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The Role of Choyta Kaashsha Sacred Forest for Biodiversity Conservation in Ethiopia

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ABSTRACT

This study was conducted in Choyta Kaashsha Sacred Forest in Kucha Woreda, Gamo Zone, Ethiopia to determine floristic composition, plant community types and to identify traditional conservation practices that have maintained the area. Thirty-two (20m X 20m) quadrates were used to collect data. Height and diameter at breast height (DBH ≥2.5cm) of woody species were recorded including altitude, aspect, slop and UTM. In-depth interviews and group discussion were conducted with local people to identify conservation status and threats. Vegetation structure was analyzed using descriptive statistical tools. Vegetation classification was performed using PC-ORD version 5.0. Species diversity and evenness were computed using Shannon diversity indices. Forty eight woody species belonging to 44 genera and 32 families were recorded. Four community types *Euphorbia ampliphylla-Celtis Africana*, *Podocarpus falcatus-Millettia ferruginea*, *Ficus thonningii-Podocarpus falcatus* and *Syzygium guineense- Bersama abyssinica* were identified. The total density and basal area of sacred forest are 1314.84 stems/ha and 102.63 m^2/ha, respectively. The density of woody species was decreasing with increasing height and DBH classes. The findings revealed the sacred forest has exclusively been conserved for socio-religious purpose in relation with ***Eeqa - Gaca*** ritual ceremony. Nevertheless, the long maintained sacred forest is exposed to threat due to anthropogenic pressure. Disrespecting social taboos, *Gome*, and religious prohibitions, argument on ownership issues are worth mentioning threats. Proper recognition of customary rule of ritual leader and local resource use norm confined with social taboo, *Gome*, reinforced by contemporary conservation measures were recommended to maintain the sustainability of the sacred forest.

Keywords: Sacred, Kaashsha, Eeqa-Gaca, Taboo, Gome

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1. INTRODUCTION

Protection of nature for religious purpose is an ancient practice and people believe such areas as sacred (Berkes, 2008; Sponsel, 2008). Khan *et al*. (2008) described that majority of the sacred areas are associated with deities, legends and rituals, and traditional communities protect them primarily for spiritual or cultural values. The respect of such communities for nature and restriction of access to resource extraction due to religious sanctions and taboo have maintained sacred areas with high biological diversity (Berkes, 2008; Pruthi and Burch, 2009). Colding and Folke (1997; 2001) emphasized on the role of the social taboos on conserving sacred forest resources and discussed how they bind the members of society for smooth functioning. Such bans reduced the human impact in terms of harvesting pressures and permitted the complex array of ecological processes to continue uninterruptedly (Berkes, 2008; 2012).Thus, sacred sites play a pivotal role in biodiversity conservation and act as a refuge for threatened, endangered and keystone species (Bhagwat and Rutte, 2006), reduces risk of extinction of vulnerable species that may have great potential of diverse uses (Ormsby and Bhagwat, 2010). Moreover, many sacred areas are connected with other natural ecosystems through ecological corridors creating biological connectivity and spatial linkage. As a result, they provide a number of ecosystem services like a perennial source of water, conservation of soil, reduction of habitat destruction, maintenance of hydrological cycle and favorable microclimate, ease dispersal of seeds (Berkes, 2008; 2012).

However, in spite of numerous socio-cultural and ecological significances of sacred areas, their contribution to biodiversity conservation goes unnoticed and vulnerable to external threats since they are founded on the basis of customary rules and have no direct relation to government agencies and official policies (Khan *et al*., 2008; Berkes, 2008; 2012). Nevertheless, currently they are gaining much interest in the international arena as major contributors to the conservation of biological and cultural diversity (Bhagwat and Rutte, 2006).

People of Ethiopia with distinct cultures and religions have a wealth of knowledge and long history of close association with sacred nature (Desalegn, 2007; Desalegn and Healey, 2015; Zerihun, 2009; 2014). Traditional beliefs like **Adbar** (belief in landscapes) and **Guido** (cultural forests serving as places of worship in Kafa) are evident. Such areas are intentionally maintained by local people and intertwined with their religious and socio-cultural practices (Desalegn, 2007; Zerihun, 2009).

