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Floristic Composition and Vegetation Structure of Gemehat Remnant Forests, Habru Woreda, North Eastern, Ethiopia

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Abstract
The study was conducted on Gemeshat Forest in North Wollo,northeastern Ethiopia with the objectives of determining the floristic composition & vegetation structure. Stratified random samplings of 60 (20 m × 20 m) plots were sampled along line transects radiating from the peak of the Forest in north-south directions. In each main pots, five subplots (5 m x 5 m) and 2m×2m distributed one at each corner and one at the center were laid down to sample trees ,shrubs and seedling and sapling of tree and shrub species. All plots were laid at a distance of 100 m along the transect lines. In each main plot, data on floristic Composition, species diversity, height and Diameter at Breast Height (DBH) of woody plant species and altitude, slope and aspect were recorded. Community classification was performed using R-Free Statistical Software. Shannon-Wiener diversity index were used to compute species diversity between the plant communities. Structure of the forest was analyzed using DBH, basal area and IVI. Results showed that a total of 60 woody plant species representing 60 genera and 38 families were identified. The dominant families were Fabaceae and Oleaceae (4 species and genera each) respectively. The highest density (4938 stems ha^{-1}) and basal area (21.9 m^2 ha^{-1}) was recorded by chekaw forest followed by kelta forests with a density(3032 stems ha^{-1}) and a total basal area (9.66 m^2ha^{-1}). The forest is characterized by high density of trees in the lower class than in the higher.Based on the results of vegetation classification, kelta,chekaw and Gosh Wona forest possess three and four plant communities were identified and described respectively. Species richness, diversity and evenness varied among the plant communities. Results of structural analysis revealed that the forest was dominated by small sized trees & shrubs indicating that it is in the stage of secondary development and there are species that require urgent conservation measure. Based on the results of this study, regeneration status and medicinal values of the forest and appropriate conservation measures for sustainable use of the forest resources are suggested.
Keywords: Diversity, plant community, Gemeshat Forest, sustainable use of forest

1. Introduction

Ethiopia is one of the top 25 biodiversity-rich countries in the world as the major center of diversity and endemism for several plant species, due to its great geographical diversity, elevation, vegetation (Abiyou *et al.,* 2013). Biodiversity measurement typically focuses on the species level and species diversity is one of the most important indices for sustainable land use practice to reverse the decline of biodiversity by evaluating ecosystems at different scales (Shackelton, 2000, Ardakani, 2004).

According to MEFCC (2016), current Ethiopia's forest cover is 15.5 % which includes enormous areas of forest, dense wood lands, bamboo and plantation forests of the country.

The rate of deforestation and forest degradation activities have accelerated the loss of biological diversity (Sager and Singh,2006).The annual deforestation rate in Ethiopia ranges from 80,000 to 200,000 ha per year(Temesgen, 2015). According to the report of Desta, (2001), about 20,000 ha of forests are annually harvested in Amhara region for fuel, logging, and construction purposes. This has contributed to the current low forest area, i.e.; only 60,688 ha state natural forest and 2.4 million ha public forests, which are not properly demarcated and managed (DHV, 2001).

Remaining forests are only small remnant patches mostly confined to inaccessible areas (steeply and mountainous areas and sacred places (churches, monasteries and mosques) (Alemayehu *et al.,* 2005). With the prevailing alarming rate of deforestation, the remaining natural forests could disappear within a few decades, unless appropriate and immediate measures are taken. Remnant trees are spared from cutting when forests cleared for agricultural or grazing. They have a clear effect on the species diversity, composition, and ecology of the surrounding woody vegetation (Manette and Robin, 2014). Vegetation cover in the study area plays an important role in stabilization of the slopes by modifying the soil moisture, reducing erosion through plant root system (Jemal ,2011).

Most of the remaining natural forests in Ethiopia are found in the southern and southwestern parts of the country, and the forests have almost disappeared from the rest of the country except a few scattered and relatively small areas of forest cover that remained in the northern, central and eastern parts of the country (Getahun and Anteneh, 2015).

The flora of North wollo is the least known still now, mainly due to lack of access (Alerts *et al.*, 2006). Woody species diversity and structure in the study areas are vital to know past management and to set management intervention (Ermias *et al.,* 2011). Thus, assessment of floristic composition and vegetation

structure of remnant natural forests ensures the conservation and management of the remaining remnant forests of North Wollo.

The management and conservation of forests in all areas throughout the country has been becoming a big challenge. Since most of the activities did not involve the local community (Dessalegn, 2001).

Nowadays, even the remnant natural forests in these areas are continuously threatened by human activities.Gemeshat forest is also one of the remaining forests in northern Ethiopia. So far, no studies have been reported on the forest. Therefore, this study was undertaken to describe and provide valuable information on floristic composition and vegetation structure of woody species in the forest.This intern helps to undertake appropriate conservation and management measures.

2. Materials and methods

2.1. Description of the Study Area

The study area (Figure 1) is located in Habru District, North Wollo Zone,Amahra Region at the distance of 478 km far from Addis Ababa along Dessie to Woldiya road. It is found at 23 km from Habru district at Wurgessa town. The forest is located between UTM 56°40'00"-56°70'00"E longitude and latitude 37N 12°73'.50"to 12°78'.40"N latitude. Gemeshat forest is estimated to cover an area of 527 hectare; of these, 94 hectare accounts an area of kelta forest (2045-2300m a..l), 74 hectare for Gosh Wona forest (and 128 hectare belongs to Chekaw forest (1996-2433m a.s.l). The annual mean temperature of study area is 27˚c with mean annual rain of 923mm. The altitudinal ranges is from 1996 to 2433 meters above sea level (m.a.s.l.) and its rainfall distribution is bimodal with the main rainy season July to September and the small rainy season at end of February to end of April (Shimelse,2007).

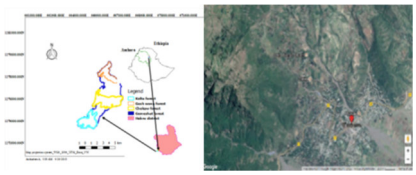

Figure 1.Map of the study area

2.2. Sampling design

A systematic stratified random sampling technique was used to collect vegetation data in the forest. Sample plot of 20 m× 20 m (400 m^2) was for trees of height >2m and DBH>10cm. Five sub plot of 5mx5m (25 m^2) were laid for shrubs with height greater than 0.5-5m.Five smaller plot of 2mx2m (4 m^2) also used for seedling <2m height and DBH<2.5cm and sapling >2m with DBH<10cm at the four corners and one at the center for tree regeneration study (Amare and Bhardwaj, 2016,Feyera,2006,FRA,2015). Sampling sites were arranged along transects which were laid at a distance of 100 m from each other. Along each transect, sample plots of 20 m x 20 m were taken at distance of 100 m from each other. A total of 60 quadrats were laid for vegetation data collection. Five 2 m x 2 m sub plots, one at each corner and one at the centre of the plot were laid to collect seedling ,2m height and DBH <2.5cm and sapling>2m height and DBH <10cm data. Sample plots along three line transect in church forest were laid systematically in a concentric way at every 50m along transect lines, which were 50m apart from each other. In each Gemeshat forest sites, the sample plots were established systematically along ten lines transects at every 100m interval between quadrats and transects. The distance between transects equally for each study sites by entering 20m from the edge of the forest. The sample plots taken for all forests were 9, 15, 19 and 26 for Church forest, Gosh Wona, Kelta and Chekaw forests respectively. The difference in the distance between transects line of the remnant forests were to capture the difference existed in forest area and altitudinal gradient and to increase precision of woody species diversity, structure, regeneration and soil characteristics. The study areas was classified in to three altitude classes: Lower altitude (1900-2100m a.s.l), middle altitude (2100-2300m a.s.l) and upper altitude class >2300m a.s.l.

