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Woody plant species diversity of Shello Giorgis dry Afromontane forest, Farita district, West Amhara, Ethiopia

Abstract

The study was conducted in Shello Giorgis Afromontane forest, Farita District; Western Amhara Region, Ethiopia to investigate woody plant species diversity. The specific objectives of the study were to identify the indigenous woody plant species, regeneration status and to set priority list of woody plant species for the vegetation of the area. The data was collected using a systematic and predetermined sampling system with the main quadrate of 50mx 10m size and sub-quadrate of 10m x 2m size were established with in the main quadrate at the longest sides of both ends. A total of 40 plots within 20000m^2 were discovered and representative plant specimens with basic information were collected. The major land cover types of the study area belongs to open woodland, wooded shrub and bush land at lower and flat part of the vegetation area. In the vegetation area there are factors that cause deforestation and disturbance of forests, among the major disturbance factors grazing, cutting, increment of agricultural land and charcoal production take the priority. A total of 50 plant specimens were collected, pressed and dried; out of which 46 specimens were identified. Among the 30 seedling plant species recorded *Calpurnia aurea, Opuntia ficus-indica, Dodoaea angustifolia* and *Croton macrostachyus* respectively take the highest seedling density of the study area. In contrast no seedling densities were recorded in the plant species of *Celtis africana, Olea europaea*, *Buddleja polystachya* and *Premna oligotrricha*. This indicates appropriate conservation methods should apply to protect plants in the area.

Keywords: seedling, sapling, forest, vegetation, species

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Introduction

Ethiopia has grater geographical diversity ranging from 100m. a.s.l below sea level to 4600m.a.s.l. The highlands, defined as above 1500 m.a.s.l account 45% of the total area in the country[1] and also Ethiopia has a significant portion of its land area in the Dry afromontane forest and grassland complex vegetation type (DAF). The DAF is found scattered as small fragments in many cases and extensive coverage in few cases in the north, northwest, northeast, central, south, southeast and southwest highlands of Ethiopia.[2,3] While the low lands lies below 1500 account 55%. As a result 35% of the land might once have been covered by natural high forest was reduced to 2.7% in 1990s.[4,5] Forest in these wide agro-ecological zones provide socio-cultural; economic, environmental and biodiversity conservation values to human.[6,7] Tropical forests are vanishing and being degraded rapidly due to accelerated human population growth. Forest clearing, overgrazing and luck of proper policy framework are also the major factors that contribute to loss of forest resource in the country.[8,9] Forest degradation in quality (species reduction) and quality (shrinkage in volume/area) are threatening the biodiversity resource of the country. The main cause for degradation of Shello Giorgis forests in general, the poor policy of the government related to forests. To use the forest in sustainable way, setting priority for the threatened species in vegetation types and conservation of the forest is crucial. Therefore, the main objective of the study was to undergo inventory of indigenous woody plant species and to assess the regeneration status and to set conservation priority in Shello Giorgis forest.

Materials and methods

Description of the study area

Shello Giorgis forest is located in Farita District South Gonder Zone of Amhara Regional State, Ethiopia (Figure 1). The District is located at 100km north of the Regional capital city Bahir Dar and 660km north of Addis Ababa. Geographical location of the area ranges between 11^0 59' 34.8" - 11^0 59' 26.5" N and 37^0 59' 12.5" - 37^0 59' 42.1" E.

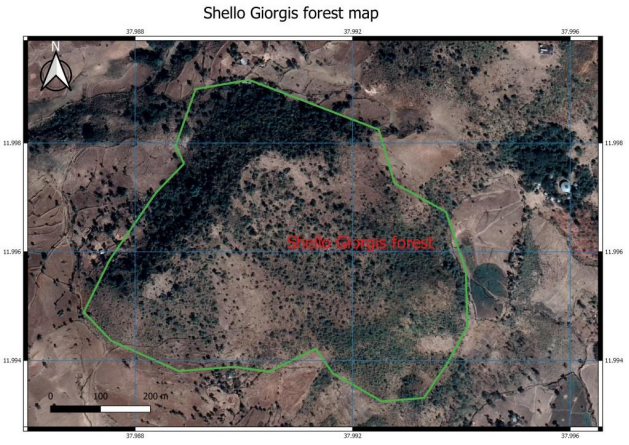

Figure 1 Shello Giorgis forest map.