Even though, various authors and scholars have described the vegetation types of the country for several years (Feyera, 2006; Kitessa and Bishaw, 2008) data on sacred areas were not adequate. Kitessa (2007), Zerihun (2009), Lowman (2011), Dereje and Tamene (2012), Catherine *et al*. (2014, Lemessa (2014), Zerihun (2014), Abiyou *et al*. (2015), Desalegn and Healey (2015), Travis *et al*. (2015) described the vegetation composition of sacred forest patches in different parts of the country. Alemayehu (2007), Alemayehu *et al*. (2010) reported trees surrounding Churches and Monasteries of the Ethiopian Orthodox Tewahido Church (**Debir** and **Geddam**) are similar with the term sacred grove and possess indigenous woody species like Junipers procera and Podocarpus falcatus. The same authors underlined the importance of religious sanctions like **Gizete** in protecting the deterioration of sacred areas due to human interference.

Besides the information gap, the ecological and economic benefits of sacred areas are not sufficiently recognized by policy makers and environment protection institutions. All these factors contribute to the deterioration of sacred areas together with changes in age-old socio-cultural traditions and religious beliefs that maintained the sites.

Though the Choyta Kaashsha sacred forest contains several important species, its floristic composition and the role it plays in the socio-cultural life of the local community is not documented. The site, being located within an agricultural landscape, faces a serious threat of erosion due to several anthropogenic factors that may lead to complete degradation. Thus, the objectives of this study were to determinethe floristic composition of the sacred forest; identify plant community types and their structures; assess the cultural and spiritual aspects of the local community that maintained the sacred forest, identify the existing threats of the forest.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

Choyta Kaashsha Sacred Forest is found in Kucha Woreda of Gamo Zone, southwestern Ethiopia (Figure. 1). It is located at about 65km south of Selamber (administrative town of Kucha Woreda), in Choyta kebele along altitudes between 1950 and 2155 m.a.s.l. Choyta kebele is bordered with Fango kebele in the north-west, Halleha kebele in the west, Kullo kebele in the east of Kucha woreda and Egrisa Woqqe and Sozzo kebeles of Ditta woreda in the south and southeast, respectively.