2.3. Data Collection and identification

2.3.1. Floristic Data Collection

Every plant species encountered in each quadrate was recorded using local name (vernacular names). For those species difficult to identify and give scientific name in the field, plant specimen were collected, pressed and brought to the national herbarium of Ethiopian, Addis Ababa University for taxonomic identification using published volume of the flora of Ethiopia and Eritrea(Edwards S and Hedberg, 1989) and NDA (Natural Database for Africa) software. Moreover, for specimens being difficult to identify in the field, voucher samples were collected, pressed, and submitted for proper identification and botanical nomenclature at the National Herbarium, at Addis Ababa University. For basal area calculation, tree species with DBH >2 cm were selected for comparison of remnant forests.

2.3.2. Structural data collection

The tree density, diameter at breast height (DBH), frequency, basal area and IVI were measured,recorded and used for description of vegetative structure. For the purpose of the study "seedlings" ,"saplings" and "mature trees/shrubs" were defined as plants with heights less than 1 m, 1–2 m with DBH <10cm and greater than 2 m and DBH >10cm respectively. DBH measurement was taken at about 1.3m from the ground using measuring tape. Seedling and saplings of trees and shrubs were counted to estimate the regeneration status of the forest.

3. Data Analysis

3.1. Vegetation Classification

Cluster analysis was used for the purpose of vegetation classification into different community types using the statistical software R-package for windows version 2.15.0 (Venables and D. M, 2012). The Indicator Species Analysis was made to compare the species present in each community.

Hierarchical cluster analysis was conducted to identify vegetation samples that are similar in terms of their woody species composition. The cover abundance data of species were used for the analysis. The plant community types were named after two or three dominant species selected using the relative magnitude of their mean cover abundance values.

Of the total sixty six plant species recorded from the study area, hence, sixty six plant species were used for structural data analysis. The diameter at breast height (DBH), basal area, tree density, height, frequency and important value index were used for description of vegetation structure.

3.2. Diversity Index

Species diversity and evenness are often calculated using Shannon-Wiener diversity index (Kent and Coker, 1992). $H' = -\sum \frac{ni}{N} \times ln \frac{ni}{N} — (1)$

Where H' is Shannon diversity index, ni is the total number of individuals of species i and N is the total number of individuals of all species in that stand& Ln=natural logarithm. Possible values of the H′ range between 1.5and 3.5 and only rarely exceed 4.5, where high values indicate high diversity

Species evenness was calculated as the: $J = \frac{H'}{Hmax} = \frac{H'=-\sum \frac{ni}{N} \times ln \frac{ni}{N}}{\ln s} ------(2)$

Where J=species evenness H' = observed Shannon diversity index; S = the number of species. H max is the maximum level of diversity.

The Sorenson's coefficient of similarity (SC) was also computed as:

$$SC = \frac{2c}{a+b+2c} \times 100 ---------- (3)$$

Where C=Number of species common to both forest sites; a and b =the number of species at forest sites a and b

3.3. Vegetation Structure

To describe the vegetation structure of the forest, basal area, density, frequency, height, Diameter at Breast Height (DBH), **floristic Composition**, importance value index and basal area were calculated following.

Basal Area

It is the cross-sectional area of all of the stems in a stand at breast height (1.3 m above ground level). This basal area per unit area is used to explain the crowdedness of a stand of forests. It is expressed in square meter/hectare (Muller-Dombois and Ellenberg,1974).

The basal area was computed as: $BA = \sum \frac{3.14*DBH2}{4} ------- (4)$

Where, BA=basal area, DBH=average diameter at breast height.

Therefore, Relative basal area (RBA) was computed as

$$RBA = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100 ------(5)$$

Density is defined as the number of plants of a certain species per unit area.

$$Density = \frac{Total\ number\ of\ individual\ species}{n \times plot\ area} --------(6)$$

For density/ha calculation, the sum of individuals per species were calculated and analyzed following methods (Mueller Dombois & Ellenberge, 1974).

Relative density (RD) is the study of the numerical strength of a species in relation to the total number **of** individuals of all the species.

$$RD = \frac{Desnity\ of\ individual\ species}{Total\ density\ of\ all\ species} \times 100 -------(6)$$

Frequency is defined as the chance of finding a plant species in a given sample area or quadrat (Kent and Coker, 1992). It is calculated with the formula:

$$\text{Frquency} = \frac{\text{Total number of quadrats in which the species occur}}{\text{Total number of quadrats studied}} \times 100 - - - -(7)$$

Relative frequency (RF) is the degree of dispersion of individual species in relation to the number of all the species occurred. It was computed;

$$\text{RF} = \frac{\text{Frequency of individual species}}{\text{Sum of frequency of all species}} \times 100 - - - - - - - - - - -(8)$$

The basal area measures the cross-sectional area of the stem at 1.37m above the ground, a base for making important forest management decision like forest regeneration (Jim and Becky, 2012). The basal area was computed as:

$$BA = \frac{3.14 * DBH2}{4} - - - - - - - - - - (7)$$

Where, BA=basal area, DBH=average diameter at breast height.

Therefore, Relative basal area (RBA) was computed as

$$RBA = \frac{Total\ basal\ area\ of\ a\ species}{Total\ basal\ area\ of\ all\ species} \times 100 - - - - - -(9)$$

Importance value index (IVI) was was computed using (Krebs, 1989):

$$IVI = RD + RF + RBA - - - - - - - - -(10)$$

3.4. Species Population Structure

Woody species in the remnant forests with a diameter at breast height (DBH) greater than 2.5cm and height greater than 2 m were measured to analyze the DBH class distribution by classifying the DBH values in to nine class intervals(<2.5cm,2.5-5,5.1-10cm,10.1-15cm,15.1-20cm, 20.01-25 cm,25.01-30 cm, 30.1-35cm and >35cm.Similarly, their height was measured and categorized in to seven class intervals such as <2m,2-5m,5-10m,10-15m,15-20,20-25m and >25m.Individuals with DBH less than 2.5 cm and height less than 2m were counted.