Materials

Materials used during the study were; compass, measuring tap, digital camera, not book, data sheet, GPS (global positioning system), DSH/DBH measurement (caliper) and meter.

Methods

Sampling system and design: To get the general view about the vegetation of the forest was inventoried during 2008/2015 for 15 respective days in Shello Giorgis. Systematic and predetermined sampling systems were followed. Data were collected in the main quadrate of 50mx 10mx size and a sub-quadrate of $10mx^2$ size was established within the main quadrate at the longest sides of both ends. A total of 40 plots within $20000m^2$ were discovered and representative plant specimens with basic information were collected.

Transect and quadrate layout

Four transect were laid along the gentle to flat landscapes perpendicular to the baseline. The gravel rods either crossing or bordering the vegetation were used as a base line. The forest and the second transect were laid to the north east, the 3rd to the southeast, the 4th and the 5th laid to the south east direction. The transect were 200m far apart each other and the quadrates were established with regular interval of 200m from each other. In general a total of 4 transects, 40 quadrates were used to collect the inventory data from the Shello Giorgis.

Data collection

Topographic characteristics; slop gradient and depth, slop position and aspect were collected following the woody plant species diversity assessment field manual prepared by Ethiopian Institute of Biodiversity (EBI).

Results

Environmental data

Land use/land cover: The major land cover types of the study area belong to open woodland, wooded shrub land and bush land. The major factors recorded during the study were grazing, deforestation, agricultural explanation, charcoal production and highly increment of invasive plant species.

Forest disturbance

The vegetation of northwest Ethiopian highlands has been subject to severe disturbance regimes such as deforestation for settlement and agriculture; over utilization such as selective logging and over grazing; and manmade fires since human antiquity.[10–12] Even though the disturbance regimes vary from place to place, the consequences have been of similar nature and as a result many areas are now devoid of vegetation or only few trees and shrubs are found scattered on mountain ranges, agricultural fields and grazing areas. Despite this fact, some forest fragments still exist in abandoned agricultural areas, sacred areas such as churches, protected areas such as priority forests areas and national parks and in inaccessible areas such as mountain chains with high slopes. On this virtue, there are biotic and abiotic factors for disturbance of forests. Among biotic factors human interference take priority like agricultural explanation, charcoal production and wounding the bark of the plant. The collected data result showed that 49%cutting and 51% grazing takes the highest influence in Shello Giorgis forest (Table1).

Geographical aspect

The geographical and topographical aspect with three slop position upper, middle and lower including altitude ,slop gradient, aspect, soil depth and bearing of the study area is shown in Table 2.

Table 1 Major factor for forest disturbance

Factors for forest disturbance	Disturbance scale				
	1&2 negligible	3 light	4 moderate	5intensive/ heavy	Total%
Cutting		13.3	22.8	13.4	49.5
Grazing		10	25.5	15	50.5

Table 2 The geographical and topographical aspect of the study area

Slop position	Altitude (m.a.s..l)	Slop gradient (%)	Aspect	No of quadrate	Forest disturbance type	Forest disturbance intensity	Proportion of sample plot (%)
upper	2199-2296	28-Mar	NE,N,WE,S,SE	8	Grazing and cutting	light	33.3
middle	2155-2264	Oct-32	N,E,S,W	7		Moderate, shallow	29.1
lower	2146-2246	Oct-32	W,NE,E,SE	9		Moderate, shallow	37.5
total				24			100

Floristic

From the study area of shello forest, a total of 50 plant specimens were collected; out of which 46 species were identified which belonging to 14 families with frequently recorded of Fabaceae.

Structure

Species dimension

Among the collected plant specimen maximum height was recorded by *Acacia tortilis* and *Inula paniculata* 10.25m and 10 m respectively.

In contrast *Osyris quadripartita* 3m species was the minimum height recorded. In terms of DBH/DSH class *Croton macrostachyus* reaches 80 cm. and the least of DBH/DSH *Acacia Senegal* 2.8 and *Osyris quadripartita* reached 3 m.

