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Floristic Composition, Vegetation Structure and Regeneration Statues of Woody Plant Species of Sheleko Medihanialem State Forest in Fogera District, Ethiopia

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Abstract
This study was conducted in Shelekomedihanialem state forest in Fogera district, South Gondar Zone, Ethiopia, to identify the floristic composition, vegetation structure,diversity and regeneration status of the woody plant species. Systematic sampling method was used to collect vegetation data from 5 transect lines 200m far apart and 50(20m x20m) quadrates at distance of 100m. To collect data for seedling and sapling, five 1m x 1m sub-plots were laid in each of the main plot, where four were at the corners and one at the center. Diameter at breast height was measured DBH ≥2.5cm while height was≥2m.Shannon-WiennerDiversity Index was used to calculate species diversity, richness and evenness. The densities of mature, sapling and seedling of woody plant species were 2055.5,2240 and 2400.5 individuals/ha respectively and the basal area of the forest was 2.246 m^2/ha.The result of vegetation structure of woody plant species and regeneration status analysis in the forest revealed that the forest was dominated by small-sized trees and shrubs indicating that it is in the stage of secondary development. Finally, this study indicated that the population structure of the most woody plant species in Shelekomedihanialem state forest is in a good status of regeneration recruitment level. From the point of view of managing forests for the sake of biodiversity conservation, if appropriate management measures are taken, the nature of the population structure of most of tree species could be improved.
Keywords: Ethiopia, Floristic composition, regeneration, Forest, vegetation structure
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Introduction

Biodiversity is the variability among living organisms on Earth, manifested by three main components such as gene, species and ecosystem components (biotic and abiotic).Loss of biodiversity is a growing concern in many parts of the world (Abyot Dibaba *et al.*, 2014). With respect to its biological resources, vast geological history, broad latitudinal and altitudinal ranges, Ethiopia is regarded as one of the most important country in Africa (EFAP, 1994).These variations lead to the emergence of different habitats suitable for the existence and survival of different plants and animals species, which contributes to the overall biodiversity of the country (Tamene Yohannes *et al*., 2016). However, the natural forest cover of the country has been declining over the years due to various human induced pressures, rapid human population growth, deforestation, over grazing, lack of integration of local people living around the conservation areas and other factors contribute to the loss of forest biodiversity resources in the country and this in turn led to the expansion of cultivated land at the expense of forests (Mitiku Haile *et al*., 2006).

In the northern highland of Ethiopia, patchy remnants of old aged afromontane forests can be found mainly around the Ethiopian Orthodox Tewahido churches (EOTC) which contain many plant and animal species and preserve the indigenous vegetations (Abiyou Tilahun *et al*., 2015). However, forests in other parts of the country have been completely destroyed and converted into farming and grazing lands over many years: as a result, church forests still pose a great heritage of diverse gene pool of many forest species (Alemayehu Wassie *et al.,* 2005).With the prevailing alarming rate of deforestation and other factors described above, the remaining natural forests could disappear within a few decades, unless appropriate and immediate measures are taken (Haileab Zegeye*et al.*, 2011).It is very important to understand forest structure and composition and such understanding helps to assess the potential impacts of degraded ecosystems (Congdon and Herbohn, 1993). Analysis of floristic composition, vegetation structure and regeneration status of forest communities is also useful in identifying important elements of plant diversity, protecting threatened and economic species, and monitoring the forest communities (Tilman, 1988; Ssegawa and Nkuutu, 2006).Woody plant species play crucial roles in providing goods and services necessary for the well-being of both humans and animals. They serve as sources of food, beverages, animal feed, and timber for various purposes, fuel wood, charcoal, medicine, honey, spices, gums and resins, tourism and other non-timber products (Haileab zegeye*et al*., 2005).

The diversity, regeneration status, floristic composition, and vegetation structure are crucial elements to clearly visualize the anthropogenic activities as well as environmental factors affecting the vegetation of an area (FAO, 2007). But up to now there is limited study carried out on woody plant species of Shelekomedihanialem

state forest located in Amhara region, South Gondar Zone, Fogera district (north west Ethiopia).Thus, this study is aimed at, a comparative investigation of floristic composition, vegetation structure and regeneration statues of woody plant species of Shelekomedihanialem state forest of Fogera district.

Materials and Methods

The study area is located at South Gondar Zone, Amhara National Regional State, Ethiopia at about 625km away from Addis Ababa and 55km from the regional capital, Bahir Dar.It is located between 11^0 58' to $12^0$54'N latitude and 370^0 41' to 37^0 58'E longitudes (ANRS-BOFED, 2006). Woreta is main town of the district with respect to the study site, Shelekomedihanilem state forest which covered 150 hectare area of land, is located at10 km from woreta with the altitudinal range from 1869 to1993 meter above sea level(Fig.1).

Climate of fogera district is belonged to the Woina Dega agro-ecological zone of Ethiopia (IPMS, 2005;Ergano *et al*.,2010).Metrological data obtained from West Amhara Metrology Service Center(Bahir Dar),indicates that fogera area obtains high and low rain fall between May and September, while it receives the low rain fall between December and February. The highest mean annual rain fall of the district within ten years (2010-2019) was 1033.4mm recorded in August followed by 759.5mm in July whereas the lowest mean annual rain fall over ten years was 1.5 mm recorded in January. The rain fall distribution increases from March to May then decrease October to November. From June to September the amount of rain fall is high. The lowest mean temperature over ten years was 8.4o^{c}recorded in December whereas the highest temperature was 26.9o^c recorded in April.