4. Result and discussion

4.1. Floristic Composition

Sixty five species recorded in the quadrats from all Gemehsat forest sites represented 65 genera and 42 families. Totally 29, 38 and 26 families and, 36, 56 and 36 Genera and species were identified in Kelta,Chekaw and Gosh wona forests respectively. Among these 21 families, 25 genera and 25 species are common to Gemeshat forest sites.

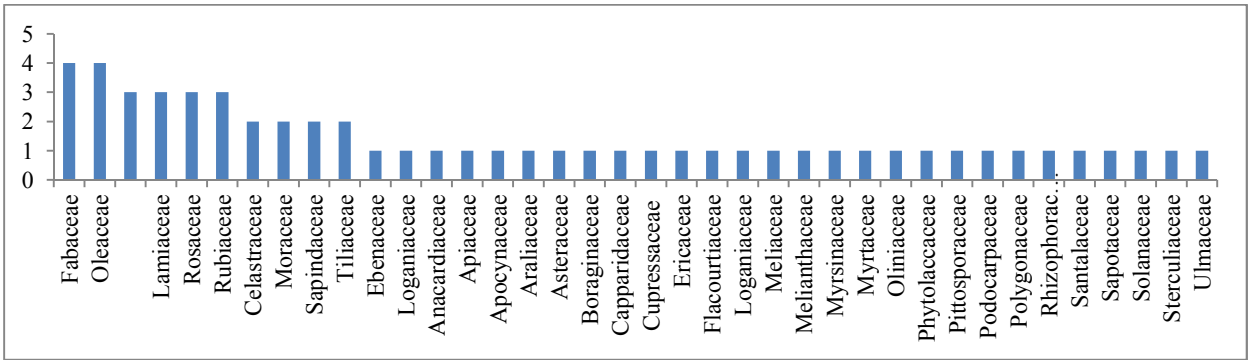

Figure 2.All woody species per families across Gemeshat forest sites

The most frequent families are Fabaceae and Oleaceae(4 species), and Euphorbiaceae, Lamiaceae, Rosaceae, and Rubiaceae (3 species each),Celastraceae,Moraceae, Sapindaceae, and Tiliaceae (2 species each) 28 families(represented by 1 species accounts 5.26%, 10.53%, and 10.53% share in the study areas respectively. Twenty eight families were represented by only one species (73.68%).

The number of families recorded is greater than the works of (Kitessa and Bishaw .2008).This might be due to the more percentage of trees than shrub species. Woody species belongs to shrub and trees account 48.3% and 51.7 % respectively. The total number of tree species recorded from the study area also comparable with Wof-Washa reported by (Gebremicael et *al*., 2013).

Table 1. Number of families, genera as and species encountered in the remnant forests

Taxa	Gosh wona forest	Chekaw forest	Kelta forest
No of genera	36	56	36
No of families	26	38	29
No of species	36	56	36

The highest number of families, genera species and genera/ family was recorded for Chekaw forest

followed by kelta, (Table 6). The total number of tree species recorded from remnant forest of north wollo also comparable with remnant forest of Wof-Washa and Zengena remnant Forests reported by (Gebremicael et *al*., 2013, Desalegn et al., 2014).

4.2. Vegetation classification

From cluster analysis of the forest, each community was named by the species having higher indicator value. Each community was named after two dominant species within the group (Whittaker, 1972). The dominant species were those with highest mean cover- abundance value for a given community (Table 2).Accordingly, Gemeshat forest three forest sites are identified communities as follows: Kelta forest three plant communities were identified as displayed in figure 2 described as *Euclea shmperi* (community type 1), *Erica aroborea* (community type 2) and *Juniperus procera* community type 3;Chekaw forest three plant communities were identified as shown in figure 3 described as *Dodonea angustifolia* - *Dombeya torrida* and *Grewia biocolr* (community type 1), *Podocarpus falcatus –Olea capensis*(community type 2) and *Erica arobore –Olea europea* (community type 3) and Gosh wona four plant communities known as shown in figure 4 portrayed as *Olea europea* (Community type 1),*Rhus natalenis* (community type 2),*Juniperus procera*(community type 3) and *Acacia abyssinica*(community type 4).

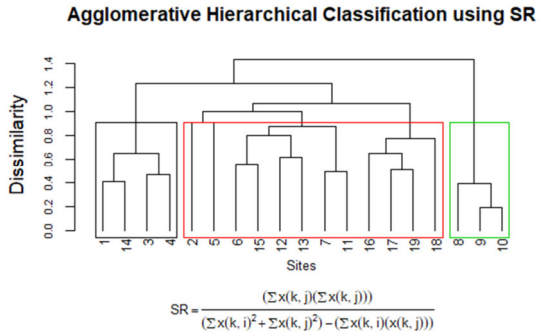

Figure. 2. Dendrogram showing the three community types obtained from cluster analysis of Kelta Forest

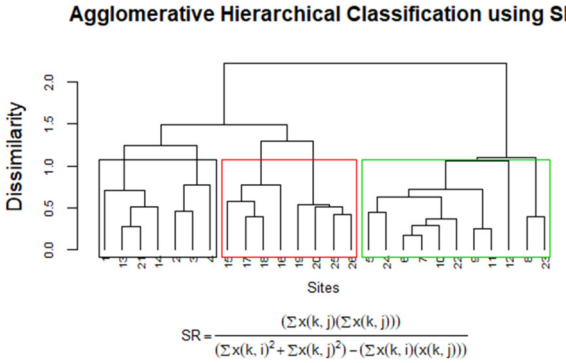

Figure. 3. Dendrogram showing the three community types obtained from cluster analysis of Chekaw Forest.

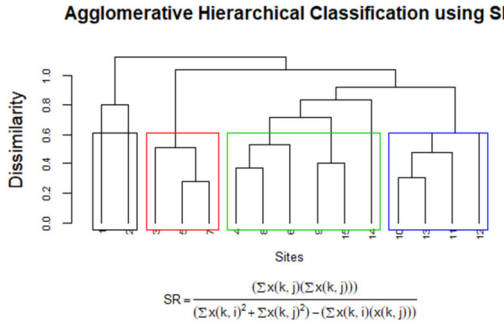

Figure. 4.Dendrogram showing the three community types obtained from cluster analysis of Gosh wona Forest

***Euclea shmperi* community type**

This community in Kelta forest is located between the altitudinal ranges of 2199m -2343m a.s.l. It was represented by 12 plots and 26 species. One species were found to be indicator species *Euclea shmperi*.Other associated tree species include *calipuria aurea, Rhus.natalensis, Acacia.abyssinica* and *Dodnea.angustiofolia*.

***Erica aroborea* community type**

This community in Kelta forest is located between the altitudinal ranges of 2260m -2345m a.s.l. It was represented by 2 plots and 35 species. One species were found to be indicator species *Erica aroborea*.Other associated tree species include *Junierus.procera*, Olinia rochetiania, Euclea.shmeperi ,*Maytenus arbitifolia*,*Carrisa spanarium*, and *Calipuria aurea*.