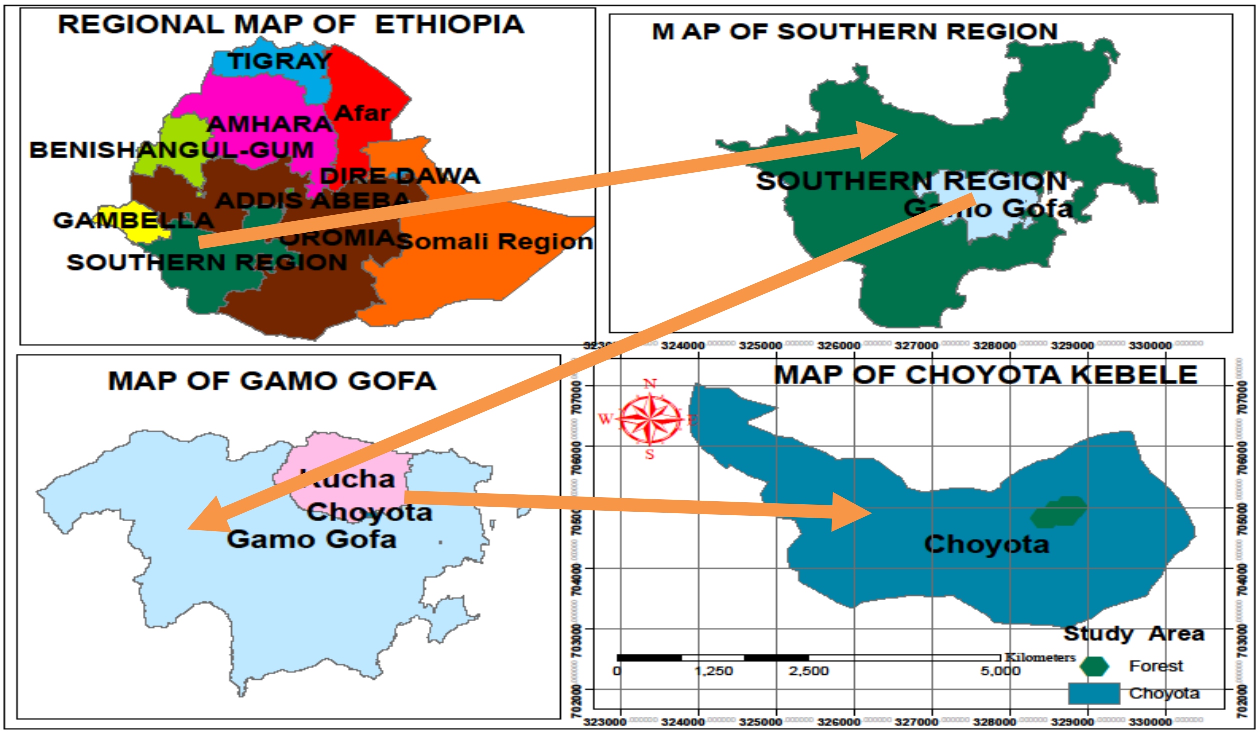

Figure1: Location Map of the Study Area

The total area of Kucha woreda fall mainly under two main agro ecological zones, ***woina dega*** (56%), kolla (43%) and the remaining 1% is ***dega***. Choyta kebele, where this research is conducted, comes under the ***woina dega*** zone. There are two distinct rainy seasons; the smaller one from February to March and the main rainy season extend from July to September. The mean annual rainfall of the woreda is 1152.5 mm while the annual minimum and maximum were recorded to be 903.4 mm and 1833.85 mm respectively.

2.2. Vegetation and Environment Data Collection

Reconnaissance and data collection were carried out from October to November 2014. Vegetation data were collected from 32 quadrates of 20m x 20m following Feyera (2006) since the sacred forest was homogeneous. Environmental variables like altitude, aspect, slope and UTM were also recorded. Woody species with DBH ≥2.5cm in each quadrate were recorded and coded with vernacular name (Gamogna). Species cover abundance was estimated following the procedure of modified Braun-Blanquet scale (1965) by Van der Maarel (1979) with 8 scales as follows:

1= 1-5 individuals of plants, cover <5%

2 = 6-50 individuals of plants, cover < 5%

3 = more than 50 individuals, cover <5%

4 = any number of individuals, cover 5-15%

5 = any number of individuals, cover 16-25%

6 = any number of individuals, cover 26-50%

7 = any number of individuals, cover 51-75%

8 = any number of individuals, cover 76-100%

2.3. Ethnobotanical Data Collection

Ethnobotanical data related to the socio-cultural and religious importance of the sacred forest were collected through in-depth interviews, direct field observation and group discussions (Cotton, 1996). The ritual ceremonial spot of the sacred forest was observed. Group discussions were held with local people of different age groups (15 years to above 80 years old) and education levels (Illiterate to college Diploma) of both sexes. Focus group discussions were held with 6 households whose heads age above 80 years.

2.4. Data Analysis

Hierarchical cluster analysis was performed using PC-ORD 5.0 to classify vegetation into plant community types (McCune and Mefford, 1999). Community types were named after two dominant species selected from 48 woody species using their mean cover abundance values. In order to describe vegetation structure, density, height, DBH and Basal Area (BA) were used. Relative density, relative frequency, relative dominance and Importance Value Index (IVI) were calculated using the following formulae (Muller-Dombois and Ellenberg, 1974):

Density = Total number of individuals/Total area in hectare

Relative density= Number of individuals of a species/Total number of individuals of all species X 100.

Frequency = Number of quadrates in which a species recorded/Total quadrate

Relative Frequency= Frequency of a species/Sum frequency of all species x 100.

Basal Area (BA) = $\pi d^2/4$; Where $\pi = 3.14$; d = diameter at breast height.