Species frequency

As it is illustrated in Figure 2, the species frequency ranges between 25-97%. The greater number of frequency recorded by *Combretum molle, Croton macrostachyus Calpurnia aurea*. While, *Cadaba farinosa, Allophylus abyssinicus, Ximenia americana,Terminalia brownii* and *Colutea abyssinica* take the lowest. Therefore, the result showed that highest % of species less compared to the low class species.

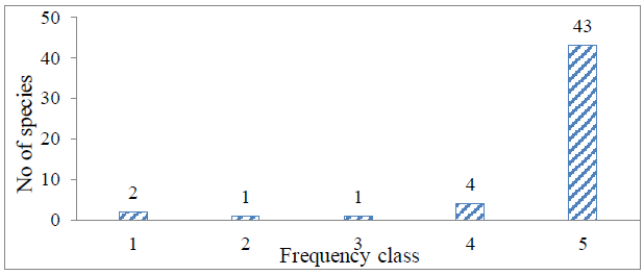

Figure 2 Frequency classes of species.

Species density

During the survey the species density of Shello Giorgis forest ranges between 0.5-659 per ha. The greater no of density was recorded as *Calpurnia aurea* (659.5), *Dodonaea angustifolia*(161) and *Croton macrostachyus* (257.5), on the other hand the lowest relative density (<0.5) recorded species such as *Ficus sycomorus, Acacia abyssinica, Osyris quadripartite.* The result showed that there is significant variation among individuals trees/shrub species in density and relative density per ha with the diameter size greater than 10cm DBH/DSH 173.5 and greater than 20 were 68 DBH/DSH with the ratio 2.55. Total species density recorded during the study was 1512.5 (Table 3).

Stand diameter and height profile

Stand diameter profile

Comparison and interpretation of diameter class were formed in to Ten; A(2.5-5 cm), B(5.1-10cm),C(10.115 cm), D (15.1-20 cm), E(20.1-25) F(25.1-30)G(30.1-35),H(35.1-40), I(40.1-45 cm) and J(>45cm) The total result of diameter analysis profile data showed that 73.9% tree/shrub fallen in diameter class A, 73.9% B, 17.4% C, 4.0% D, 2.0% E, 0.9% F, 0.6 G, 0.3% H, 0.5% I, 0.3% and J 0.2%diameter classes (Figure 3).

Table 3 Density class and distribution of the species

Species density class	Total density	Relative density	No of species	Percentile (%)
A(>100)	1078	71.4	3	5.88
B(50.1-100)	130.5	8.6	2	3.92
C(20.1-50)	138	9.1	5	9.8
D(1-20)	162.5	10.8	34	66.67
E(<1)	3.5	0.2	7	13.73
Total	1512.5	100	51	100

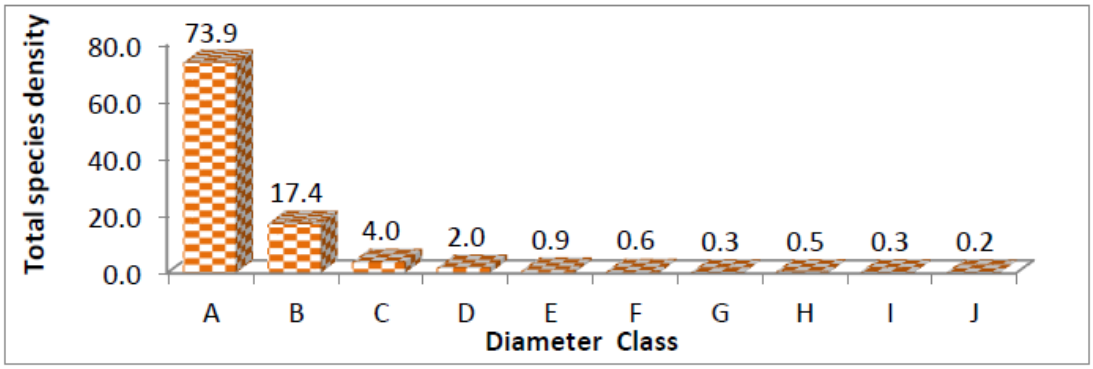

Figure 3 Species density by diameter class.