The information obtained from fogera district agriculture and rural development (FDARD, 2012) indicates that most parts of the lands currently observed as free in the district were covered with vegetation in the past. Today, few remnants of big trees are observed in the farm lands and road sides. Currently, there is some vegetation area of the forests found in the district. One of the natural vegetation areas of the district is shelekomedihanialem state forest. But the patchy remnant of the district, forest is in decline due to different reasons like agriculture expansion and cultivation, fuel wood, timber production etc. In most areas of Ethiopia, deforestation has been one of the serious problems. Now a day the shelekomedihanialem state forest is protected and it is one of the patchy remnants forest conserved in the Fogera district.

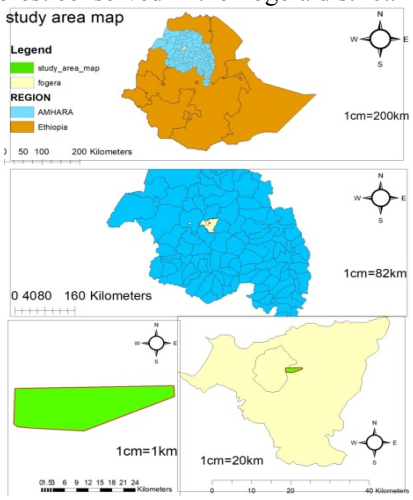

Fig. 1Study Area Map

Data collection

Systematic random sampling technique was employed to collect vegetation data and a total of 5 transects at a distance of 200m between them. Each transect contains different numbers of plots depending on the length of each transect 50(20m x 20m) quadrates at a distance of 100m between them were laid down to collect all woody plant species and 5 (1m x1m) sub quadrates, 4 at each corner of the main quadrates and 1 at the center of each quadrates were also laid down to count the number of seedlings and samplings (regenerations).The altitude of each transect was recorded by using Garmin-72 (G-72) Geographic Position System(GPS).Plant species found within each sampling plot were identified by their vernacular and scientific names using the published volumes of flora of Ethiopia and Eritrea (Inga Hedberg and Sue Edwards, 1989; Sue Edwards *et al*., 1995;Sue Edwards *et al.,* 2000; lnga Hedberg*et.al*., 2004and Azene Bekele, 2007).

Data Analysis

Vegetation Structure

All individuals of woody plant species recorded in all the 50 quadrates were used in the analysis of vegetation

structure, such as density, DBH, height, frequency, basal area and IVI. Bar graphs were developed using the DBH versus density (0-10, 11-20, 21-30, 31-40 and >40) five classes and height versus density (0-10, 11-20, 21-30 and >30) of individuals for four arbitrary classes. According to (Mueller-Dombois, Ellenberg, 1974; Kent &Coker, 1992; Semere Beyene, 2010), the vegetation data were computed using the following parameters.

1. Density (D); is a count of the numbers of individuals of a species within the quadrates.
2. Relative density (RD**)**; Number of individuals of a species A / Total number of individuals of all species x 100.
3. Frequency (F**);** number of plots in which species A occurs/Total number of plots sampled.
4. Relative frequency (RF); Frequency of a species/ Sum frequency of all species x 100
5. Dominance (DO); is the degree of coverage (basal area) of species A /Area sampled.
6. Relative dominance (RDO)**;**dominance for species A/Total dominance of all species x100
7. Diameter at Breast Height (DBH)**;** measurement technique is taken at about 1.3m from the ground.
8. Basal area (BA); is the area outline of a plant near ground surface (BA= $\frac{\pi d^2}{4}$).
9. Importance Value Index (IVI) is sum of relative frequency (RF), relative density (RD) and relative dominance (RDO).
10. Height (H)**;** is a straight forward parameter used for direct measurement purposes.

Diversity Analysis

In order to analyze the diversity of above ground vegetation, Shannon-Weiner index (H') (Shannon, 1948) was widely used approaches in measuring the diversity of species. The species richness(S) and evenness (E) of woody plant species computed by using the following method used by (Kent &Cocker, 1992; Krebs, 1999; Jayarman, 2000).

Results

Floristic composition

A total of 80 woody plant species representing 65 genera and 50 families were identified in the study area. The comparative distribution of species within the families is given in Table 1.The life forms of the study area were trees, shrubs and climbers. The tree has the largest proportion of life forms of the species, trees with 41(51.25%) species, shrub with 25(31.25%) species and climber with 14(17.5%) species (Appendex.1).