***Juniperus procera* community type**

This community in Kelta forest is located between the altitudinal ranges of 2260m -2345m a.s.l. It was represented by 2 plots and 35 species. One species were found to be indicator species *Erica aroborea*.Other associated tree species include Olinia.rochetiania, Olea.europea, psydrax.shemperi, Allophylus.abyssinicus, Acacia abyssinica and Olea capensis.

***Dodonea angustifolia - Dombeya torrida* and *Grewia biocolar* community type**

This plant community in Chekaw forest was found at altitudinal ranges of 1996 m - 2433m a.s.l. This community comprised of 12 quadrates and 34 species. Three species were found to be indicator species (*Dodonea angustifolia*, *Dombeya torrid* and *Grewia biocolr*) with significant indicator values in the community. Other associated tree species include *Euclea shmeperi*, *Calipuria aurea*, *Rhus.natalensis,* Olea.europea and *Dodnea.angustiofolia*.

***Olea capensis -Podocarpus falcatus* –community type**

This community in Chekaw forest is located between the altitudinal ranges of 2056m -2328m a.s.l. It was represented by 11 plots and 39 species. Two species were found to be indicator species (*Olea capensis* - *Podocarpus falcatus*).Other associated tree species include Dombeya.torrida, Grewia.bicolor, Dodonea.angustifolia and Calpuria.aurea.

***Erica arobore –Olea europea* community type**

This community type in Chekaw forest is represented by 13 quadrates and 32 species .Two species (*Erica arobore* and *Olea europea* were found to be indicator species of the community as they displayed the highest indicator values. This plant community was found at altitudinal gradient between 2056m -2408m. Other associated tree species include Olea capensis, podocarpus falcatus, Psdyrax shemperi, Mayetnus aribotifolia and Carrisa spanarium.

***Olea europea* Community type**

This community type in Gosh wona forest is represented by 15 quadrates and 10 species. *Olea europea* was found to be indicator species of the community as they displayed the highest indicator value. This plant community was found at altitudinal gradient between 2136m -2394m a.s.l. Other associated tree species include *Rhus natalenis, Eucea shemperi, Juniperus procera* and *Acacaia.abyssinica*.

***Rhus natalenis* community type**

This community type in Gosh wona forest is represented by 11 quadrates and 19 species *Rhus natalenis* was found to be indicator species of the community as they displayed the highest indicator value. This plant community was found at altitudinal gradient between 2136m -2390m a.s.l.Other associated tree species include *Eucea.shemperi,Juniperus.procera, Olea.europea, Acacaia.abyssinica, Dodnea.angustiofolia and Mayentus.aributifolia.*

***Juniperus procera* community type**

This community type in Gosh wona forest is represented by 14 quadrates and 27 species. *Juniperus procera* was found to be indicator species of the community as they displayed the highest indicator value. This plant community was found at altitudinal gradient between 2136m -2394m a.s.l.Other associated tree species include *Acacaia.abyssinica, Mayentus.aributifolia, Olea.europea and Carisa spanarium.*

***Acacia abyssinica* community type**

This community type in Gosh wona forest is represented by 13 quadrates and 26 species. *Acacia abyssinica* was found to be indicator species of the community as they displayed the highest indicator value. This plant community was found at altitudinal gradient between 2136m -2390m a.s.l. Other associated tree species include *Dodnea angustiofolia*, *Allophylus.abyssinics* and *Juniperus.procera*.

4.3. Species diversity and richness

The result of Shannon-wiener diversity index computed for the three different sites of study area is indicated that the Chekaw forest site displayed relatively the highest diversity 3.3 of trees and shrubs followed by Kelta forest 3.1 (Table 5). Gosh Wona forest was the least in species richness, diversity. This lower value of diversity index could be due to the dominance of only certain trees and shrubs species such as *Juniperus procera, Acacia abyssinica*, and *Maytenus arbitifolia.*

Shannon-Wiener diversity index, species richness and evenness of plant communities of trees and shrubs at Gemeshat forest sites.

Site of study	Species richness	Diversity index	Species evenness
Kelta forest	36	3.1	0.86
Chekaw forest	56	3.3	0.81
Gosh wona forest	36	2.78	0.8

A similar study by researchers Getinet *et al*., (2015) in Alemsaga Forest, Northwestern Ethiopia revealed similar result. In general, compared to most of the studies conducted in the country lower species richness and diversity index were recorded for Gemeshat forest. This could be associated to different anthropogenic activities such as selective cutting of economically important trees, Agricultural land expansion, grazing and browsing by livestock and other environmental factors. In our survey we were able to observe such activities (figure 5,6 and figure 7).




Fig 5. Agricultural land expansion Fig 6.Illegal cutting of trees for timber and firewood. Fig7. Grazing by livestock

4.4. Similarity among the plant community types

Woody species retained on Gemeshat forest are remnants of the natural vegetation found in the same agro ecology with slight altitudinal difference in north Wollo, Ethiopia. Hence, similarities in woody species composition are expected between the forests. Accordingly, 80 % of the species in the Kelta forest were also observed chekaw forests followed by 78.3% of species found in Kelta and Gosh wona (Table 2).This difference is due to nature of species, altitude and soil status of the forest. Table 2.Sorensen similarity coefficient in Gemeshat forests of North Wollo, Ethiopia.

Forest sites	Keleta forest	Chekaw forest	Gosh wona forest
	Similarity		
Keleta forest	1	80	78.3
Chekaw forest		1	66.7
Gosh wona forest			1

4.5. Vegetation structure

4.5.1. Density and diameter at breast height

Woody species with a diameter at breast height (DBH) greater than 2.5cm were measured to analyze the DBH and height class distribution in the forests. The DBH size classes were defined as to nine class intervals(<2.5 cm, 2.5-5 cm, 5.1-10 cm,10.1-15 cm,15.1-20 cm, 20.01-25 cm, 25.01-30 cm, 30.1-35cm and >35cm. Individuals with DBH less than 2.5 cm and height less than 2m were counted.

The number of tree species in DBH class less than 2.5cm.were represented by 1253 stems ha^{-1}(42.1%) ,1294 stem /ha(26.2%), and 681 stems/ha(26.2%) at Kelta forest, chekaw and Gosh wona forest. While, the DBH class >10cm were also highest in chekaw forest followed by Keleta and Gosh wona forests (Figure 3).