Dominance = Area covered by a species (BA) / Sum of all quadrates area in hectares

Relative Dominance =Basal area of a single species / Total basal area of all species x100.
Important value Index (IVI) = Relative density + Relative frequency + Relative dominance.

The Shannon - Wiener indices of diversity (H′) and Evenness (E) were computed to determine the species diversity and evenness in the sacred forest following Magurran (2004)

Shannon-Wiener indices of diversity;

$$(\mathrm{H}') = -\sum_{i=1}^{s} \mathrm{PilnPi}$$

where:

"s"is the number of species
"pi"is proportion of the i^{th} species = ni / N
"ni" is number of individuals of species i and
"N" is total number of individuals

Evenness (E) = H′/H′max**,**

where :

H'= Shannon-Wiener diversity index and
H'max= ln S where *S* is the number of species

3. RESULTS AND DISCUSSION

3.1. Floristic composition

A total of 48 woody species belonging to 44 genera and 32 families were recorded from the sacred forest. The dominant family was Celastraceae having 5 species (10.42%) followed by Rhamnaceae with 3 species (6.25%). Euphorbiaceae, Fabaceae, Myrsinaceae, Oleaceae, Ranunculaceae, Rosaceae, Rubiaceae, Rutaceae, Sapindaceae and Verbenaceae were represented by 2 species each. The remaining 20 families were represented by single species. While majority of the species belonged to Angiosperms, the only Gymnosperm species was *Podocarpus falcatus* of Podocarpaceae. The dominance of two families and individuals of *Podocarpus falcatus* could be attributed to the ecological adaptation of member species to the area and also the special protection given to the charismatic tree of Podocarpus. Concerning proportional contribution of habit categories of species, 29 (60.42 %) were trees, 10 (20.83 %) were shrubs and 9 (18.75 %) was liana. Based on this feature, it is possible to suggest that the sacred forest is a remnant of a closed forest with established canopy layers that had dominated the landscape in the past. If total size of the sacred forest was considered, the result indicated that the area is rich in species composition. Some of the tree species in the sacred forest like *Podocarpus falcatus*, *Celtis africana*, *Ekebergia capensis*, *Syzygium guineense* and *Prunus africana* belongs to the national priority tree species of the country. This finding agrees with Alemayehu *et al*. (2010) on monastery forests in north Ethiopia, Desalegn (2007) on traditional sacred landscapes of Gamo in southwest highlands of Ethiopia, Dereje and Tamene (2012) on traditional sacred landscapes in Bedelle, western Ethiopia, Abiyou *et al*. (2015) on the forest management of the Ethiopian Orthodox Tewahido Church in North Shewa Zone. All the researchers concluded that sacred sites (traditionally protected by local community or religious institutions) are used as the last refuge for many threatened, endangered and endemic species of plants and animals.

3.2. Vegetation Structure

Vegetation structure refers to the organization of individuals in space that form plant association (Muller-Dombois and Ellenberg, 1974). Plant growth forms, stratification, and coverage are the main components of vegetation structure. Height, density, basal area (BA) and IVI were computed and analyzed to describe the vegetation structure of the sacred forest. Eight height classes were conventionally established to describe the height class distribution of vegetation in forest (Figure 2).

