	0.1	1.9
4	15.1-20	4	10.3	948.55	33.46	90.5	0.1	3.2
5	>20	1	2.6	643.9	22.71	668.5	1.0	23.5

39	100	2834.84	100	2840.5	100

Accordingly, species with the largest contribution in basal area can be considered as the most important woody species in the forest. Therefore, from the relative basal area calculation, it is indicated that *E. globulus*, *E. camaldulensis*, *A. melanoxylon, C.cunninghamiana, F. sur,* and *C. lusitanica* were the most dominant and most important tree species having high density and area coverage in the forest (Table 5).

Table 5:- Most Dominant Plant Species of Mount Furi Plantation (RF: Relative frequency, RD: Relative Density, BA: Basal Area in m^2, IVI: Important Value Index)

Species name	Family	RF	RD	Mean BA	RDO	IVI
Eucalyptus globulus Labill.	Myrtaceae	3.36	11.9	643.9	22.71	38.03
Eucalyptus camaldulensis Dehnh.	Myrtaceae	1.14	0.42	282.16	9.95	11.52
Casuarina cunninghamiana Miq.	Casuarinaceae	0.54	0.08	255.40	9.01	9.63
Ficus sur Forssk.	Moraceae	0.34	0.07	214.75	7.58	7.98
Cupressus lusitanica Mill.	Cupressaceae	1.88	1.05	196.23	6.92	9.85
Acacia mellifera (Vahl) Benth	Faraceae	1.54	0.38	175.70	6.20	8.12
Salix subserrata Willd.	Salicaceae	0.20	0.04	120.70	4.26	4.50
Croton macrostachyus Huchst.ex Del.	Euphorbiaceae	0.54	0.07	120.22	4.24	4.85
Pittosporum abyssinicum Del.	Pittosporaceae	0.20	0.08	105.02	3.70	3.99
Dodonaea angustifolia L.f.	Sapindaceae	0.47	0.10	98.47	3.47	4.04

Importance Value Index

According to the collected data the most important and ecologically significant species of the area are *Eucalyptus globulus, E. camaldulensis, Carissa spinarum, Myrsine africana,* and *Rhus natalensis. Justicia schimperiana, Erica arborea, Clausena anisata, Maytenus addat,* and *Rhus retinorrhea* are found to be among species with high conservation needs. Based on their IVI value the tree species of the area are grouped into classes for the dominant plant species and species with high conservation priority needed as follows in Figures 4 and 5.

