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Research Article

Assessment of Wood Production and Structural Composition of Domboma Community Based Forest in Dasse Chiedom, Moyamba District, Sierra Leone

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Abstract: This research was carried out in August and September 2020 in the Domboma community-Based forest of Domboma community in Dasse chiefdom, Moyamba district, southern Sierra Leone. The objective of the study was to assess wood production and structural composition of Domboma community Based-forest in Dasse Chiefdom, Moyamba District. The systematic sampling design was adopted and data were collected in 12 circular sample plots with a radius of 10 m and an area of 0.031 ha. The stand was divided into four transects that were 50 m apart and the interval between sample plots in any transect was 10 m. In total, 12 plots covering a sampling area of 0.38 ha were laid out. In each plot all trees ≥ 10 cm diameter at breast height (DBH, 1.3 m above ground level) were measured for both DBH and total height, using diameter tape and suunto hypsometer, respectively. The species was identified for every measured tree either directly by botanical name or by local names. The total individual trees enumerated were 147. These individual trees were distributed into four diameter classes as follows; 76 trees in diameter class 1, 33 trees in diameter class 2, 4 trees in diameter class 3 and 34 trees in diameter class 4. The Shannon-wiener index of diversity calculated was 3.38 using natural logarithm for the four diameter classes. The index of dominance was 0.76 and the index of dispersion estimated was 16.0 for all diameter classes respectively. The average (DBH) and height of trees were 51.17cm and 27.06m respectively. The basal area and wood volume were 241.35m^2/ha and 31227.62m^3/ha respectively and the stocking was 390 stems ha^{-1}. The 26-tree species found in all the 12 plots were listed in IUCN redlist categories as follows; 19.2% as data deficient (DD), 57.7% as least concerned (LC), 3.8% as nearly threatened (NT), 11.5% as vulnerable (VU), 7.7% as endangered (EN) and none of the species was classified as critically endangered.

Keywords: Basal area, diameter, wood volume, IUCN red list, vulnerable.

Introduction

Forest inventory is the systematic collection of data and forest information for assessment or analysis; it is a systematic collection of data because there are procedures or steps to follow during data collection to ensure accuracy and precision. Forest inventory assesses tree and forest resources, it also provides qualitative and quantitative information on extent, state, use, management of the resources and enhances forest planning; it promotes sustainable forest management through the provision of information about the forest characteristics. Most forest inventories have been, and will continue to be, focused on timber estimation. However, the need for information on forest health,

water, soils, recreation, wildlife and scenic values, and other non-timber values has stimulated the development of integrated or multi-resource inventories. When non-timber information is required, specialists in the pertinent fields should cooperate in planning and executing the inventory. A complete forest inventory for timber evaluation provides the following information: estimates of the area, description of topography, ownership patterns, accessibility, transportation facilities, estimates of timber quantity and quality, and estimates of growth and drain.

Forest inventory serves as a very important tool in forest management; it provides the data for planning, monitoring, evaluation, research, growth and yield, timber sale. It is an attempt to describe quantity, quality and stocking density (diameter distribution) of forest trees and many characteristics of land upon which trees are growing towards the efficient and sustainable management of the forest ecosystem. Zerihun and Yemir, (2013), reported that forest inventory is defined in different ways by different authors, but essentially with more or less the same meaning. Forest inventory: is a tool that provides the information about size and shape of the area as well as qualitative and/or quantitative information on the growing stock within the forest ecosystem. Forest inventories are designed to measure the extent, quantity, composition, and condition of forest resources, (Kangas *et al.,* 2006).

Wulder *et al.,* (2008), stated that support of sustainable forest management, up-to-date forest inventories are required to assess the composition, structure, and distribution of forest vegetation that, in turn, can be used as base information for management decisions. He also reported that at the operational level, forest inventories are used for harvest planning, road layout, assessment of growing stock, and planning of silvicultural activities. At the strategic level, forest inventories provide data for long-term forest management plans and, in concert, support a multitude of decisions relevant to forest protection and wildlife management.