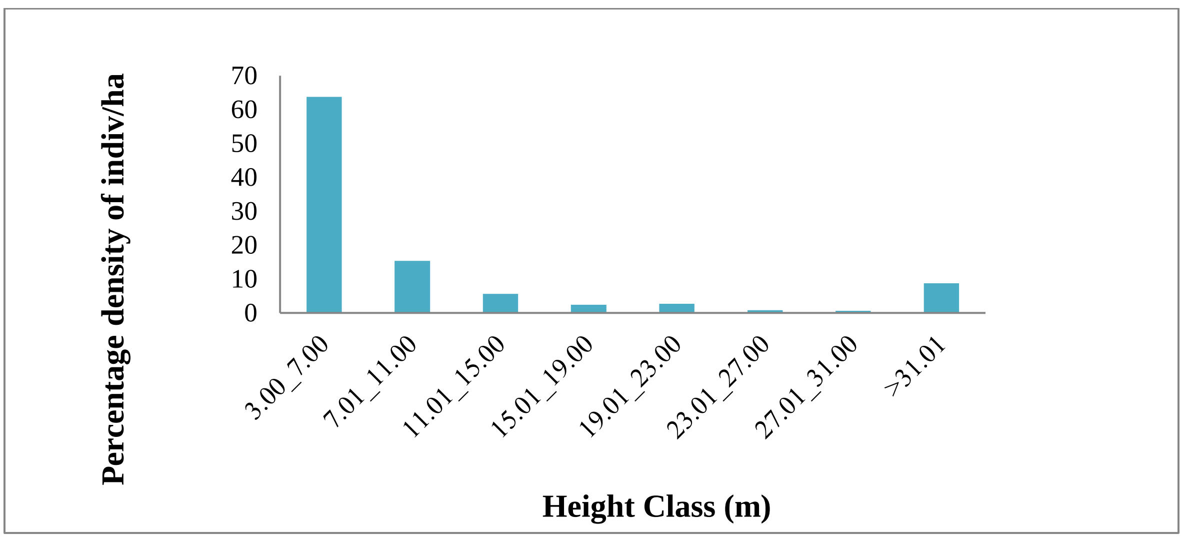

Figure 2: Height Class Distribution of Individuals per hectare in the study area

The densities of height class distribution showed that about 838.3(63.8%) individuals/ha have height ≤ 7m and 202.3(15.4%) individuals/ha have height less ≤ 11m. Together they cover about 79.2% of the total height class of the sacred forest (Figure 2). Heights classes 3 and 4 together account for 104.7(8%) individuals/ha while the remaining 54.2(4%) individuals/ha have height between 20-31m (Height classes 5, 6 and 7). About 115.6(8.8%) individuals/ha of woody species have attained height >31m. The occurrence of such overcrowded tall trees in this sacred forest might disclose the usefulness of age-old traditional forest protection habits among local communities. Evidently, the abundance of such tall trees owes to the presence of *Podocarpus falcatus*, a unique symbol of the sacred forests' socio-cultural value. *Podocarpus falcatus* is exceptional as its dry remains were not used for fuel even during the New Year's festivity. The height class result of the forest is comparable to Gurra Farda forest (Kitessa and Bishaw, 2008) containing tall trees growing a height above 30m.

The International Union for Forestry Research Organization classification scheme classifies vertical structure of forests in three layers/storey based on mean heights of canopy tree species (Lamprecht, 1989); upper story/layer (tree height >2/3 of top height), middle story (tree height between 1/3 and 2/3 of top height) and lower story (< 1/3 of top height). Due to the presence of very emergent trees; the forest vegetation of the study area was classified into three vertical strata. The tallest tree observed in sacred forest was Podocarpus falcatus which grew above 35m high. The mean heights of canopy trees of the study area were comparable to that of moist evergreen Afromontane forests of southwestern Ethiopia (Feyera, 2006). Trees in the lower story include Teclea nobilis, Clausena anisata, Maytenus arbutifolia, Maytenus undata, Chionanthus mildbraedeii and middle story contains Croton macrostachyus, Euphorbia ampliphylla, Millettia ferruginea, Schefflera abyssinica while upper story Podocarpus falcatus and Ficus thonningii.

The overall density of woody species with DBH ≥ 2.5 of the sacred forest was 1314.84 stems/ha. Out of these, 245.3(18.66%) individuals/ha was contributed by Teclea nobilis followed by Podocarpus falcatus with 232.8(17.70%) individuals/ha. Clausena anisata 98.44(7.48%) and Euphorbia ampliphylla 66.4(5%) contributed 5% ≥ density while all the remaining species have relative density less than 4%. In contrast; frequency is the number of quadrates in which a given species occurred in the study area. Podocarpus falcatus and Teclea nobilis are common species with frequency of 100%, followed by Clausena anisata with 93.75 % frequency. Tamrat Bekele (1993) described the most frequent species were pioneer species occurring abundantly a given forest. Thus, Podocarpus falcatus and Teclea nobilis are the top most abundant and indicator species of the sacred forest. The woody species were conveniently classified into 14 DBH classes (Figure 3).