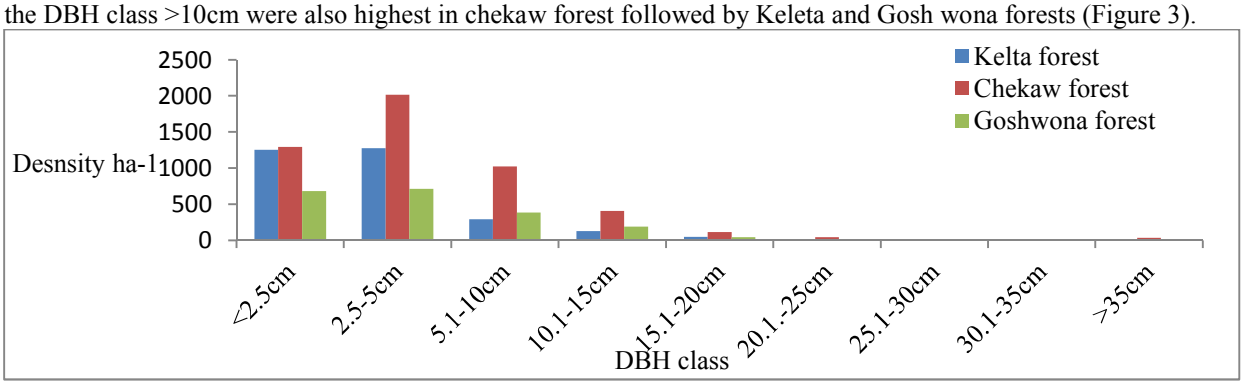

Figure 3.The DBH class of Gemeshat forest sites

The density of woody species also decrease as the DBH class increases, implies the number of individuals

ha-1 is highest in the lower DBH class. A similar result was reported by (John *et al.,* 2015, Ahmed et al., 2017,Tesfaye *et al.,* 2017,).The density of plant species with DBH class as their contribution of the numbers of species were given in (Table 3).The density of woody plant species increases with increasing number of species. So the general pattern of DBH class size distribution forms an irregular inverted J-shape (Figure 3) for the most selected dominant trees species. This might be associated with selective cutting of trees by people for construction and other house use.

Table 3.DBH class and the density of plant species in Kelta,chekaw and Gosh wona forest

DBH Class	No. Species			Density ha^{-1}			BA (m^2ha^{-1})		
	Kelta	Chekaw	Goshona	Kelta	Chekaw	Goshona	Kelta	Chekaw	Goshona
<2.5cm	15	26	14	1253	1294	681	0.19	0.17	0.11
2.5-5cm	10	25	11	1277	2015	710	0.58	0.83	0.37
5.1-10cm	12	13	7	291	1021	384	0.69	1.57	0.84
10.1-15cm	6	8	6	129	405	191	0.83	1.82	1.17
15.1-20cm	5,	7	3	48	113	42	0.63	0.92	0.45
20.1.-25cm	2	3	1	17	44	4	0.26	0.68	0.82
25.1-30cm	2	1	1	10	11	4	0.28	0.28	0.13
30.1-35cm	0	1	1	0	3	4	0	0.08	0.23
>35cm	1	5	1	10	33	4	0.63	2.05	0.29

The density of all woody species in Gemeshat forest sites based on DBH (Diameter at Breast Height) greater than 10 cm (a) was found to be 177,518 and 233 individuals per hectare in kelta, Chekaw and Gosh wona forest respectively. While it was 20, 37 and 91 individuals per hectare on DBH greater than 20 cm (b) in Kelta, Chekaw and Gosh Wona forest respectively. Similar result on Bale mountain national park also reported (Haile *et al.,* 2008).

The highest basal area is recorded in DBH class 10.1-15 cm and the highest basal area attained by chekaw forest followed by Gosh Wona forest.In Gemeshat forest sites, the number of individuals per hectare for both DBH classes (DBH>10 and DBH > 20) was also high. This indicates the forest is under serious degradation due to human activities such as illegal cutting of woody species; grazing and browsing of by livestock. The ratio of DBH greater than 10 cm (a) to DBH greater than 20 cm (b) for Kelta, Chekaw and Gosh wona forest was found to be 3.59,5.69 and 11.65 respectively,. So, this ratio is used as a good indicator as to the status of a particular forest. In this regard, compared many forests, the Gemeshat forest sites showed a higher ratio implies the predominance of small size trees and shrubs. Hence, it could be considered as a regenerating forest.

The total number of species found in the lower DBH class is highest in Chekaw forest followed by Keleta and Gosh wona forest. This trend also decrease as the DBH class increases in all Gemeshat forest sites. The result is higher than Wotagisho forest south west Ethiopia reported by (Dikaso and Tesema, 2016).

4.5.2. Importance value index (IVI)

The highest IVI value was contributed by *Juniperus procera in Gosh wona forest* and the lowest IVI value by *Maytenus gracilipes* (Table 6). As indicated in IUFRO classification scheme (Lamprecht, 1989), IVI value is used for comparison of ecological significant of species in which high IVI values indicate that the species structure in the community is high. According to (Abiyou *et al.,*2015), IVI is a good measure for summarizing vegetation characteristics of a given habitat and also useful to compare the ecological significance of species and for conservation practices.

The three importance species with their IVI values were *Juniperus procera*(35.6%),*Olea europaea*(26.6%) and *Olinia rochetiana*(25.1%) in Kelta forest, *Podocarpus falcatus*(19.2%),*Erica arborea*(13.3%) and both *Olea europaea* and *Olinia rochetiana* each(12.6%) in chekaw forest.While, *Euphorbia abyssinica(30.8%),Myrica salicifolia(29.1% and Juniperus procera(25%)* were also the three important species in Gosh Wona forest.In the present study, IVI of species varied from 0.5 to 36.5 % in Kelta forest followed by Gosh wona forest (0.9-30.8 %) and the three IVI values contributed in Keleta, chekaw and Gosh wona forests over 29.1%,19.23% and 28.3% respectively.

Table 4. Frequency, relative frequency, density, relative density, basal area, relative basal area and IVI of woody species (dbh > 2 cm) in Gemeshat forest sites