Methodology

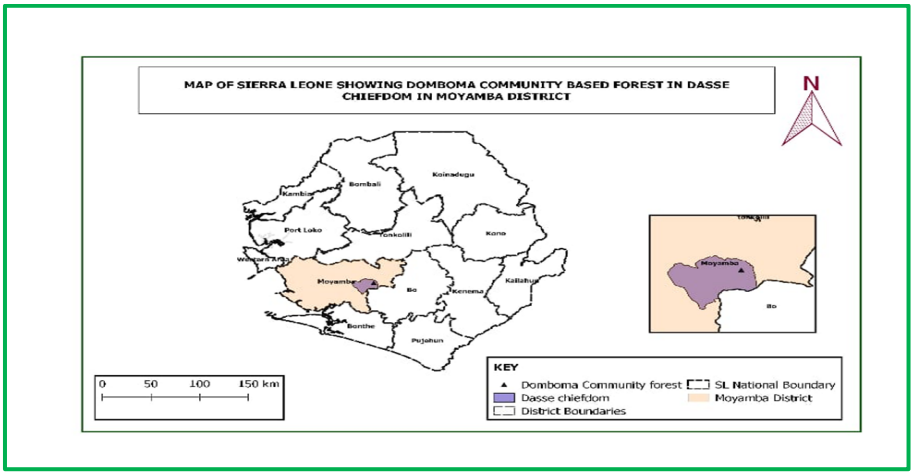

Figure 1. Map of Sierra Leone indicating Domboma Community-Based forest

Description of study area

The research was conducted in August and September 2020 in the Domboma community-Based forest of Domboma community in Dasse chiefdom, Moyamba district, southern Sierra Leone. Dasse chiefdom is one of the largest chiefdoms in Moyamba districts. It is geographically located along the south northern region axis. This area has an estimated population of 13,217 (2015 census) Domboma community is located along the Mano Dasse highway. Domboma experiences a different rainy and dry season. The monomodal rainy last from April to November while the dry season extends from December to March. The mean monthly air temperature ranges from 21^0C-23^0C maximum for the greater part of the day and night. Average rain fall which is synonymous to the district ranges from 3,330mm to 4000mm with mean maximum temperature of 29^0C to 30^0C (Jusu, 1990). The vegetation belts comprise mainly forests, freshwater, swamps or inland valley swamps and extension

biome of which sometimes could be used for rice farming, arable cropping and vegetable production (Jusu, 1990). The soil ranges from clay to loamy. Majority of the people in this chiefdom depend on this type of soil for their farming as a way of sustaining their lives (Jusu, 1990).

Description of the forest

The forest was established on 27 March 2017. The size of the forest is 51.0ha, thus is referred to as rainforest in which a complex community whose framework is provided by trees of many sizes. Within the forest, the microclimate differs from that outside. There is high humidity and temperature is relatively lower. Many of the smaller trees grow under the shade of the larger ones. Upon the framework of the trees and within the microclimate of the forest, are growth a range of other kinds of plants such as climbers, epiphytes, strangling plants, parasites and saprophytes.

Sampling design

Circular sample plots were used, each with a radius of 10 m and an area of 0.031 ha. In order to cover part of the area of the stand, the systematic sampling design was adopted for this study. The stand was divided into four by transects that were 50 m apart and the interval between sample plots in any transect was 10 m. In total, 12 plots covering a sampling area of 0.38 ha were laid out. This was a simplified method of Nduwamungu (1996). In each plot all trees ≥ 10 cm diameter at breast height (DBH, 1.3 m above ground level) were measured for both DBH and total height, using diameter tape and Haga altimeter, respectively. The species was identified for every measured tree either directly by botanical name or by local names which were later translated (Deighton, 1957; Savill and Fox, 1967). The species name of every tree was recorded.

Data Collection

In each plot all trees greater than and equal to 10cm diameter at breast height (dbh) were measured for both dbh and total height, using diameter tape and Haga altimeter, respectively. Every tree species was identified either directly by botanical name or by local names which were later translated (Deighton, 1957). The species name of every tree was recorded.

Data analysis

The data was analyzed as stated below:

Species Richness

Species richness, i.e. the number of species in a community (Purvis and Hector, 2000; Smith and Smith, 2012; Taylor *et al*., 2013) was calculated as the total number of species per hectare. Further, calculation included index of diversity and the other indices as follow.

Shannon-Wiener index of diversity

It is a measure of the information content of sample (bits per individual) and the information content is a measure of the uncertainty. The larger the value of H', the greater the uncertainty. The Shannon-wiener function is calculated in accordance with (Krebs, 1989; Kent and Coker, 1992; Nolan and Callahan, 2006):

$H' = - \sum p_i (\ln p_i)$

Where

H'= species diversity index,

p_i = proportion of individuals belonging to the ith species in the dataset,

ln = natural logarithm.

Index of dispersion

Krebs (1989) states that this is the simple method of detecting vegetation pattern and then test its goodness of fit with the chi-square (χ^2). That is, a measure of the extent to which a set of observed numbers of plants in randomly distributed quadrants follows a Poisson distribution (Upton and Cook, 2008). The variance-to-mean ratio, which is also called dispersion index, is calculated as follows:

Index of dispersion (I) = variance (s^2)/mean ($\bar{x}$).
The variance-to-the mean ratio is a good (if not the best) measure of dispersion. The chi square (χ^2) to test the goodness of fit of the index of dispersion is calculated as follows:
$\chi^2 = I^*(n-1)$
Where,
s^2 = sample variance
$\bar{x}$ = sample mean
I = index of dispersion
n = number of sample plots
n–1 = degrees of freedom.

Index of dominance (C)
As reported by Krebs, (1989); Misra, (1989) the dominance index (C) measures the distribution of individuals among the species in a community. It is calculated using the formula below:
$C = \sum (n_i/N)^2$
Where n_i = number of individuals of species íth in the sample;
N = total number of individuals (all species) in the sample

Wood production parameters
Data analysis for wood production parameters was carried out at four diameter classes as follows:
Diameter Class 1: 10 cm ≤ DBH ≤ 20 cm,
Diameter Class 2: 20 cm < DBH ≤ 30 cm,
Diameter Class 3:30< DBH ≤40 cm.
Diameter Class 4: DBH> 40
The quantitative metric data was used to estimate three parameters for wood production: the number of stems ha^{-1} (N), the basal area ha^{-1}(G) and the wood volume ha^{-1} (V) (Mattia *et al.,* 2015).

Number of stems ha^{-1}
This was estimated using the formula (Mattia, 1997; Mattia and Kargbo, 2013):
$N = (1/n)*\sum (x_i /a_i)$
Where,
N = number of stems ha^{-1}
n = number of plots
x_i = number of stems in plot
a_i = area of plot in ha

Basal area ha^{-1}
The formula used was (Philip, 1983): $G = (\sum g_i) /A$
Where $g_i = (\pi\ d_i^2) / (40\ 000)$
A is total sampling area (ha), d_i is DBH (cm) and g_i is basal area of stem i respectively.