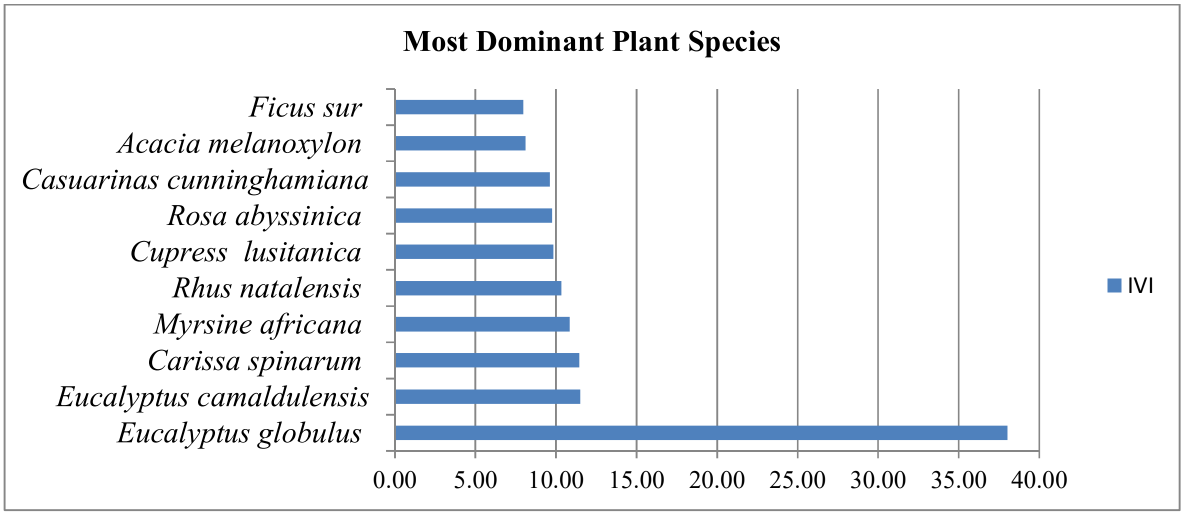

Figure 4:- IVI value of most dominant tree and shrub species

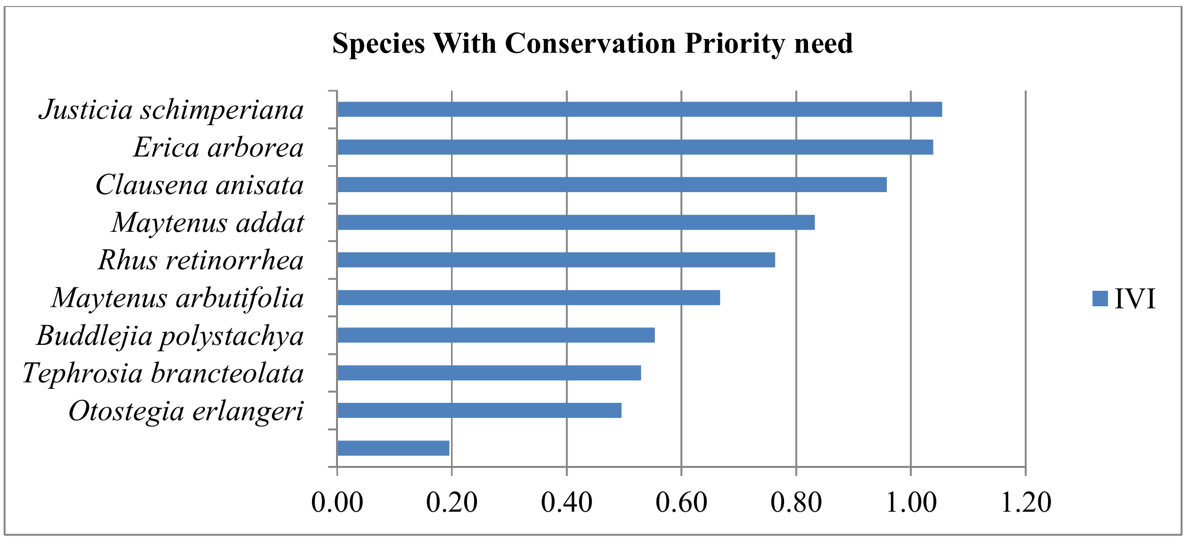

Figure 5:- IVI Value for species with conservation priority needs

4. Discussion

Study of population structure in tropical forests is ecologically significant and useful and functional in forest management practices (Bajpai et al., 2012; Shiferaw et al., 2018). The population structure of a given forest or individuals of species indicate the health of the forest. The population structure of plants is described either by age, size or by their life stage. The population structure of woody perennial species is often estimated by size class (Venter and Witkowski, 2010; Raj, 2018). Information about the population structure of a tree species indicates the history of disturbance of species in the past and its environment, which in turn can be used to assume the future trend of the population of particular species (Botelanyele et al., 2016; Iyagin and Adekunle, 2017). According to Lamprecht (1989), high value in higher frequency and low value in lower frequency classes reveal constant or similar composition, and conversely, a high percentage of the number of species in the lower frequency classes and low percentage of the number of species in the higher frequency classes points out a high degree of floristic heterogeneity (Shibru & Balcha, 2004).