Table.1Family-wise percentage distribution of species

Family	Number of species	Percentage	Family	Number of Species	Percentage
Euphorbiacea e	4	5	Boraginaceae	1	1.25
Celastraceae	2	2.5	Sterculiaceae	1	1.25
Fabaceae	14	17.5	Loganiaceae	1	1.25
Tiliaceae	1	1.25	Vitaceae	1	1.25
Apocynaceae	1	1.25	Melianthaceae	1	1.25
Asclepiadaceae	2	2.5	Sapotaceae	1	1.25
Rutaceae	1	1.25	Apiaceae	1	1.25
Capparidaceae	1	1.25	Convolvulaceae	1	1.25
Rubiaceae	4	5	Compositae	1	1.25
Moraceae	4	5	Cucurbitaceae	1	1.25
Acanthaceae	2	2.5	Menispermaceae	1	1.25
Asteraceae	1	1.25	Scrophulariaceae	1	1.25
Verbenaceae	2	2.5	Myricaceae	1	1.25
Bignoniaceae	1	1.25	Myrtaceae	1	1.25
Arecaceae	1	1.25	Olacaceae	1	1.25
Simaroubceae	2	2.5	Phytolaccaceae	1	1.25
Anacardiaceae	1	1.25	Polygalaceae	1	1.25
Ebenaceae	1	1.25	Asparagaceae	1	1.25
Lamiaceae	4	5	Salicaceae	1	1.25
Pittosporacear	1	1.25	Meliaceae	1	1.25
Annonaceae	1	1.25	Ranunculaceae	1	1.25
Santalaceae	1	1.25	Sapindaceae	1	1.25
Oleaceae	1	1.25	Solaraceae	1	1.25
Sapandaceae	1	1.25	Cupressaceae	1	1.25
Combretaveae	1	1.25	Compcitae	1	1.25

Vegetation Structure

Height and DBH measurements were used to construct the density distribution for the various categories. The height distribution of woody plant species was grouped into four classes 1 (0-10 m), 2 (11-20 m), 3 (21-30m) and 4 (>30m) and showed an inverted J-shape pattern, which indicates that a number of individuals in the first class were highest, and decreased towards the middle and higher diameter classes (Fig.2).The highest number of species was found to be 59 species (73.75%) belong to the lowest height classes i.e. (0-10m). Only few species 8 (10%) attain heights of more than 21m.

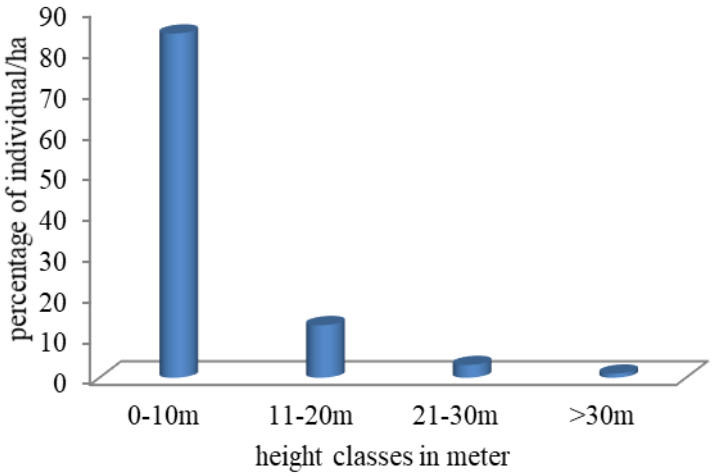

Fig.2 percentage of distribution of height classes in study area.

DBH measurements reveal that the majority of woody plant species distributed in the first class (0-10 cm) 69.33%.About 2.21% belong to second DBH class (11-20cm) and 8.98%have DBH greater than 40 cm.

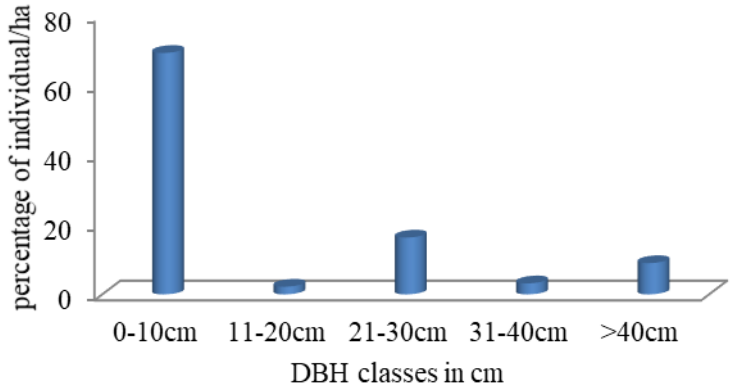

Fig.3 DBH class Vs Percentage of individual/ha.

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).The importance Value Index (IVI) of woody plant species of study area was calculated and listed in (Table 2).

Table 2. Value Index of the woody plant species of the study area

Scientific name	RF	RD	RDO	IVI	IVI%
Croton macrostachyus Hochst	4.6	3.8	2.87	11.27	3.77
Maytenus arbutifolia(A.Rich)Wilcek	5.2	16.25	0.02	21.47	7.16
Calpurnia aurea (Ait.) Benth	4.6	9.2	0.02	13.82	4.61
Grewia ferruginea Hochst.ex A.Rich	4.11	6.3	0.11	10.52	3.51
Pterolobium stellatum (Forsk.) Brenan	3.01	2.1	0.02	5.13	1.71
Carissa spinarum L.	4.94	8.4	0.02	13.36	4.45
Pergularia daemia L.	0.6	0.17	0.16	0.93	0.31
Clausena anisata (Willd)Benth	1.33	1.3	0.07	2.7	0.9
Capparis tomentosa L.	4.1	3.3	0.13	7.53	2.51
Pavetta oliveriana	0.84	0.95	0.04	1.83	0.61
Acacia hockii DeWilld	1.93	1.41	1.76	5.1	1.7