Stand height profile

In terms of stand height profile the height class was formed in to 4 groups ; <5m, 5.1-10m, 10.1-15m and 15-20 m. majority of species height class belongs to <5m while; no species were recorded 15.1-2m height. The possible reason could be that selective mature tree cutting intensive browsing and moisture deficit. And also kind of population pattern was also obtained by[13] in Afromontane rainforest areas indicating a high proportion of individuals in the lowest height class and few individuals in the largest height class. Height class of plant species recorded during in the study area shown in the following Figure 4.

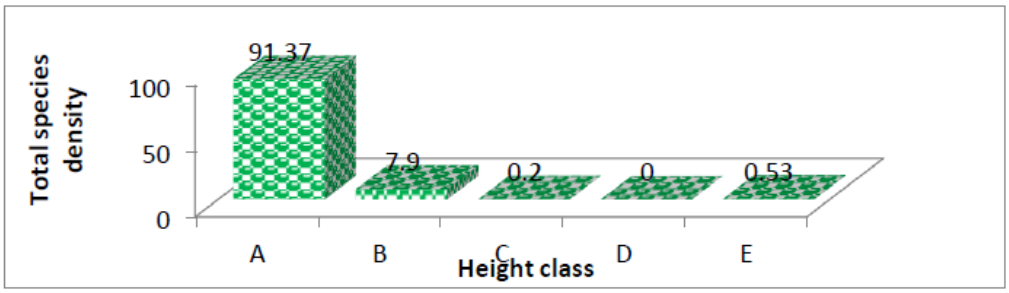

Figure 4 Species density by height class.

Table 4 Woody plant species under the IVI class category

No	A(<1)	B(1.1-7)	C(7.1-13)	D(13.1-19)	E(>19.1)
1	*Acacia abyssinica*	*Ekebergia capensis*	*Bersama abyssinica*	*Combretum molle*	*Crotonmacrostachyus*
2	*Osyris quadripartita*	*Grewia ferruginea*	*Euclea schimperi*		*Calpurnia aurea*
3	*Gardenia ternifolia*	*Zefek*	*Cadaba farinosa*		
4	*Cheba meni*	*Cheba gerar*	*Lannea fruticosa*		
5	*Prunus africana*	*Brucea antidysenterica*			
6	*Acacia seyal*	*Ximenia americana*			
7	*Allophylus abyssinicus*	*Olea europaea*			
8	*Colutea abyssinica*	*Buddleja polystachya*			
9	*Terminalia brownii*	*Causena anisata*			
10	*Dichrostachys cinrea*	*Premna oligotrricha*			
11	*Ficus carica*	*Dederae*			
12	*Acacia tortilis*	*Opuntia ficus-indica*			
13	*Dombeya torrida*	*Pterolobium stellatum*			
14	*Inula paniculata*	*Carissa spinarum*			
15	*Acacia senegal*	*Acokanthera schimperi*			
16	*Albizia gummifera*	*Entada abyssinica*			
17	*Celtis africana*	*Rhus glutinosa*			
18		*Maytenus ovata*			
19		*Capparis tomentosa*			
20		*Ficus thonningii*			
21		*Stereospermum kunthianum*			

Basal area and dominance of woody plant species

The total area for the inventoried Shello Giorgis forest was represents 132m^2 per ha. *Dichrostachys cinrea(*0.13m^2)(recorded the biggest basal area whereas, species like *Carissa spinarum, Maytenus ovate, Lannea fruticosa* are showed the least mean basal area coverage (0.001m^2). Among the top dominant woody plant species recorded during the study *Acacia tortilis, Terminalia brownii* and others ranging from 0.102-0.0132m^2/ha.

Important value index

In the study area important value index result varies between minimum 0.432 and maximum 123.14. Among the species the highest ivx were recorded by *Calpurnia aurea* (123.141), *Croton macrostachyus*(39.78) and *Combretum molle*(14.67) and the lowest ivi recorded *Allophylus abyssinicus, Prunus Africana* and *Acacia seyal*.