Gemeshat forest sites	Keleta forest							Chekaw forest							Gosh Wona forest						
Species	D ha-1	RD (%)	BA (m2 ha-1)	RBA (%)	F	RF (%)	IVI (%)	D ha-1	RD (%)	BA (m^2 ha^{-1}	RBA (%)	F	RF (%)	IVI (%)	D ha-1	RD(%)	BA ha-1	RBA%	F	RF %	IVI%
Acacia abyssinica	100	3.3	1.4	14.	42.1	3.1	20.4	88	1.8	0.37	1.7	38.5	2.6	6.1	127	6.27	0.88	8.91	86.7	7.1	22.3
Allophylus abyssinicus	100	3.3	0.2	2.5	57.9	4.2	10.0	78	1.6	0.17	0.8	38.5	2.6	5.0	87	4.27	0.03	0.50	86.7	7.1	11.9
Bersama abyssinica	66	2.2	0.1	1.2	31.6	2.3	5.6	58	1.2	0.44	2.0	34.6	2.4	5.6	33	1.65	0.02	0.63	20.0	1.6	3.9
Bridelia micrantha	-	-	-	-	-	-	-	38	0.8	0.05	0.2	7.7	0.5	1.5	-	-	-	-	-	-	-
Calpurnia aurea	166	5.5	0.1	0.8	52.6	3.8	10.1	88	1.8	0.09	0.4	30.8	2.1	4.3	29	1.44	0.01	0.23	40.0	3.3	4.9
Canthium oligocarpum	34.0	1.1	0.0	0.1	47.4	3.5	4.7	73	1.5	0.06	0.3	57.7	3.9	5.7	25	1.23	0.01	0.40	13.3	1.1	2.7
Capparis tomentosa	-	-	-	-	-	-	-	25	0.5	0.05	0.2	3.8	0.3	1.0	-	-	-	-	-	-	-
Carissa spinarum	159	5.3	0.1	1.1	78.9	5.8	12.1	83	1.7	0.09	0.4	73.1	5.0	7.1	63	3.13	0.02	0.40	86.7	7.1	10.6
Cassipourea malosana	-	-	-	-	-	-	-	25	0.5	0.08	0.4	7.7	0.5	1.4	-	-	-	-	-	-	-
Celtis africana Burm.	-	-	-	-	-	-	-	68	1.4	0.38	1.7	26.9	1.8	4.9	-	-	-	-	-	-	-
Chionanthus mildbraedii	-	-	-	-	-	-	-	63	1.3	0.38	1.7	15.4	1.0	4.0	-	-	-	-	-	-	-
Clerodendrum myricoides	-	-	-	-	-	-	-	42	0.8	0.02	0.1	11.5	0.8	1.7	-	-	-	-	-	-	-
Clutia abyssinica	-	-	-	-	-	-	-	25	0.5	0.00	0.0	3.8	0.3	0.8	-	-	-	-	-	-	-
Clutia lanceolata	-	-	-	-	-	-	-	75	1.5	0.01	0.0	3.8	0.3	1.8	-	-	-	-	-	-	-
Croton macrostachyus	6	0.2	0.0	0.2	10.5	0.8	1.1	33	0.7	1.96	9.0	11.5	0.8	10.4	25	1.23	0.01	0.60	20.0	1.6	3.5
Dodonea angustifolia	172	5.7	0.1	1.1	78.9	5.8	12.5	309	6.3	0.21	0.9	53.8	3.7	10.9	113	5.56	0.03	0.36	80.0	6.6	12.5
Dombeya torrida	9	0.3	0.0	0.2	15.8	1.2	1.6	193	3.9	0.10	0.5	38.5	2.6	7.0	63	3.09	0.04	0.80	26.7	2.2	6.1
Dovyalis abyssinica	9	0.3	0.0	0.0	10.5	0.8	1.1	25	0.5	0.04	0.2	7.7	0.5	1.2	25	1.23	0.01	0.40	6.7	0.5	2.2
Ehretia cymosa	-	-	-	-	-	-	-	83	1.7	0.41	1.9	23.1	1.6	5.1	0	-	-	-	-	-	-
Ekebergia capensis	16	0.5	0.5	4.7	15.8	1.2	6.3	50	1.0	1.61	7.3	3.8	0.3	8.6	0	-	-	-	-	-	-
Erica arborea	63	2.1	0.1	1.3	10.5	0.8	4.1	360	7.3	1.03	4.7	19.2	1.3	13.3	0	-	-	-	-	-	-
Euclea schimperi	269	8.9	0.2	1.7	78.9	5.8	16.4	122	2.5	0.10	0.4	30.8	2.1	5.0	79	3.91	0.02	0.30	80.0	6.6	10.8
Euphorbia abyssinica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	3.70	1.56	26.6	6.7	0.5	30.8
Euphorbia candelabrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	2.47	0.17	4.45	6.7	0.5	7.5
Ficus ovate	-	-	-	-	-	-	-	75	1.5	0.45	2.1	7.7	0.5	4.1	25	1.23	0.01	0.33	6.7	0.5	2.1
Ficus sur	-	-	-	-	-	-	-	25	0.5	2.46	11.2	7.7	0.5	12.3	-	-	-	-	-	-	-
Grewia bicolor	-	-	-	-	-	-	-	246	5.0	0.83	3.8	23.1	1.6	10.3	-	-	-	-	-	-	-
Grewia ferruginea	13	0.4	0.0	0.0	15.8	1.2	1.6	63	1.3	0.21	1.0	15.4	1.0	3.3	50	2.47	0.02	0.41	40.0	3.3	6.2
Heteromorpha arborescens	-	-	-	-	-	-	-	50	1.0	0.01	0.0	3.8	0.3	1.3	-	-	-	-	-	-	-
Jasminum grandiflorum	-	-	-	-	-	-	-	50	1.0	0.01	0.0	3.8	0.3	1.3	-	-	-	-	-	-	-
Juniperus procera	238	7.8	2.1	22.0	78.9	5.8	35.6	95	1.9	0.50	2.3	42.3	2.9	7.1	127	6.28	1.21	12.2	80.0	6.6	25.0
Maytenus arbutifolia	219	7.2	0.3	2.9	68.4	5.0	15.1	145	2.9	0.24	1.1	92.3	6.3	10.3	157	7.74	0.09	0.71	73.3	6.0	14.5
Maytenus procumbens	-	-	-	-	-	-	-	63	1.3	0.22	1.0	15.4	1.0	3.3	-	-	-	-	-	-	-
Myrica salicifolia	-	-	-	-	-	-	-	75	1.5	0.07	0.3	3.8	0.3	2.1	50	2.47	1.02	26.1	6.7	0.5	29.1
Myrsine Africana	38	1.2	0.0	0.1	52.6	3.8	5.2	104	2.1	0.06	0.3	50.0	3.4	5.8	35	1.73	0.01	0.32	33.3	2.7	4.8
Nuxia congeta	22	0.7	0.2	1.6	26.3	1.9	4.3	31	0.6	0.13	0.6	34.6	2.4	3.6	-	-	-	-	-	-	-
Olea capensis	100	3.3	0.2	1.7	31.6	2.3	7.3	213	4.3	0.59	2.7	61.5	4.2	11.2	-	-	-	-	-	-	-
Olea europaea	222	7.3	1.4	14.3	68.4	5.0	26.6	216	4.4	0.81	3.7	61.5	4.2	12.3	113	5.60	0.15	1.68	100	8.2	15.5
Olinia rochetiana	309	10.2	0.8	8.7	84.2	6.2	25.1	142	2.9	1.10	5.0	69.2	4.7	12.6	44	2.16	0.05	1.33	26.7	2.2	5.7
Osyris quadripartite	78	2.6	0.0	0.4	52.6	3.8	6.9	86	1.7	0.05	0.2	34.6	2.4	4.3	43	2.12	0.01	0.40	46.7	3.8	6.3
Otostegia fruticosa	-	-	-	-	-	-	-	33	0.7	0.01	0.0	11.5	0.8	1.5	-	-	-	-	-	-	-
Pavetta oliveriana	13	0.4	0.0	0.3	15.8	1.2	1.8	65	1.3	0.04	0.2	19.2	1.3	2.8	35	1.73	0.03	0.98	33.3	2.7	5.4
Phytolacca dodecandra	6	0.2	0.0	0.0	5.3	0.4	0.6	75	1.5	0.07	0.3	7.7	0.5	2.4	0	0.00	0.00	0.00	0.0	0.0	0.0
Pittosporum viridiflorum	66	2.2	0.2	1.6	47.4	3.5	7.3	97	2.0	0.22	1.0	73.1	5.0	7.9	25	1.23	0.01	0.53	6.7	0.5	2.3
Podocarpus falcatus	97	3.2	1.1	10.9	36.8	2.7	16.8	330	6.7	2.11	9.6	42.3	2.9	19.2	-	-	-	-	-	-	-
Polyscias fulva	-	-	-	-	-	-	-	38	0.8	0.41	1.9	15.4	1.0	3.7	50	2.47	0.04	0.97	6.7	0.5	4.0
Pouteria altissima	16	0.5	0.0	0.3	21.1	1.5	2.3	25	0.5	0.05	0.2	3.8	0.3	1.0	50	2.47	0.02	0.46	6.7	0.5	3.5
Premna schimperi	72	2.4	0.0	0.3	42.1	3.1	5.7	25	0.5	0.02	0.1	11.5	0.8	1.4	46	2.26	0.00	0.13	40.0	3.3	5.7
Prunus africana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	1.23	0.14	6.92	6.7	0.5	8.7
Psydrax schimperiana	116	3.8	0.3	3.2	52.6	3.8	10.9	197	4.0	0.53	2.4	61.5	4.2	10.6	-	-	-	-	-	-	-
Pterolobium stellatum	19	0.6	0.0	0.0	26.3	1.9	2.6	46	0.9	0.02	0.1	26.9	1.8	2.8	75	3.70	0.01	0.16	6.7	0.5	4.4
Rhamnus prinoides	3	0.1	0.0	0.0	5.3	0.4	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhus natalensis	181	6.0	0.2	1.9	68.4	5.0	12.9	86	1.7	0.15	0.7	53.8	3.7	6.1	142	7.00	0.06	0.55	80.0	6.6	14.1
Rhus retinorrhoea	-	-	-	-	-	-	-	25	0.5	2.86	13.1	3.8	0.3	13.8	25	1.23	0.01	0.58	6.7	0.5	2.4
Rosa abyssinica	16	0.5	0.0	0.2	15.8	1.2	1.8	25	0.5	0.03	0.1	15.4	1.0	1.7	40	1.98	0.02	0.63	33.3	2.7	5.3
Rubus apetalus	3	0.1	0.0	0.0	5.3	0.4	0.5	31	0.6	0.00	0.0	15.4	1.0	1.7	50	2.47	0.00	0.05	13.3	1.1	3.6
Rumex nervosus	13	0.4	0.0	0.0	10.5	0.8	1.2	63	1.3	0.01	0.0	7.7	0.5	1.8	-	-	-	-	-	-	-
Sesbania sesban	-	-	-	-	-	-	-	25	0.5	0.00	0.0	3.8	0.3	0.8	-	-	-	-	-	-	-
Solanum incanum	-	-	-	-	-	-	-	50	1.0	0.01	0.0	19.2	1.3	2.3	25	1.23	0.00	0.04	6.7	0.5	1.8
Vernonia amygdalina	3	0.1	0.0	0.4	5.3	0.4	0.9	25	0.5	0.02	0.1	3.8	0.3	0.8	-	-	-	-	-	-	-
Total	3032	100	9.66	100	1368	100	300	4938	100	21.9	100	1465	100	300	2025	100	5.69	100	1220	100	300