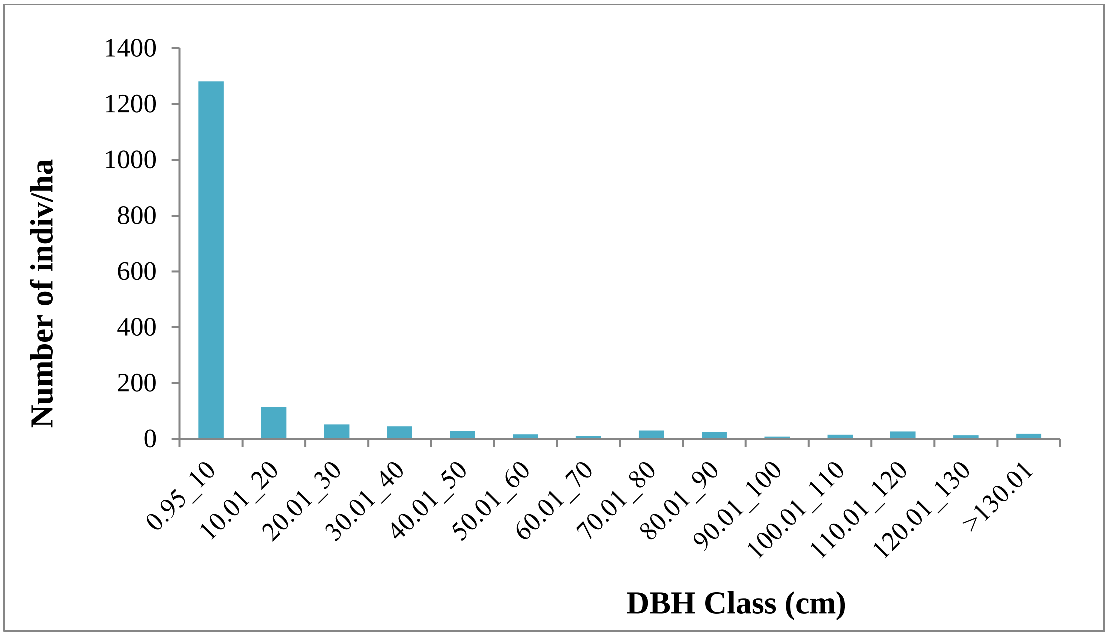

Figure 3: DBH Class Distribution and the Number of Individuals/ha of Woody Species

Most of the woody species in the sacred forest were distributed in the first DBH class (<10cm) with 1281 stems/ha. In general, it was observed that as the DBH class size increases, there was successive decrease in the density of woody species from the first DBH class to last. This revealed that there were a greater number of individuals at lower DBH classes and a smaller number of individuals at higher DBH classes. Similar results were reported by various researchers (Feyera, 2006; Feyera *et al*., 2007; Kitessa and Bishaw, 2008). The above researchers indicated such pattern of distribution in which higher number of individuals occurs in lower DBH class depicts good regeneration potential of a given forest and the same justification could be remarked for the sacred forest.

The total BA calculated for the sacred forest was 102.63 m^2/ha. Different species contributed differently to the total BA. For example, *Podocarpus falcatus* alone contributed 66.62% of the total BA while, *Syzygium guineense* (11.7%), *Euphorbia ampliphylla* (4.8%) were species with high BA. Figure 4 shows top 10 species contributed about 95.68% of the total BA.