Scientific name	RF	RD	RDO	IVI	IVI%
Ficus vasta Forssk	0.84	0.27	11.78	12.89	4.3
Acanthus sennii Chiov	1.82	3.53	0.02	5.37	1.79
Vernonia amygdalina Del	0.72	1.3	0.27	2.29	0.76
Premno schimperi Engl.	3.85	3.5	1.43	8.78	2.93
Stereospermum kumthianum C	0.72	0.46	1.47	2.65	0.883
Jesteicia schimperana	1.2	0.66	3.03	4.89	1.63
Brucea antidysenterica J.F.Mill	0.72	0.12	4.16	5	1.67
Senna multiglandulosa	2.53	1.56	1.18	5.27	1.76
Maerua aethiopica (Fenzl) Oliv	1.56	0.51	1.07	3.15	1.05
Rhus quartiniana A.Rich	3	2.6	1.29	6.89	2.3
Euclea schmperi	3.4	3.4	1.25	8.06	2.69
Ocimum lamiifplium Hochst e	0.5	0.88	0.02	1.5	0.5
Pittosporum viridiflorum	0.5	0.12	1	1.72	0.57
Annona senegalensis	1.6	0.34	0.73	2.67	0.89
Gardenia ternifolia	1.45	0.6	4.28	6.33	2.11
Osyris quadripartita Dec	0.84	0.6	0.07	1.51	0.50
Jasminum grandiflorum L.	1.45	0.9	0.07	2.42	0.81
Varnonia amygdalina El	0.6	0.88	0.02	1.51	0.503
Combretum molle R.Br.exG.Don	1.32	1.26	0.04	2.63	0.877
Canthium oligacarpumHiern	1.57	0.62	0.07	2.26	0.753
Acacia hockii DeWilld	1.2	0.56	1.91	2.67	0.89
Cordia africana Lam	1.2	0.78	3.23	5.21	1.737
Aeollanthus abyssinicus Hochst. ex Benth. (1848)	0.6	0.19	0.04	0.83	0.28
Acacia tortils	1.45	0.54	4.21	6.2	2.1
Acacia abyssinica Hochst.ex Benth.(1846)	0.5	0.19	3.69	4.48	1.493
Bridelia micranta (Hochst) Bill	0.84	0.24	2.25	3.33	1.11
Sapium ellipticum (Hochst.) Pax.	0.95	0.56	1.2	2.72	0.91
Buddleja polystachya Fresen	1.32	0.95	1.43	3.71	1.24
Rhoicissus tridentata L.f	1.45	0.97	0.02	2.44	0.813
Clutia lanceolata Forsk	0.95	0.88	1.27	3.11	1.037
Bersama abysstnica Fresen	1.32	1.39	0.11	2.83	0.94
Mimusops kummel A .DC	0.72	0.39	4.29	5.4	1.8
Steganotae nia araliacea Hochst.	0.72	0.83	1.36	2.91	0.97
Impomoea cairica L Sweet(1827)	0.72	0.21	0.02	0.95	0.32
Vernonia myriantha Hook.f.	1.32	1.6	0.02	2.95	0.983
Momordica trifoliolata	0.72	0.17	0.02	0.91	0.303
Albizia gummifera(J.F.Gmel)C.ASm.(1930)	0.95	0.19	3.41	4.56	1.52
Staphania abyssinica	0.5	0.12	0.02	0.74	0.247
Verbascum stelurum Murb(1933)	1.08	0.22	0.04	1.34	0.447
Myrica salicifolia	0.83	0.24	0.18	1.26	0.42
Szygium goineense (Wild) DC.	0.47	0.24	4.34	5.06	1.69
Ximenia americana L.	1.2	0.71	2.61	4.52	1.507
Entada abyssinica	0.47	0.54	0.02	1.04	0.347
Brucea antidysenterica	0.35	0.12	0.09	0.57	0.19
Ficus ovata (Vahi)	0.71	0.15	0.49	1.36	0.45
Phytolacca dodecandra	0.47	0.27	0.26	1.02	0.34
Securidaca longepedunculata	0.35	0.09	0.02	0.47	0.157
Pavella oliveriana	0.84	1.05	0.04	1.93	0.64
Acacia pillspina Pic-Sem.(1951)	0.95	0.41	0.09	1.46	0.49
Asparagus africanus	0.5	0.22	0.02	0.84	0.28
Dovyalis abyssinica	0.35	0.12	0.9	1.39	0.463
Ekebergia capensis parrm S	0.47	0.09	3.07	3.64	1.213
Millettia feruganea (Hochst) Bak	0.35	0.15	0.04	0.55	0.183
Calotropis procera	0.35	0.07	0.57	1.01	0.34
Lippia adoedisis	0.35	0.73	1.5	2.49	0.83
Clematis simensis Fresen	0.5	0.19	0.02	0.81	0.27
Allophylus abyssinica(Hochst) Radkofer	0.35	0.07	0.67	1.1	0.37
Acnthus sennii Chiove	0.35	0.15	0.02	0.53	0.177