Juniperus procera , *Podocarpus falcatus* and *Euphorbia abyssinica* are the most important species in Keleta,Chekaw and Gosh wona forests respectively. According to Simon and Girma, (2004), Species with less than 10 ranks in the IVI values deserve appropriate conservation measures.

4.5.3. Basal area

The normal value of basal area in Africa is expected to be between 23-37m^2/ha reported by (lamperchet, 1989).In this regards, the total basal area of Gemeshat forest sites was recorded in the order of Chekaw forest (21.9 m^2ha^{-1}) followed by kelta forest (9.66m^2ha^{-1}), and Gosh wona forests (5.69 m^2 ha^{-1}) (Table 5).However, the total basal area recorded in the study areas are less than Gurra Farda Forest(90.6 m^2 ha^{-1})(Kitessa and Bishaw,2008),Wof-Washa (46.32m^2ha^{-1}) (Gebermicael et al.2013),and Denkoro forest(45 m^2 ha^{-1}) (Ayalew et al.,2006) of Ethiopia. While, the total basal area of Chekaw forest site of Gemeshat forest are greater than Yilat(1 m^2 ha^{-1}) (Sissay,2016),and lammo natural forest(13.35 m^2 ha^{-1})(Melese and Wendawek,2016).

Table 5.Basal area distribution across Gemeshat forests of North Wollo, Ethiopia

Forest sites	Gosh wona forest	Kelta forest	Cheakw forest
Basal area(m^2/ha)	5.69	9.66	21.9

5. Conclusion and recommendation

The major families identified in Gemehsat forest include Fabaceae and Oleaceae (four species each).The highest genera and families are found in Chekaw forest followed by Kelta forest.

The result of hierarchical cluster analysis of the forest revealed three communities identified in both forest sites (kelta forest ;namely *Euclea shmperi* (community type 1), *Erica aroborea* (community type 2) and *Juniperus procera*(community type 3),and in Chekaw forest ;such as *Dodonea angustifolia - Dombeya torrida* and *Grewia biocolr* (community type 1), *Podocarpus falcatus –Olea capensis*(community type 2) and *Erica arobore –Olea europea* (community type 3).While, four plant communities indentified in Gosh wona forest *Olea europea* (Community type 1),*Rhus natalenis* (community type 2),*Juniperus procera*(community type 3) and *Acacia abyssinica*(community type 4).

The highest species diversity is attained in Chekaw forest and the lowest species diversity is recoded in Gosh Wona forest. High species richness and diversity in the forest implies a good source of forest products and needs conservation priority. The less diverse of Gosh wona forest site implies degraded forest than the two forest sites.

The highest basal area is recorded by Chekaw forest (21.9 $m^2 ha^{-1}$) followed by kelta forest (9.66 $m^2 ha^{-1}$).

IVI analysis showed that considerable proportions of species are not well represented in the forest and are rare. The highest IVI value was contributed by *Juniperus procera* and *Euphorbia abyssinica* in Kelta forest and Gosh wona forests respectively.

The density of woody species decreases with increasing DBH and it was highest in chekaw forest followed by Keleta forest.

Analysis of structural status of the forest indicated that several species have abnormal population structure and predominance of small sized individuals in the lower diameter classes imply good reproduction potential and rare occurrence of large individuals. Moreover, the analysis of population structure in the forest implies that some tree species have no or few individuals at a lower size classes. These species need urgent conservation measures that would bring healthy regeneration.

It can be concluded that Chekaw forest was the leading in species diversity, diverse floristic composition, & healthy structural population followed by Keleta forest.

However, the major natural & anthropogenic activates observed include landslide, erosion, overgrazing, inappropriate land use, illegal cutting of tree for timber and fuel wood collection.

Therefore, it needs effective management intervention to sustain goods &services from forests.