Wood volume ha^{-1}
This was estimated using the formulae (Philip, 1983):
$V = \{\sum (\sum v_{ij})\}/na$, and $v_{ij} = g_i h_i f$

Where,
V = average volume ha^{-1} in m^3 estimated from n samples each of a hectare,
v_{ij} = volume of individual standing tree measured on the i^{th} plot,
g_i = basal area (m^2) as defined above,
h_i = total height (m) of stem i
f = form factor.

Form factor of 0.562 from Mattia (1997) for natural mangrove forest in Tanzania was employed.

Results

Plant species richness and composition

Tree species

The total individual trees enumerated were 147. These individual trees were distributed into four diameter classes as follows; 76 trees in diameter class 1, 33 trees in diameter class 2, 4 trees in diameter class 3 and 34 trees in diameter class 4 (Table 1). The estimated percentage individuals were 52%, 22%, 3%, and 23% in diameter classes 1, 2, 3, and 4 respectively. The total individual trees identified belong to 26 specie (Table 2) in which 21 species falls in diameter class 1, 12 species in diameter class 2, 4 species in diameter class 3 and 10 species in diameter class 4 (Table 1). 8 Species were found to be common to both diameter class 1 and 2, also 4 species were found in diameter class 2 and 3, and two were also common to diameter class 3 and 4**,** and only one species was found to be common in all of the four diameter classes.

Table 1. Plant species richness and composition

Diameter Classes	Nos. of Plots	Total number of individuals	% individuals	Nos. of species
Class 1	12	76	51.70	21
Class 2	12	33	22.45	12
Class 3	12	04	2.72	04
Class 4	12	34	23.13	10
Total		**147**	**100**	-

Table 2. Scientific, Local and family names of trees in Domboma Community-Based forest

No.	Species	Local names	Families	Counts (ni)
1	*Acioascabrifolia*	Nyɛgai	Rosaceae	12
2	*Afzelia spp*	kpɛndɛi	Caesalpiniaceae	2
3	*Albizia ferruginea*	Gano-kpakpei	Mimosaceae	3
4	*Berlinia spp*	sakpɛi	Caesalpiniaceae	8
5	*Cleistopholis patens*	Moigbamei	Annonaceae	1
6	*Cola lateritia*	Bunei	Sterculiaceae	1
7	*Danielliathurifera*	Gbɛsiɛ	Caesalpiniaceae	1
8	*Dialiumguineense*	Mamboi	Caesalpiniaceae	6
9	*Elaeisguinensis*	Tokpoi	Areacaceae	2
10	*Funtumia africana*	Boiboi	Apocynaceae	16
11	*Gmelina arborea*	Yeamani	Verbenaceae	25
12	*Hunteria spp*	Kofei	Apocynaceae	1
13	*Lophiraalata*	Hɛndui	Caesalpiniaceae	1
14	*Hymenocardia spp*	Fagbanjoi	Euphorbiaceae	1
15	*Milletia spp*	Tɔlugbɛlei	Fabaceaae	4
16	*Ochthocosmus africanum*	TowanyƐi	Ixonanthaceae	33
17	*Ongokea gore*	Bui	Olacaceae	3
18	*Phyllanthus discoideus*	Tijoi	Euphorbiaceae	3
19	*Piptadeniastrum africanum*	Mbɛlɛi	Mimosaceae	2
20	*Pycnanthus angolensis*	kpɔyɛi	Myristicaceae	1
21	*Strombosia glaucescens*	Kovui	Olacaceae	1
22	*Trichilla heudeloti*	Njawei	Meliaceae	1
23	*Uapaca guinensis*	Kondii	Euphorbiaceae	16
24	*Brachystegia leonensis*	Singinii	Caesalpiniaceae	1
25	*Didelotia afzelii*	PelegblagƐi	Caesalpiniaceae	1
26	*Xylopia spp*	Hewei	Anonaceae	1
Total				**147**

Local names were translated to scientific from Deighton (1957).

Shannon-Wiener index of diversity (H^1)

The Shannon-wiener index of diversity calculated was 3.38 using natural logarithm for the four diameter classes. This calculated value was distributed into four diameter classes as 0.98, 0.95, 0.60, and 0.84 in diameter classes 1, 2, 3, and 4 respectively (Table 3). The computed diameter classes are shown in appendix 2.

Index of dominance (C)

The total calculated index of dominance was 0.76 and this was distributed into four diameter classes as follows; 0.18, 0.14, 0.25 and 0.19 in diameter classes 1, 2, 3, and 4 (Table 3). The various computed values are illustrated in appendix 3.

Index of dispersion

The index of dispersion estimated was 16.0 and was distributed as follows; 10.60, 2.12, 0.00, and 3.28 in diameter classes 1, 2, 3, and 4 respectively (Table 3). The calculated chi-square (x^2) values are shown in table 3.

Table 3. Summary of floristic characteristics

Parameters	Diameter Classes				Total
	1	2	3	4	
Area of a sample plots	0.031415	0.031415	0.031415	0.031415	**0.37698**
Number of individuals	76	33	04	34	**147**
Number of species	21	12	04	10	**47**
Shannon-Wiener indices	0.98	0.95	0.60	0.84	**3.38**
Index of dominance	0.18	0.14	0.25	0.19	**0.76**
Index of dispersion	10.60	2.12	0.00	3.28	**16.0**
Chi-square (X^2)	211.92	23.36	0.00	29.53	**264.81**

Wood production parameters

Diameter at breast height and tree height

The average diameter at breast height (DBH) was 51.17cm and the average height was 27.06m (Appendix 1). The relationship between diameter and height of trees is illustrated in figure 1.