Scientific name	RF	RD	RDO	IVI	IVI%
Solanum marginatum	0.47	0.15	0.02	0.65	0.217
Ficus sycomorus L.	0.6	0.32	2.95	3.88	1.29
Casuarina cunninghamiana Miq.	0.35	0.07	2.8	3.24	1.08
Vernonia auriculifera Hiern	0.72	3.53	0.02	4.27	1.42
Ficus thonningii Blume	0.24	0.05	1.67	1.96	0.65
Acacia hockii De Willd	0.35	0.2	1.52	2.07	0.69
Albezia schimperiana	0.24	0.09	3.45	3.78	1.26
Eucalyptus camaldulensis dehnh(1831)	0.35	0.19	1.6	2.15	0.717
Acacia ciseyal Del	1.2	0.61	2.83	4.64	1.55
Clerodedrum myricoid(Hochst)	0.47	0.62	1.14	2.25	0.75
Maytenus senegalensis	0.84	0.29	0.04	1.18	0.39
Total	100	100	100	300	100

Regeneration Status of the study area

According to Dereje Denu (2006), regeneration status of any vegetation can be explained on the basis of number and type of seedlings as well as saplings associated with that vegetation. The composition and density of seedling, sapling and mature of woody plant species in shelekomedihanialem state forest accounted for 35.85%, 33.45% and 30.69%of density/ha of individual species respectively. Density/ha of individual of species showed that the seedling >sapling >matured tree in the study forest. Figure 4 depicts that the number of tree; seedling & sapling, shrup; seedling & sapling and climber; seedling & sapling.

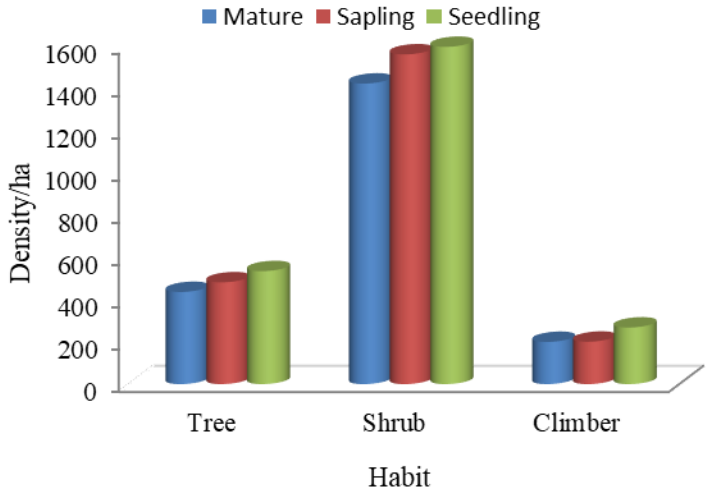

Fig.4 Seedling and sapling distribution Vs mature tree of woody plant species of study forest

Discussion

In the study area Fabaceae is the most dominant family with 14species followed by Euphorbiaceae, Rubbiaceae, Lamiaceae and moraceae 4 species each.5 families have 2 species each. The dominance indicates suitability of the condition and adaptation of the environment. Most families (80%) of shelekomedihanialem state forest were represented by one species (table 1).The data analysis showed that the density of trees decreased with increasing height classes(Appendix1).This means, there are higher number of individuals in the lower size and a gradual decrease towards the middle and upper size trees. The highest number of individual trees was found to be class 3457 (84.09%) individual representing the height first. Height can be used as an indicator of age of the forest. Only few individual trees (3.06%) of the total were recorded in the highest height (21m to 30m).This reveals that the vegetation of shelekomedihanialem forest can be categorized under secondary regeneration that is most primary plants could be cut before growing in to big trees.

The DBH analysis showed that the majority of woody plant species distributed in the first class (0-10cm) which has atotalof2850individualswith1425(69.33%)individuals/ha. The least woody plant species distributed in the second class (11-20cm) has total of 91individuals with 45.5(2.21%) individual/ha which shows that most proportion of the vegetation is represented by shrubs and small trees. However, as the DBH class increased, density was decreasing, that means, the vegetation has small number of big trees in the higher DBH classes as compared to shrubs and small trees concentrated in the lower DBH classes.

IVI values are very important parameters that reveal the ecological significance of species in a particular

ecosystem (Simon Shibru& Girma Balcha2004). Species with the highest IVI values are the most dominant species. The importance Value Index (IVI) of woody plant species of shelekomedihanialem state forest was calculated and listed in (Table.2).*Maytenus arbutifolla* has highest IVI value(7.157%), followed by *Carpurinia aurea*(4.607%)*Carissa spinarum*(4.453%) and *Ficus vasta*(4.453%).Species have higher IVI value is that their higher relative density, relative frequency and relative dominance relative to other species in the forest. The leading dominant and ecologically most significant species may be the most successful species in regeneration, pathogen resistance, least preferred by browsing animals, attractive of polinators that facilitate seed dispersal within that environmental condition (Fufa Kenea, 2008).Analysis of the frequency distribution indicated that *Maytenus arbutifolia, Carissa spinarum, Croton macrostachyus, Calpurnia aurea, Grewia ferruginea* and *Capparis tomentosa* were found to be with the highest relative frequency indicating their good distribution throughout the forest(Table.2).About 15% of woody plant species have a relative density greater or equal to 2%, while 85% of the species have a relative density of less than 2%. Relative dominance, which is the basal area of a single species, divided by total basal area of the species X 100.22.5% of woody plant species fall between 2.25 % to 11.78 % of basal area, while 62 (77.5%) of specieshavebasalarearangesfrom0.02%to1.92%.