Based on the findings the following recommendation was forwarded:

Raising awareness on the values of the forest and its ecological consequences of deforestation..

Species with low IVI needs to be prioritized for conservation.

To prevent local extinction of rare species, effort of nursery establishment and plantation of indigenous species should be practiced.

Detailed ethno botanical studies are required to explore the wealth of indigenous knowledge on the diverse use of plants and their implication to conservation.

Sustainable protection and management of the forests needed through the collaborative effort of the government, NGO and the local community for reduction of woody species cutting.

Regeneration and soil status of the forest should be further investigated from remnant forest on suitable basis.

Study on the carbon sequestrations potential of the Gemeshat forest sites.

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Appendix

List of woody species encountered in Gemeshat forest sites with corresponding family and local names, life forms and spatial distribution at Habru District, North Wollo, Ethiopia.

Species	Family	Local name	Life forms	Gemeshat forest sites		
				Kelta	Chekaw	Gosh Wona
Acacia abyssinica Hochst.	Fabaceae	Yehabesha Girar	T	+	+	+
Allophylusabyssinicus Hochst.	Sapindaceae	Embus	T	+	+	+
Bersama abyssinica Fresen.	Melianthaceae	Azamir	T	+	+	+
Buddleja polystachya Fresen.	Loganiaceae	Nechelo/Amfar	S	-	+	+
Bridelia micrantha(Hochst). Baill.	Euphorbiaceae	Yenebir Tifir	S	-	-	(*)
Calpurnia aurea (Ait.) Benth.	Fabaceae	Digita	S	_	+	+
Canthium oligocarpum Hiern	Rubiaceae	Dengay seber	S	+	+	+
Capparis tomentosa Lam.	Capparidaceae	Gumero	S	+	+	-
Carissa spinarum L.	Apocynaceae	Agam	S	_	+	+
Cassipourea malosana(Baker) Alston.	Rhizophoraceae	Nacha	T	+	+	-
Celtis africana Burm.	Ulmaceae	Fertkuma	T	_	+	-
Chionanthus mildbraedii (Gilg & Schellenb.)Stearn	Oleaceae	Wogeda	T	_	+	-
Clerodendrum myricoides Hochst.	Lamiaceae	Misirich	S	_	+	-
Clutia abyssinica Jaub. & Spach.	Euphorbiaceae	Fyele Fejj	S	_	+	-
Clutia lanceolata Forssk.	Euphorbiaceae	sertlijen	S	_	+	-
Croton macrostachyus Del.	Euphorbiaceae	Bisana	T	_	+	-
Dodonea angustifolia L. f.	Sapindaceae	Kitkita	S	_	+	+
Dombeya torrida (J. F. Gmel.)	Sterculiaceae	Danisa	T	+	+	+
Dovyalis abyssinica (A.Rich.) Warb.	Flacourtiaceae	Koshem	T	+	+	+
Ehretia cymosa Thonn.	Boraginaceae	Ulaga	T	+	+	+
Ekebergia capensis Sparrm.	Meliaceae	Sembo	T	+	+	-
Erica arborea L.	Ericaceae	Aseta	T	_	+	-
Euclea schimperi Murr.	Ebenaceae	Dedeho	S	+	+	-
Euphorbia abyssinica Gmel.	Euphorbiaceae	Kulkual	T	+	-	+
Euphorbia candelabrum Kotschy	Euphorbiaceae	Qulkual	T	+	-	+
Ficus ovate Vahl	Moraceae	Yewof Sholla	T	_	+	+
Ficus sur Ib Friis	Moraceae	Sholla	T	_	+	+
Grewia bicolor Juss.	Tiliaceae	Wonze ademqe	T	_	+	-
Grewia ferruginea Hochst. ex A. Rich.	Tiliaceae	Lenkawata	T	_	+	-
Heteromorpha arborescens (Spreng.)	Apiaceae	Aliharqal	S	_	+	+
Jasminum grandiflorum L.	Oleaceae	Tembelel	S	+	+	-
Juniperus procera Hochst. ex Endl.	Cupressaceae	Yehabesha tid	T	_	+	-
Maytenus arbutifolia (A. Rich.)	Celastraceae	Atat	T	_	+	+
Maytenus procumbens	celastraceae	(Wonkabero*)	T	+	+	-
Myrica salicifolia A. Rich.	Myrtaceae	Shinet	T	_	+	+
Myrsine Africana L.	Myrsinaceae	Kerchemo	S	+	+	-
Nuxia congeta R.Br. ex Fresen.	Loganiaceae	Askwar	T	_	+	+
Ocimum urticifolium Roth	Lamiaceae	Damakisse	S	_	-	+
Olea capensis L.	Oleaceae	Lemech	T	+	+	-
Olea europaea L.subsp. cuspidata	Oleaceae	Weyera	T	+	+	-
Olinia rochetiana A. Juss.	Oliniaceae	Tefie	T	_	+	-
Opuntia ficus indica (L.) Miller.	cactaceae	Manka kulkal	S	+	-	+
Osyris quadripartite Decn.	Santalaceae	Kert	S	+	+	+
Otostegia fruticosa Forssk.	Lamiaceae	Geram tunjet	S	+	+	-
Pavetta oliveriana Hiern.	Rubiaceae	Buna bunet	S	_	+	+
Phytolacca dodecandra L'Her.	Phytolaccaceae	Endode	S	+	+	-
Pittosporum viridiflorum Sims.	Pittosporaceae	Kefeto	T	_	+	+
Podocarpus falcatus (Thunb.) Mirb.	Podocarpaceae	Zegeba	T	+	+	-
Polyscias fulva Hiern.	Araliaceae	Zenfoke	T	+	+	+
Pouteria altissima A.Chev.	Sapotaceae	Kerero	T	+	+	-
Premna schimperi Engl.	Lamiaceae	Checho	S	+	+	+
Prunus africana Hook.f.	Rosaceae	Tekur inchet	T	_	+	+
Psydrax schimperiana A. Rich.	Rubiaceae	Seged	T	+	+	+
Pterolobium stellatum Forssk.	Fabaceae	Kenetefa	S	+	+	+
Rhamnus prinoides L'Herit.	Rhamnaceae	Gesho	S	_	-	-
Rhus natalensis Krauss	Anacardiaceae	Debobosha	S	+	+	+
Rhus retinorrhoea Oliv	Anacardiaceae	Talo	S	+	-	-
Rosa abyssinica Lindley.	Rosaceae	Kega	S	+	+	+
Rubus apetalus Poir.	Rosaceae	Enjori	S	+	+	+
Rumex nervosus Vahl.	Polygonaceae	Embacho	S	_	+	+
Sesbania sesban L.	Fabaceae	Sesbania	S	+	+	+
Solanum incanum L.	Solanaceae	Embway	S	+	+	-
Vernonia amygdalina Del.	Asteraceae	Grawa	S	+	+	-
Total				36	56	36

N.B. Presence and absence of species is indicated by (+) and (-), respectively. (*) implies species found only in seedling life form. T= tree , S=shrub