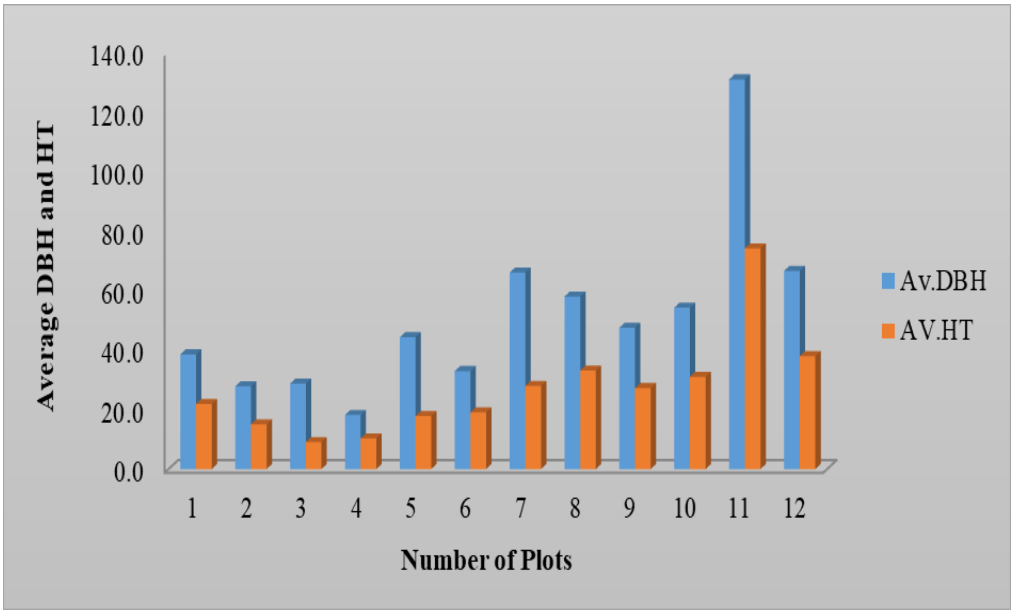

Figure 1. Relationship between diameter at breast height and height of trees per plot.

Basal area ha^{-1}

The basal area was 241.35m^2/ha and the estimated total value was distributed into four diameter classes as follows; 3.41m^2/ha in diameter class 1, 4.25m^2/ha in diameter class 2, 0.83m^2/ha in diameter class 3 and 232.86m^2/ha in diameter class 4 respectively (Table 4).

Wood Volume ha^{-1}

The estimated wood volume was 31227.62m^3/ha and this estimated wood volume was distributed into four diameter classes as follows; 18.44m^3/ha, 34.88m^3/ha, 9.12m^3/ha and 31165.17m^3/ha in diameter classes 1, 2, 3 and 4 respectively (Table 4).

Basal area vs wood volume

The co-efficient of determination (R^2) on the graph shows that there is strong linear relationship between the wood basal area and wood volume of the trees in the Domboma community-based forest.

A linear graph between basal area and volume is illustrated in figure 2 below.

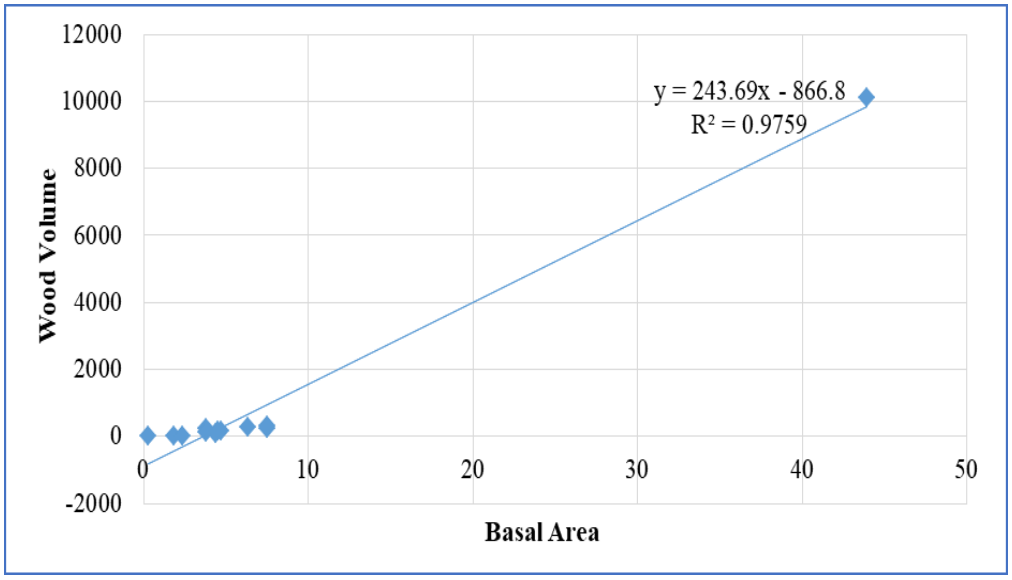

Figure 2. Regression of basal area and volume

Stocking ha^{-1}

The stocking was 390 stems ha^{-1}. This was distributed into four diameter classes as follows; 202 stems ha^{-1} in diameter class 1, 88 stems ha^{-1} in diameter class 2, 11 stems ha^{-1} in diameter class 3 and 90 stems ha^{-1} in diameter class 4 respectively (Table 4).