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Species population structure

Species population structure represented by the evaluation of the diameter class total species density distribution as an inventoried J-shaped curve which a pattern of total density distribution has highest the evaluation of selected individual species also revealed two main patterns of population distribution. 1, inverted J-shape curve for general trend of the diameter class total density distribution and shows the pattern which has the highest species density distribution in the lower diameter class and a gradual decrease towards the higher classes; 2. Bell shaped curve for which is type of density distribution in which it is high in the middle diameter classes and lower in the lower and higher diameter classes (Figure 5).

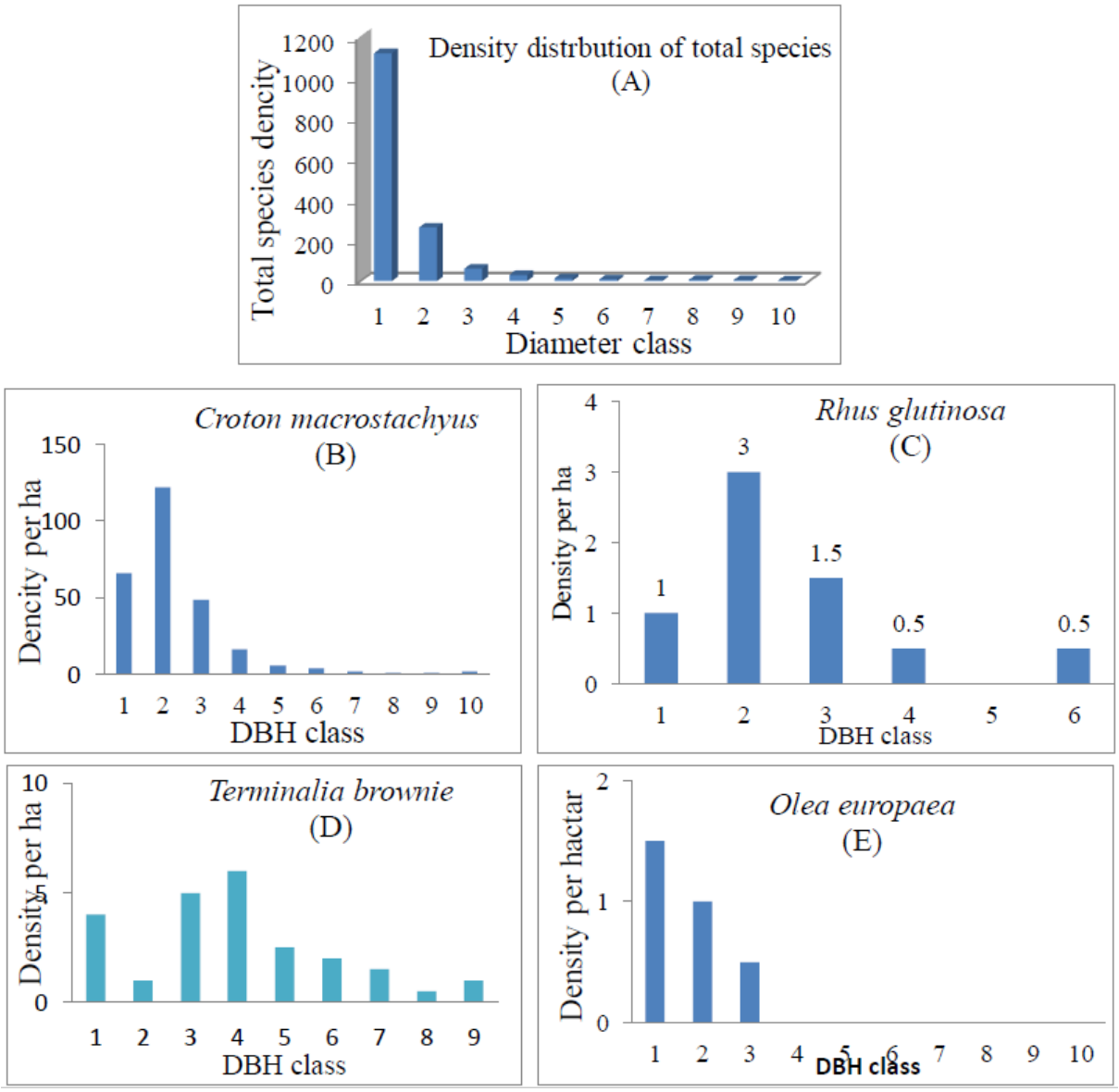

Figure 5 Diameter class density distributions of total and selected tree species.