In the shelekomedihanialem state forest 97.5 % of woody species have seedling stages and 98.25 % of woody species have sapling stages. The only woody species *Calotropis procera* has no represented by the seedling and *Casuarina cunninghamiana* has no both seedling and sapling stages. The ratio of seedlings to mature individuals of woody plant species in study forest was 1.17, the ratio of seedlings to saplings was 1.07 and sapling to matured individuals was 1.09.This indicated that the successful regeneration status of the forest and stability of the species to the environment in that vegetation. Regeneration status is a crucial phase of forest management because it maintains the desired species composition and stocking after disturbances (Duchok *et al*., 2005).

Conclusion

This study provides useful information on the present conditions of the woody plant species diversity, structure and regeneration status of Shelekomedihanialem state forest. The study showed that a total of 80 species of woody plants were identified. From80 different species, a total of 4111individuals of woody plants were collected. The vegetation structure analysis showed that the study site is dominated by shrubs and small sized trees; this is due to the anthropogenic factors. Primary plants could be cut down before growing in to big trees. As a result young plants can regenerate and replace primary regeneration. The total number of mature woody plant species, saplings and seedlings are counted and the analysis results of regeneration status revealed that the number of seedlings exceeds the number of saplings and the number of saplings exceeds the number of mature. Moreover, the study site is diversified, and has good regeneration potential. To improve the natural diversity and structure of the forest, to minimize the influence of the anthropogenic factors and utilize the forest resources sustainably for present and future generation.

Reference

Abyot Dibaba, Teshome Soromessa, Ensermu Kelbessa & Abiyou Tilahun (2014).Diversity, Structure and Regeneration Status of the Woodland and Riverine Vegetation of Sire Beggo in Gololcha District, Eastern Ethiopia.

Abiyou Tilahun, Hailu Terefe, and Teshome Soromessa (2015).The contribution of Ethiopian Orthodox Tewahido Church in forest management and its best practices to be scaled up in North Shewa Zone of Amhara Region, Ethiopia.Agriculture, Forestry and Fisheries 4(3):123137.

Alemayehu W, Demel T, Powell N. (2005) Church forests in north Gondar Administrative Zone, northern Ethiopia.For Trees Livelihoods;15:349–73.

ANRS-BOFED (2006).Annual report of Amhara regional state of Bureau of finance and Economic Development.

Azene Bekele (2007). Useful trees and shrubs for Ethiopia. Identification, propagation and management for 17 agro climatic zones. RELMA in ICRAF, Nairobi.

Congdon, R. A., & Herbohn, J. L.(1993).Ecosystem Dynamics of Disturbed and Undisturbed Sites in North Queensland Wet Tropicalrain Forest. I. Floristic Composition, Climate and Soil Chemistry. Journal of Tropical Ecology, 9, 349-363.

David Tilman (1988).Plant Strategies and the Dynamics and Structure of Plant Communities.Princeton, NJ: Princeton University Press.

Dereje D.(2006).Floristic composition and ecological study of Bibita Forest (Gura Ferda),South west Ethiopia. M.Sc.Thesis Addis Ababa University.

Duchok, R., Kent, K., Khumbongmayum, AD., Paul, A. and Khan, ML. (2005).Population structure and regeneration status of medicinal tree Illicium griffithii in relation to disturbance gradients in the temperate broad-leaved forest of Arunachal Pradesh. Current Science 89(4): 673-676.

EFAP (1994).Ethiopian Forestry Action Program, VolumeIII .The Challenge for Development. Ministry of

Natural Resources, Addis Ababa Enoki,T. and Abe,A .(2004). Saplings distribution in relation to topography and Canopy openness in an evergreen broad-leave forest.Plant ecology173:283-291.

Ergano, K., Belay, A., and Leta, G. (2010).Integrated Rainwater Management for Enhanced Livelihoods While Sustaining Environment: Baseline Survey Narretive of Project Site (Jeldu, Fogera and Diga Woredas).

FAO (2007) State of the World's Forests, FAO, Forestry Department.

FDARDO (2012). Annual report of Fogera district Agricalture and Rural Development Office.

Fufa Kenea (2008). Remnant vegetation and population structure of woody species of Jima Forest, Western Ethiopia. M. Sc.Thesis (Unpublished).Addis Ababa University, Addis Ababa.

Haileab Zegeye, Demel Teketay and Ensermu Kelbessa (2005).Diversity, regeneration status and socio‐economic importance of the vegetation in the islands of Lake Ziway, south‐central Ethiopia. Flora 201: 483–498.

Haileab Z., Demil T &Ensermu K (2011).Diversity and regeneration status of woody species in Tara Gedam and Abebaye forests, northwestern Ethiopia. Journal of Forestry Research 22(3): 315 328.

IPMS (Improving Productivity and Marketing Success, 2005). Fogera Woreda PilotLearning Site Diagnosis and Program Design. Improving Productivity and marketingSuccess- International Livestock Research Institute. Addis Ababa: Ethiopia.

Inga Hedberg and Sue Edwards, Eds., Flora of Ethiopia and Eritrea, Vol. 3: Pittosporaceae to Araliaceae, National Herbarium, Addis Ababa University, Addis Ababa, Ethiopia; Department of Systematic Botany, Uppsala University, Uppsala, Sweden, 1989.