Table 4. Summary of wood production parameters

Parameters	Diameter Classes				Total
	1	2	3	4	
Basal area (m^2/ha)	3.42	4.25	0.83	232.86	**241.35**
Wood volume (m^3/ha)	18.44	34.88	9.12	31165.17	**31227.62**
Stocking (stem/ha)	202	88	11	90	**390**

Conservation status of tree species in Domboma community-based forest

The results of the 26-tree species found in all the 12 plots were listed in IUCN redlist categories as follows; 19.2% as data deficient (DD), 57.7% as least concerned (LC), 3.8% as nearly threatened (NT), 11.5% as vulnerable (VU), 7.7% as endangered (EN) and none of the species was classified as critically endangered (Figure 3).

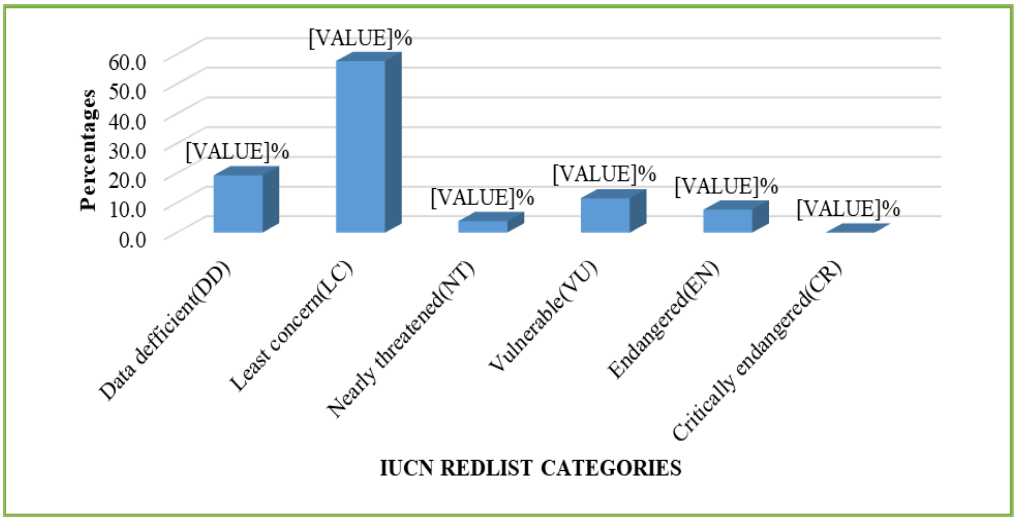

Figure 3. IUCN redlist categories.

Table 5. Tree species and their IUCN redlist categories.

No.	Species	Local names	Conservation status	Counts(ni)
1	*Acioascabrifolia*	Nyɛgai	Data deficient	12
2	*Afzelia spp*	kpɛndɛi	Nearly threatened (NT)	2
3	*Albizia ferruginea*	Gano-kpakpei	Vulnerable (VU)	3
4	*Berlinia spp*	sakpɛi	Data defficient (DD)	8
5	*Cleistopholis patens*	Moigbamei	Least concerned (LC)	1
6	*Cola lateritia*	Bunei	Least concerned (LC)	1
7	*Danielliathurifera*	Gbɛsiɛ	Least concerned (LC)	1
8	*Dialiumguineense*	Mamboi	Least concerned (LC)	6
9	*Elaeisguinensis*	Tokpoi	Least concerned (LC)	2
10	*Funtumia africana*	Boiboi	Least concerned (LC)	16
11	*Gmelina arborea*	Yeamani	Least concerned (LC)	25
12	*Hunteria spp*	Kofei	Data Diffecient (DD)	1
13	*Lophiraalata*	Hɛndui	Vulnerable (VU)	1
14	*Hymenocardia spp*	Fagbanjoi	Least concerned (LC)	1
15	*Milletiaspp*	Tɔlugbɛlei	Endangered (EN)	4
16	*Ochthocosmus africanum*	TowanyƐi	Data defficient (DD)	33
17	*Ongokea gore*	Bui	Least concerned (LC)	3
18	*Phyllanthus discoideus*	Tijoi	Least concerned (LC)	3
19	*Piptadeniastrum africanum*	Mbɛlɛi	Least concerned (LC)	2
20	*Pycnanthus angolensis*	kpɔyɛi	Least concerned (LC)	1
21	*Strombosiagl aucescens*	Kovui	Data deficient (DD)	1
22	*Trichilla heudeloti*	Njawei	Least concerned (LC)	1
23	*Uapaca guinensis*	Kondii	Least concerned (LC)	16
24	*Brachystegia leonensis*	Singinii	Vulnerable (VU)	1
25	*Didelotia afzelii*	PelegblagƐi	Endangered (EN)	1
26	*Xylopia spp*	Hewei	Least concerned (LC)	1
Total				**147**

Discussions

Tree species richness and composition

There was significant variability across the number of tree species in the four diameter classes. The number of the tree species decreases with increase in diameter classes. The highest number of trees occurred in diameter class 1 with 76 species and the lowest in diameter classes 3 with 4 species

(Table 1). The diameter class 1 was mainly made up of small diameter trees while diameter classes 2, 3 and 4 were made up of large diameter trees.

This is in collaboration with study of Salami and Akinyele (2018) that discovered highest number of trees for diameter class 10-19.9 cm (27.93%) at Gambari Forest. The higher number of tress in the diameter class 1 in the current study is an indication of high regeneration potentials of trees in the forest.