The population structure and regeneration status of a forest are influenced by a collection of biotic and abiotic factors. Several types of disturbances like logging, landslides, gap formation, litterfall, herbivores, fire, grazing, light, canopy density, soil moisture, soil nutrients, and anthropogenic pressure can affect the potential regenerative status of species composing the forest stand spatially and temporally (Pokhriyal et al., 2010; Sharma et al., 2014; Bajpai et al., 2017). Environmental and anthropogenic factors affect the population structure and accordingly regeneration condition of a forest ecosystem. The population structure of a tree species and its natural regeneration pattern are related. The high-frequency value of a given plant species in the community indicates that it is widely distributed in the area under the study (Denu; 2007). The proportion of small-sized individuals was much larger (50%) although the above ratio is lower, indicating that Furi Forest is at stages of secondary regeneration may not be due to natural but anthropogenic factors of cutting of matured trees.

Anthropogenic factors were also stated as a major problem in different forest areas of the country (Shibru & Balcha; 2004; Kuma & Shibru, 2015). The forest has a normal invented J – shape which indicates the vegetation has good reproduction but low recruitment which is due to selective cutting of large tree individuals because the forest is used for commercial purposes. A similar pattern was observed in Dindin Forest (Shibru and Balcha, 2004), Menagesha Amba Mariam Forest (Tilahun, 2009), and Sheka Meda Forest (Bitwalu, 2010). Shannon diversity index revealed that the forest cover under Daleti Kebele has an even distribution of species which may be due to less human interference and high forest protection. While the forest cover under Migira kebele has less H' value and J value which is 0.91 for the Shannon diversity index and 0.21 for Evenness, respectively. This difference may be due to anthropogenic impacts like purposive removal of plant species for commercial purposes and overgrazing. Generally, the plant species in the forest are evenly distributed and diversified. Jaccard similarity index showed that the highest similarity coefficient was recorded between Daleti and Gedamba, that is, 89% of the species recorded are similar. Most of the areas are nearly similar because they possess greater than 70% similarity of Jaccard's similarity index. Whereas Furi Garabulo has less similarity with Gelan Guda and Migira which is only 66% and 64% of their species are similar, respectively.

5. Conclusion and Recommendation

This study revealed the floristic composition of Moutain Furi Forest. From the results, it is seen that the area is rich in plant biodiversity. Ninety-three plant species belonging to 62 genera and 49 families were collected. Among the 49 families, most of them belong to the family Asteraceae and Poaceae, Lamiaceae, and Solanaceae. The calculated frequency of the area indicated the heterogeneity of the forest even though there is less homogeneity. Considering the density, the forest has a normal inverted J-shape typically observed in natural forest vegetation which indicates the vegetation has good reproduction but low recruitment which is due to the selective cutting of large tree individuals because the forest is used for commercial purposes. Based on the Basal area distribution, it is noticed that *Eucalyptus globulus, Eucalyptus camaldulensis, Acacia melanoxylon, Casuarina cunninghamiana, Ficus sur,* and *Cupressus lusitanica* were the most dominant and most important tree species, having high density and area coverage in the forest. Depending on the IVI value, the most important and ecologically significant species of the area were *Eucalyptus globulus, Rosa abyssinica, Myrsine africana, Rhus natalensis* and *Carissa spinarum.*

Based on the results of this study and personal observations, some recommendations are proposed. Furi Mountain forest needs special attention to conservation due to its floristic composition in general and the in-situ existence of at least four endemic species in the forest. The commercial plantation and harvesting are affecting the area through road construction and the effect of *Eucalyptus* tree plantation. So that, to protect the area stakeholders, local community, and local government officials need to give attention to planting other indigenous trees which can help the forest and the underground water regenerate. Also to ensure continued ecosystem services including indigenous knowledge, endemic plant species, and ecotourism activities in-situ conservation of Furi Mountain is recommended. The forest area is near the capital city Addis Ababa so there is a need for carbon sequestration and green area which is out of any type of pollution. Mount Furi Forest has the ability to serve as a lung and recreational area for society. But it needs further attention and exploration of the forest's floral and faunal capacity. Also, awareness should be created for the local community and surrounding society on the protection and wise use of the forest and forest products.

Conflict of Interests

The authors declare that there's no conflict of interest concerning to the publication of this article.

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