Regeneration status

The primary and important regeneration stage for plant is seedling. During this study there were 30 plant species seedling data were recorded. Among them greater seedling density were recorded by *Calpurnia aurea*(54), *Opuntia ficus-indica*(29), *Dodonaea angustifolia*(23); least seedling recorded by *Ficus carica, Dombeya torrida* and no saddling were recorded species like *Celtis Africana* and *Olea europaea* plant species. The sapling status recorded during the study showed 21 plant species. Among all *Calpurnia aurea, Dodonaea angustifolia* and *Croton macrostacyus* take high in number of sapling and species like *Ficus carica, Gardenia ternifolia* not recorded sapling data during the study. The observation result showed that during the study the reason for absence of seedling and sapling were browsing and grazing.

Vegetation environment relation

Floristic richens by altitude

The forest geographically located altitudinal ranges from 2146-2296 m.a.s.l in highland agro ecological zones. The forest has no much altitudinal variation that may affect the distribution and richness of woody plant species in the area. So the result showed that the floristic richness in relation to the altitudinal variation indicated little or some effect on the extent of species richness (Figure 6).

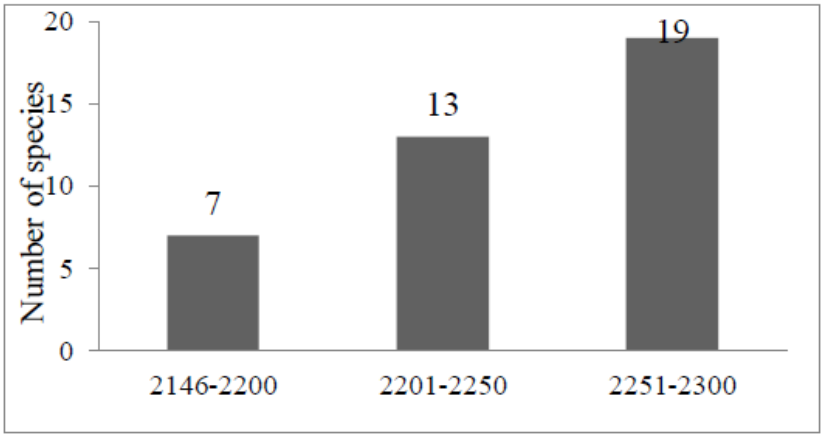

Figure 6 Altitudinal class of the forest.

Floristic richness by aspect

The study area geographical aspects were north belongs to East 31.58%, South 5.26%, West 39.47%, Southeast 5.26%, 7.89% North and Northeast 10.58% direction of the forest. No species were recorded in northwest, southwest and southeast directions.

Floristic richness by slop gradient

The species occurrence analysis by slop gradient revealed that A 16 species that contains 39.4%, B 8 species 32.9%, C 3 species 15.1% and D 12 species 12.6%.

Discussion

A total of 50 plant species were collected from the study area. Out of them 46 plant species belonging to 14 families were identified and the rest plant were recorded by their local name. The forest belongs to open woodland shrub and bush land at the lower and flat parts of the vegetation. There are factors affect the forest like cutting and browsing. The regeneration status of seedling and sapling could be related with the forest disturbance besides the environmental catastrophes. The important of regeneration seedling is to ensure the conservation in sustainable way. Similar study conducted[14] seedling and sapling conservation needed for the regeneration sustainability in the forest. During the study the height class analysis also depicted that there is a higher total density in the lower classes and then this decreases towards the higher classes. Study conducted[14] in afromontane forest indicating high proportion of individuals in the lowest height class and few individuals in the largest height class. The species whose height exceeds 13m belongs to the upper story comprising about 0.53% between 7-12m middle stratum 8% and lower layer 91% in proportion from woody plant species inventoried in Shello Giorgis forest. Study conducted by[15] there are species which appearing in each stratum such species called species with regular vertical distribution.[16,17]