The Shannon-wiener index of diversity for Domboma community-based forest was 3.38. This index was fairly large compared to the index of diversity obtained in the National Agricultural Training Centre forest (2.47). This implies that the Domboma community-based forest is under proper management as compared to NATC forest (Table 1).

In a related study (Salami and Akinyele, 2017) the Shannon Wiener seems to be high with the value of 4.05. The reason for the high value in Omo Biosphere Reserve may be due to the proper monitoring and laws that guided the use of the Biosphere. This is in conformity with the value obtained for temperate forest which ranges from 1.16 and 3.40 (Pande *et al.,* 2001) and tropical forest where it can reach up to 5.40 (Parthasaranthy *et al.,* 1992). The Shannon-Wiener diversity index obtained is higher than the tree species diversity values in tropical forests of Kalakad Forest Reserve in Western Ghats which was reported to be between 3.31 and 3.69 (Parthasaranthy *et al.,* 1992).

The overall index of dominance was 0.76. This was distributed into four diameter classes as follows; 0.18, 0.14, 0.25, and 0.19 respectively (Table 3). The value obtained in the current was higher compared to what obtained in the NATC forest (0.56). This implies that there is higher chance of selecting the same species when chosen at random.

Wood production parameters

The overall number of stems per hectare was 390 stems ha^{-1} with mean DBH and height of 51.17cm and 27.06 m respectively (Appendix 1). There were 202 stems ha^{-1} in diameter class 1, 88 stems ha^{-1} in diameter class 2, 11 stems ha^{-1} in diameter class 3 and 90 stems ha^{-1} in diameter class 4 respectively (Table 4). This is in conformity with the study of Salami and Akinyele, (2018) that there were higher numbers of stems per hectare in the smaller diameter classes of 10-19.99 cm with population sizes of 105 trees in Omo Biosphere Reserve. Diameter ranges of 20- 29.9 cm had 73 trees/ha, while the diameter class of 30-39.9 cm had 51 trees/ha in Omo Biosphere Reserve. Lesser number of stems per hectare was recorded in diameter classes of 70-89.9 cm in study area.

The total basal area estimated was 241.35m^2/ha. This was distributed as 3.41m^2/ha in diameter class 1, 4.25m^2/ha in diameter class 2, 0.83m^2/ha in diameter class 3 and 232.86m^2/ha in diameter class 4 respectively (Table 4). In a related study by Salami and Akinyele, (2018) reported a basal area of 86.45 m^2 ha^{-1}, This value was fairly small compared to that obtained in the current study.

The estimated wood volume was 31227.62m^3/ha and this estimated wood volume was distributed into four diameter classes as follows; 18.44m^3/ha, 34.88m^3/ha, 9.12m^3/ha and 31165.17m^3/ha in diameter classes 1, 2, 3 and 4 respectively (Table 4). The wood volume obtained in the current study was fairly large compared to the wood volume of 306.62 m^3 ha^{-1} in Omo Biosphere Reserve.

Conservation status of tree species in Domboma community-based forest

The present study of the conservation status of tree species shows that more than half of the species are classified in one of the threat categories (i.e.DD, LC, NT, CR, EN and VU) under IUCN Red List standards. Nineteen species are listed as DD, and it is likely that these endemic taxa are also threatened, fifty-eight species are listed as LC, four species as NT, twelve species as vulnerable. Eight species as EN and no species was listed as CR.

In related study by (Rankou *et al*., 2015), a high extinction risk was recently documented in the Red List of the endemic monocotyledons of Morocco, an African country mainly characterized by a semi-arid climate, like Cape Verde. In both cases, > 70% of the assessed endemic flora was classified in high-risk categories (CR or EN). Unlike Morocco, the higher vulnerability of the Cape Verde endemic flora could be mainly explained by its tropical dry climate and by the increasing aridity that affects the islands, especially at lower elevations, which could have led to population reductions and restrictions on distribution ranges of the taxa.

Conclusion

In the study from 12 plots, 147 individual trees species belonging to 26 plant species and 14 families were identified. *Caesalpiniaceae* was found to be the most abundant and dominant family followed by *Euphorbiaceae*. The variation in species composition and diversity among the diameter classes could be because of different environmental factors (anthropogenic and natural). The forest contains some of commercially important plant species of Sierra Leone. For structural analysis, DBH records were classified in to class intervals and more number of individuals was recorded for the lower classes. The number of matured individuals (top class) were found to be low. The general distribution pattern of species population structure in the forest based on the DBH value revealed four structural patterns. This population dynamics within the forest revealed the signs of some disturbances and requires for management and conservation practices as soon as possible. The species diversity index and abundance obtained in this study compared favorably with similar forest ecosystems. The Shannon–Weiner diversity index (3.47) obtained from this research falls within the general limit of diversity index in tropical rainforest.

Ochthocosmus africanus and *Gmelina arborea* were the most abundant tree species encountered. The prominent tree sizes in the reserve were DBH sized class of 10-20 cm, which tend to dominate.

The community-based forest of Domboma is higher dense with tree species of high wood production potential that are of economic relevance. The wood volume estimated is high in comparison to any primary forest in the tropical region. The basal area obtained indicates that the wood productivity of the timber is high. The occurrence of high number of trees in the diameter class 1 is an indication of high natural regeneration with smaller sized trees.