Inga Hedberg and Sue Edwards,Eds., Flora of Ethiopia and Eritrea, Volume 7: Poaceae (Gramineae), Addis Ababa University, Addis Ababa, Ethiopia; Uppsala University, Uppsala, Sweden, 1997.

Jayarman, K. (2000).A statistical Manual forforestry research.Bankok: FORSPA-FAO Publication, Nankok.

Kent, M. and Coker,P.(1992).Vegetation description and analysis. Belhaven pres London 363 PP.

Krebs, C.J. (1999).Ecologicalmethodology. Harperandrow cop, New York.

Mitiku Haile, Karl Herweg, and Brigita Stillhardt(2006).Sustainable Land Management Anew Approch to soil and water conservation in Ethiopia, Mekelle University Mekelle, Ethiopia, Univ.Berne,Switherland.Muller-Dombois,D.andEllenberg, H.(1974) .Aims and Methods of Vegetation Ecology.WileyandSons,NewYork, Pp547.

Muller-Dombois & Ellenberg, H. 1974. Aims and methods of vegetation ecology. John Willey and Sons, Inc, U.S.A. 547pp.

Semere Beyene (2010).Floristic composition and structure of yangudi rassa national park vegetation, NortheasternEthiopia.MSc.Thesis in Environmental Science, AddisAbabaUniversity, Ethiopia

Simon Shibru and Girma Balch (2004). Composition, structure and regeneration status of woody species in Dindin forest, conservation. Ethiopian Journal of biological sciences. 3:15-35.

Ssegawa,P.,and Nkuutu,D.N.(2006).Diversity of vascular plants on Ssese Island in Lake Victoria Central Uganda.*Africa Journal Ecology*,44,22-29.

Sue Edwards, T. Mesfin, and I. Hedberg, Eds., Flora of Ethiopia and Eritrea, Vol.2 Part 2: Canellaceae to Euphorbiaceae, the National Herbarium, Addis Ababa, Ethiopia, 1995.

Sue Edwards, D. Sebsebe, and I. Hedberg, Eds., Flora of Ethiopia and Eritrea, Volume 6: Hydrocharitaceae to Ericacea, Addis Ababa University, Addis Ababa, Ethiopia; Uppsala University, Uppsala, Sweden, 1997.

Tamene Yohannes, Tesfye A was, and Sebsibe Demissew (2016).Survey and documentation of the potential and actual invasive alien plant species and other biological threats to biodiversity in Awash National Park, Ethiopia," Management of Biological Invasives, vol.2, no.1, pp.3-14.

Appendex1.Different woody plant species in study area

Vernacular name	Scientific Name	Family	Habit	No ind.	D/H	No Qua
Bisana	*Croton macrostachyus Hochst.ExDel.*	Euphorbiaceae	T	156	78	38
Atat	*Maytenus arbutifolia(A.Rich)Wilczek*	Celastraceae	S	668	334	43
Zigta	*Calpurnia aurea(Ait.) Benth*	Fabaceae	S	379	189.5	38
Lenquata	*Grewia ferruginea Hochst.ex A.Rich*	Tiliaceae	S	260	130	34
Qentafa	*Pterolobium stellatum (Forsk.) Brenan*	Fabaceae	C	88	44	25
Agam	*Carissa spinarum L.*	Apocynaceae	S	344	172	41
Ayitareg	*Pergularia daemia L.*	Asclepiadaceae	C	7	3.5	5
Limbich	*Clausena anisata (Willd)Benth*	Rutaceae	S	54	27	11
Gimero	*Capparis tomentosa L.*	Capparidaceae	C	134	67	34
Zenezen	*Pavetta oliveriana*	Rubiaceae	S	39	19.5	7
Timbilqagirar	*Acacia hockii DeWilld*	Fabaceae	T	58	29	16