Conclusion

Shellow Giorgis forest belongs to the dry afromontane forest type of ecosystem. The forest is under population pressure largely because of intensive farming system is exercised in the border of the forest area. The main attributing factors towards the distribution were recorded as browsing grazing and selective exploitation of mature wood for house construction. This factor have caused the stunted growth and thereby the absence of the floristic composition at the higher diameter and height class. Furthermore, due to these factors and probably due to the natural factors like drought invasive alien species the regeneration status of most economically important woody plant species is not sufficient. This raises the question of 'could this vegetation continue in perpetual way keeping its optimal productivity without losing its floristic richness'. Setting species in categorized <1 need priority to conserve the woody plant species using either in-situ or ex-situ conservation methods. In general the forest requires monitoring and management efforts in sustainable way.

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Conflicts of interest

The author declares there are no conflicts of interest.

References

1. GSE. Geology of Ethiopia. Ethiopian Ministry of Mines and Geological Survey of Ethiopia. A3 Map. 2010.
2. Zerihun Woldu. Forests in the Vegetation Types of Ethiopia and their Status in the Geographical Context. In: Abebe Demissie, et al. editor. *Forest Genetic Resources Conservation: Principles, Strategies and Actions*. Proceedings of the National Forest Genetic Resources Conservation Strategy Development Workshop. 1999.

3. Friis I, Sebsebe Demissew, Breugel PV. *Atlas of the Potential Vegetation of Ethiopia*. The Royal Danish Acadamy of Sciences and Letters. Natural habitats. 2010; 1–315.
4. Molla Mekonnen. EFAP (Ethiopia forestry action program EFAP, Addis Ababa. 1994.
5. EPA's report on the environment (2003 draft).
6. Mohammed Gedefaw, Teshome Soromesa. Status and woody plant species diversity in Tara Gedam forest north Ethiopia. *Science technology and arts research journal.* 2014;3(2):113–118.
7. Tamert Bekele. Phytosociology and ecology of humid afromontane forest in the central plateaus of Ethiopia. *J Veg Sci.* 1994;5(1):87–98.
8. Amanuel Ayanaw, Gemedo Dalle. Woody species diversity structure and regeneration status of Yemerehane Kirstose church forest of Lasta district north Wollo zone Amhara region Ethiopia. *International journal of forestry research.* 2018;(8).
9. Azene Bekele, Tesema Biraie, Ann Tengnas. Useful trees and shrubs for Ethiopia. Identification, propagation and management for agriculture and pastoral communities. 1993.
10. Taye Bekele, Haase H, Teshome Soromessa. Forest Genetic Resources of Ethiopia: Status and Proposed Actions. In: S Edwards, Abebe Demissie, et al. editors. *Proceedings of Forest Genetic Resources Conservation: principles, strategies and actions*. Institute of Biodiversity Conservation and Research, Addis Ababa. 1999.
11. GTZ. Inventory Methodology for Diversity of Woody Plants. Forest Genetic Resources Conservation Project. Institute of Biodiversity Conservation, Addis Ababa. 2002.
12. Demel Teketay. Seed and Regeneration Ecology in Dry Afromontane Forests of Ethiopia: I. Seed production - population structures. *Journal of Tropical Ecology.* 2005;46(1):29–44.
13. Feyera Senbeta. Biodiversity and Ecology of Afromontane rainforests with wild *Coffea arabica L.* populations in Ethiopia. *Ecology and development Series*. 2006.
14. Badege Bishaw. Deforestation and land degradation on the Ethiopia highlands: strategy for physical recovery. 2001.
15. Lamprecht H. Siliviculture in the tropics: tropical forest ecosystem and their speciesv possibilities and methods for their long term utilization. Deutsche gesellschaft for technishe zusammenarbeit (GIZ) gmbheschbom. 1989;296.
16. Curtis JT, Mclntosh RP. An upland forest comtinum in the prairie forest border region of Wisconsin. *Ecology*. 1951;32(3):476–496.
17. Khan MI, Ecker DJ, Butt T, et al. A vector for construction of gene libraries and the expression of heterologous genes in saccharoyces cerevisiae. *Plasmid.* 1987;17(2):171–172.