Recommendations

a) To prevent the extinction of some families and species, urgent measures need to be taken to the increase the dwindling low density of some species and restock the forest reserve, particularly with species that were represented by only one stem per hectare.
b) It is recommended that more emphasis should be place on assessment (inventory) of forest and wildlife resources for up to date knowledge on endangered species.
c) Also, further inventory should be carryout in the forest estate for ease of planning and decision-making on forest production and products; this will help ecologists and Forest managers to envisage the distant future of our forest and its biodiversity for sustainable biodiversity.
d) There is need to manage this forest reserve sustainably in Sierra Leone. This is to maintain plant and animal species in the forest ecosystem.
e) Women do play a greater role in forestry but they are neglected in one way or the other. Women's program should be created to motivate them to participate in rural related forest activities.
f) We depend on forest for our survival, from the air we breathe to the wood we use. Besides providing habitat for animals and livelihoods for humans. Forest do play a vital role in the human lives, so there is need to protect the forest against forces that destroys it.
g) Inhabitants around the forest need to be educated on the dangers of wildfire and it associated effected on tree species biodiversity.

Conflicts of interest: There is no conflict of interest of any kind.

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Appendix 1. Tree basal area and volume per plot

Plot id	Basal area	Volume	Av. DBH	AV. HT	Stem Counts	Stem/ha
1	4.7	148.7532	38.6	21.9	20	636.5372
2	1.8	22.0654	27.8	15.0	13	413.7492
3	2.4	22.78664	28.7	9.1	12	381.9223
4	0.3	1.71432	18.2	10.3	10	318.2686
5	4.4	102.619	44.3	17.8	13	413.7492
6	3.8	233.2822	33.0	19.0	13	413.7492
7	7.5	221.1867	66.0	28.0	12	381.9223
8	7.5	322.9902	58.0	33.1	15	477.4029
9	3.8	141.0212	47.5	27.2	11	350.0955
10	4.5	168.0032	54.3	31.0	11	350.0955
11	43.9	10104.66	131.0	74.2	7	222.788
12	6.3	284.9798	66.6	38.0	10	318.2686
Total	**91.0**	**11774.06**	**614.02**	**324.69**	**147**	**4678.549**
BA/ha	**241.4**	**31232.59**	**51.17**	**27.06**		**389.8791**
Mean	**20.1**	**2602.716**				

Appendix 2A. Shannon wiener index of diversity in diameter class 1

Tree id	Species Names	ni	Pi=ni/N	logPi	Pi logPi
1	*Acioa seabrifolia*	11	0.144737	-0.83942	-0.1215
2	*Afzelia spp*	1	0.013158	-1.88081	-0.02475
3	*Berlinia spp*	1	0.013158	-1.88081	-0.02475
4	*Funtumia africana*	6	0.078947	-1.10266	-0.08705
5	*Uapaca guineensis*	7	0.092105	-1.03572	-0.09539
6	*Ochthocosmus africanus*	28	0.368421	-0.43366	-0.15977
7	*Daniellia thurifera*	1	0.013158	-1.88081	-0.02475
8	*Lophira alata*	1	0.013158	-1.88081	-0.02475
9	*Unknown*	1	0.013158	-1.88081	-0.02475
10	*Unknown*	1	0.013158	-1.88081	-0.02475
11	*Hunteria spp*	1	0.013158	-1.88081	-0.02475
12	*Strombosia glaucescens*	1	0.013158	-1.88081	-0.02475
13	*Cola lateritia var. maclaudi*	1	0.013158	-1.88081	-0.02475
14	*Hymenocardia spp*	1	0.013158	-1.88081	-0.02475
15	*Dialium guineense*	3	0.039474	-1.40369	-0.05541
16	*Ongokea gore*	1	0.013158	-1.88081	-0.02475
17	*Gmelina arborea*	5	0.065789	-1.18184	-0.07775

18	*Piptadeniastrum africanum*	1	0.013158	-1.88081	-0.02475
19	*Phyllanthus discoideus*	2	0.026316	-1.57978	-0.04157
20	*Millettia spp*	1	0.013158	-1.88081	-0.02475
21	*Trichilia heudelotii*	1	0.013158	-1.88081	-0.02475
Total		**76**			**-0.98491**
H^1 = -ΣPilogPi = 0.98491					

Appendix 2B. Shannon Wiener index of Diversity for Diameter class 2

Tree id	Scientific name	ni	Pi=ni/N	LogPi	Pi Log Pi
1	*Phyllanthus discoideus*	1	0.030303	-1.51851	-0.04602
2	*Gemelina arborea*	8	0.242424	-0.61542	-0.14919
3	*Pycnanthus angolensis*	1	0.030303	-1.51851	-0.04602
4	*Funtumia africana*	7	0.212121	-0.67342	-0.14285
5	*Ochthocosmus africanus*	4	0.121212	-0.91645	-0.11109
6	*Dialium guineense*	3	0.090909	-1.04139	-0.09467
7	*Cleistopholis patens*	1	0.030303	-1.51851	-0.04602
8	*Millettia spp*	2	0.060606	-1.21748	-0.07379
9	*Uapaca guineensis*	2	0.060606	-1.21748	-0.07379
10	*Acioasea brifolia*	1	0.030303	-1.51851	-0.04602
11	*Berlinia spp*	2	0.060606	-1.21748	-0.07379
12	*Elaeis guineensis*	1	0.030303	-1.51851	-0.04602
Total		**33**			**-0.94924**
H^1= - ΣPilogPi = 0.94924					