Warka	*Ficus vasta Forssk*	Moraceae	T	11	5.5	7
Kosheshile	*Acanthus sennii Chiov*	Acanthaceae	S	145	72.5	15
Girawa	*Vernonia amygdalina Del*	Asteraceae	S	53	26.5	6
Chocho	*Premna schimperi Engl.*	Verbenaceae	S	144	72	32
Zana	*Stereospermum kumthianum C*	Bignoniaceae	T	19	9.5	6
Selen	*Justeicia schimperiana*	Arecaceae	T	27	13.5	10
Quara	*Brucea antidysenterica J.F.Mill*	Simaroubceae	T	5	2.5	6
Bishbisha	*Senna multiglandulosa*	Fabaceae	T	64	32	21
Qontirgirar	*Acaciaa senegal*	Fabaceae	T	21	10.5	13
Qamo	*Rhus glutinosa A.Rich.(1847)*	Anacardiaceae	T	107	53.5	25
Dedeho	*Euclea schmperi*	Ebenaceae	S	140	70	20
Damakese	*Ocimum lamiifplium Hochst e*	Lamiaceae	S	36	18	5
Satlash	*Pittosporum viridiflorum*	Pittosporaceae	T	5	2.5	5
Wonbela	*Annona senegalensis*	Annonaceae	T	14	7	14
Gambilo	*Gardenia ternifolia*	Rubiaceae	T	25	12.5	12
Qeret	*Osyris quadripartita Dec*	Santalaceae	S	25	12.5	7
Tembelel	*Jasminum grandiflorum L.*	Oleaceae	C	37	18.5	12
Kitkita	*Varnonia amygdalina El*	Sapandaceae	S	36	18	5
Abalo	*Combretum molle R.Br.exG.Don(1827)*	Combretaceae	S	52	26	11
Dengay seber	*Canthium oligacarpumHiern*	Rubiaceae	T	25	12.5	13
Nech girar	*Acacia hockii DeWilld*	Fabaceae	T	23	11.3	10
Wanza	*Cordia africana Lam.(1792)*	Boraginaceae	T	32	16	10
yewushaziqaqibe	*Aeollanthus abyssinicus Hochst. ex Benth. (1848)*	Lamiaceae	S	8	4	5
Debene girar	*Acacia tortilis*	Fabaceae	T	22	11	12
Bazra girar	*Acacia abyssinica Hochst.ex Benth.(1846)*	Fabaceae	T	8	4	5
Yenebir tifir	*Bridelia micranta (Hochst) Bill*	Euphorbiacae	T	10	5	7
Arboj	*Sapium ellipticum(Hochst.) Pax.*	Euphorbiacae	T	23	11.5	8
Anfar	*Buddleja polystachya Fresen*	Loganiaceae	S	39	19.5	11
Wodel asfes	*Rhoicissus tridentata L.f*	Vitaceae	C	40	20	12
Fiyele fej	*Clutia lanceolata Forsk (1753)*	Ephorbiaceae	S	36	18	8
Azamir	*Bersama abysstnica Fresen*	Melianthaceae	S	57	28.5	11
Eshe	*Mimusops kummel A .DC*	Sapotaceae	T	8	4	6
Yejib dula	*Steganotaenia araliacea Hochst.*	Apiaceae	T	34	17	6
Esat abrid	*Impomoea cairica (L)Sweet (1827)*	Convolvulaceae	C	9	4.5	6
Qotiquato	*Vernonia myriantha Hook.f.*	Compositae	S	66	33	11
Qondira hareg	*Momordica trifoliolata*	Cucurbitaceae	C	8	4	6
Sesa	*Albizia gummifera (J.F.Gmel)C.A.Sm.(1930)*	Fabaceae	T	8	4	8
Nechhareg	*Staphania abyssinica*	Menispermaceae	C	5	2.5	5
Qetet	*Verbascum stelurum Murb(1933)*	Scrophulariaceae	C	9	4.5	9
Debas tek	*Myrica salicifolia*	Myricaceae	T	10	5	7
Doqima	*Syzygium guineense (Willd) DC.(1828)*	Myrtaceae	T	10	5	4
Enkoy	*Ximenia americana L.*	Olacaceae	T	29	14.5	10
Mognqentafa	*Entada abyssinica*	Fabaceae	C	22	11	4
Wangesh	*Brucea antidysenterica*	Simaroubaceae	S	5	2.5	3
Yewof sholla	*Ficus ovata (Vahi)*	Moraceae	T	6	3	6
Endod	*Phytolacca dodecandra*	Phytolaccaceae	C	11	5.5	4
Wonahy	*Securidaca longepedunculata*	Polygalaceae	S	4	2	3
Yetota miraq	*Pavella oliveriana*	Rubiaceae	S	43	21.5	7
Gorgorogirar	*Acaica pillspina Pic.-Sem.(1951)*	Fabaceae	T	17	8.5	8
Yeset qest	*Asparagus africanus*	Asparagaceae	C	9	4.5	5

koshim	*Dovyalis abyssinica(A.Rich) Warb*	Salicaceae	T	5	2.5	3
Lul	*Ekebergia capensis parrm*	Meliaceae	T	4	2	4
Birbira	*Millettia ferruginea (Hochst) Bak(1871)*	Fabaceae	T	6	3	3
Tobia	*Calotropis procera*	Asclepiadaceae	T	3	1.5	3
Kezkez	*Lippia adoedisis*	Verbinaceae	T	30	15	5
Azohareg	*Clematis simensis Fresen*	Ranunculaceae	C	8	4	5
Embis	*Allophylus abyssinica(Hochst) Radkofer*	Sapindaceae	T	3	1.5	3
Wondekushele	*Acanthus sennii Chiove*	Acanthaceae	S	6	3	3
Embuay	*Solanum marginatum*	Solaraceae	S	6	3	4
Bamba	*Ficus sycomorus L.*	Moraceae	T	13	6.5	5
Yeferenjtsid	*Cupressus lusitanica Mill(1768)*	Cupressaceae	T	3	1.5	3
Smiza	*Vernonia auriculifera Hiern*	Compcitae	S	145	72.5	6
Chibha	*Ficus thonningii Blume*	Moraceae	T	2	1	2
wulkifa	*Dombey torrida (J.F.Gmmel) P.Bamps(1962)*	Sterculiaceae	T	5	2.5	3
Tulsa	*Albezia schimperiana*	Fabaceae	T	4	2	2
Qey bahirzaf	*Eucalyptus camaldulensis dehnh(1832)*	Myraceae	T	8	4	3
Qeygirar	*Acacia ciseyal Del*	Fabaceae	T	8	4	10
Misrich	*Clerodedrum myricoid(Hochst)*	Lmiaceae	S	26	13	4
Nacha	*Maytenus senegalensis*	Celastraceae	C	12	6	7