Appendix 2C. Shannon wiener index of diversity in diameter class 3

Tree id	Scientific name	ni	Pi=ni/N	LogPi	Pi Log Pi
1	*Gemelina arborea*	1	0.25	-0.60206	-0.15051
2	*Ochthocosmus africanus*	1	0.25	-0.60206	-0.15051
3	*Funtumia africana*	1	0.25	-0.60206	-0.15051
4	*Elaeis guinensis*	1	0.25	-0.60206	-0.15051
Total		**4**			**-0.60206**
H1= - ΣPilogPi = 0.60206					

Appendix 2D. Shannon Wiener index of Diversity for Diameter class 4

Tree id	Scientific name	ni	Pi=ni/N	LogPi	Pi Log Pi
1	*Albizia ferruginea*	3	0.088235	-1.05436	-0.09303
2	*Gemelina arborea*	11	0.323529	-0.49009	-0.15856
3	*Funtumia africana*	2	0.058824	-1.23045	-0.07238
4	*Uapaca guineensis*	7	0.205882	-0.68638	-0.14131
5	*Xylopia spp*	1	0.029412	-1.53148	-0.04504
6	*Millettia spp*	1	0.029412	-1.53148	-0.04504
7	*Ongokea gore*	2	0.058824	-1.23045	-0.07238
8	*Berlinia spp*	5	0.147059	-0.83251	-0.12243
9	*Piptadeniastrum africanum*	1	0.029412	-1.53148	-0.04504
10	*Afzelia spp*	1	0.029412	-1.53148	-0.04504
Total		**34**			**-0.84026**
H^1= - ΣPilogPi = 0.84026					

Appendix 3A. Index of dominance for diameter class 1

Tree id	Species Names	ni	(ni/N)	(ni/N)^2
1	*Acioasea brifolia*	11	0.144737	0.020949
2	*Afzelia spp*	1	0.013158	0.000173
3	*Berlinia spp*	1	0.013158	0.000173
4	*Funtumia africana*	6	0.078947	0.006233
5	*Uapaca guineensis*	7	0.092105	0.008483
6	*Ochthocosmus africanus*	28	0.368421	0.135734
7	*Daniellia thurifera*	1	0.013158	0.000173
8	*Lophiraalata*	1	0.013158	0.000173
9	*Unknown*	1	0.013158	0.000173
10	*Unknown*	1	0.013158	0.000173
11	*Hunteria spp*	1	0.013158	0.000173
12	*Strombosia glaucescens*	1	0.013158	0.000173
13	*Cola lateritia var. maclaudi*	1	0.013158	0.000173
14	*Hymenocardia spp*	1	0.013158	0.000173
15	*Dialium guineense*	3	0.039474	0.001558
16	*Ongokea gore*	1	0.013158	0.000173
17	*Gmelina arborea*	5	0.065789	0.004328
18	*Piptadeniastrum africanum*	1	0.013158	0.000173
19	*Phyllanthus discoideus*	2	0.026316	0.000693
20	*Millettia spp*	1	0.013158	0.000173
21	*Trichilia heudelotii*	1	0.013158	0.000173
Total		**76**		**0.180402**
$\Sigma(ni/N)^2 = 0.180402$				

Appendix 3B. Index of dominance for diameter class 2

Tree id	Scientific name	ni	(ni/N)	(ni/N)^2
1	*Phyllanthus discoideus*	1	0.030303	0.000918
2	*Gemelina arborea*	8	0.242424	0.05877
3	*Pycnanthus angolensis*	1	0.030303	0.000918
4	*Funtumia africana*	7	0.212121	0.044995
5	*Ochthocosmus africanus*	4	0.121212	0.014692
6	*Dialium guineense*	3	0.090909	0.008264
7	*Cleistopholis patens*	1	0.030303	0.000918
8	*Millettia spp*	2	0.060606	0.003673
9	*Uapaca guineensis*	2	0.060606	0.003673
10	*Acioasea brifolia*	1	0.030303	0.000918
11	*Berlinia spp*	2	0.060606	0.003673
12	*Elaeis guineensis*	1	0.030303	0.000918
Total		**33**		**0.142332**
$\Sigma(ni/N)^2 = 0.142332$				

Appendix 3C. Index of dominance for diameter class 3

Tree id	Scientific name	ni	(ni/N)	(ni/N)^2
1	*Gemelina arborea*	1	0.25	0.0625
2	*Ochthocosmus africanus*	1	0.25	0.0625
3	*Funtumia africana*	1	0.25	0.0625
4	*Elaeis guinensis*	1	0.25	0.0625
Total		**4**		**0.25**
$\Sigma(ni/N)^2 = 0.25$				

Appendix 3D. Index of dominance for diameter class 4

Tree id	Scientific name	ni	(ni/N)	(ni/N)^2
1	*Albizia ferruginea*	3	0.088235	0.007785
2	*Gemelina arborea*	11	0.323529	0.104671
3	*Funtumia africana*	2	0.058824	0.00346
4	*Uapaca guineensis*	7	0.205882	0.042388
5	*Xylopia spp*	1	0.029412	0.000865
6	*Millettia spp*	1	0.029412	0.000865
7	*Ongokea gore*	2	0.058824	0.00346
8	*Berlinia spp*	5	0.147059	0.021626
9	*Piptadeniastrum africanum*	1	0.029412	0.000865
10	*Afzelia spp*	1	0.029412	0.000865
Total		**34**		**0.186851**
$\Sigma(ni/N)^2 = 0.186851$				

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