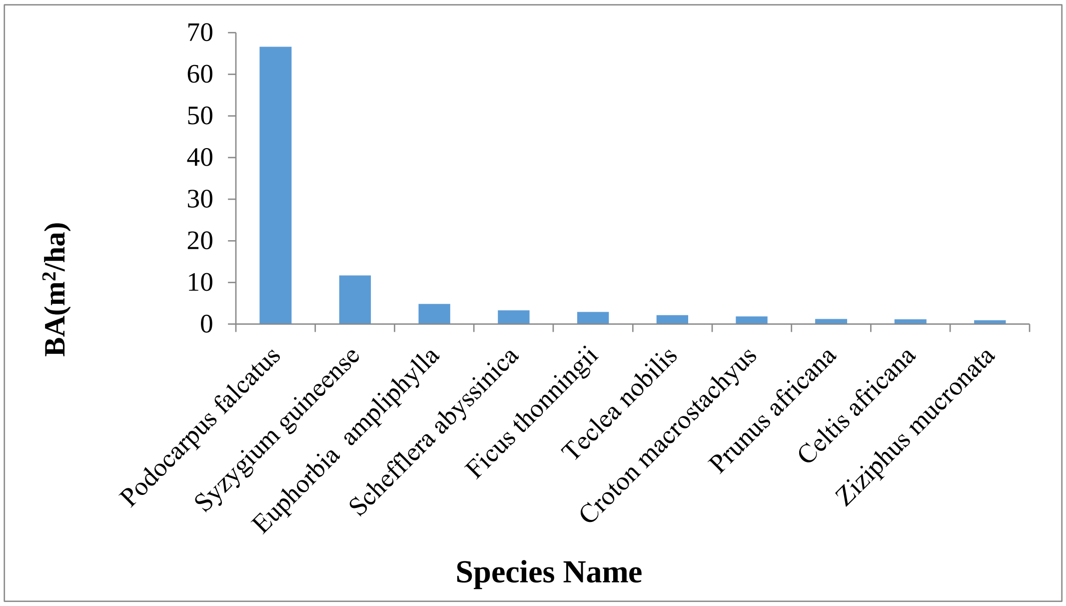

Figure 4: Basal Area of Top Ten Woody Species

The density and comparative contribution of the different species to the total BA is presented in Table1.

Table 1. Density and BA of Woody Species in the Choyta Kaashsha Sacred Forest

Scientific Name	Density	Total BA (m²/ha)	Relative BA
Podocarpus falcatus	232.813	68.38	66.621
Syzygium guineense	23.438	12.02	11.713
Euphorbia ampliphylla	66.406	4.94	4.810
Schefflera abyssinica	9.375	3.42	3.332
Ficus thonningii	14.063	2.98	2.905
Teclea nobilis	245.313	2.17	2.113
Croton macrostachyus	16.406	1.92	1.869
Prunus Africana	14.844	1.25	1.216
Celtis Africana	42.188	1.13	1.103
Ziziphus mucronate	12.500	0.97	0.943
Chionanthus mildbraedii	49.219	0.60	0.581
Millettia ferruginea	34.375	0.55	0.535
Bersama abyssinica	46.094	0.34	0.334
Psydrax schimperiana	6.250	0.27	0.258
Maytenus undata	56.250	0.25	0.247
Clausena anisate	98.438	0.21	0.203
Rothmannia urcelliformis	10.938	0.14	0.133

Maytenus arbutifolia	48.438	0.13	0.122
Becium filamentosum	9.375	0.12	0.117
Vernonia sp.	5.469	0.11	0.109
Calpurnia aurea	26.563	0.10	0.100
Ritchiea albersii	7.031	0.10	0.093
Carissa spinarum	30.469	0.07	0.068
Apodytes dimidiate	19.531	0.06	0.061
Ekebergia capensis	13.281	0.06	0.057
Allophylus abyssinicus	13.281	0.05	0.046
Maytenus senegalensis	4.688	0.05	0.044
Pittosporum viridiflorum	15.625	0.04	0.040
Catha edulis	10.938	0.04	0.039
Grewia ferruginea	14.844	0.04	0.037
Rhus ruspolii	14.844	0.04	0.034
Trichocladus ellipticus	3.906	0.03	0.027
Myrsine Africana	8.594	0.03	0.026
Premna schimperi	10.156	0.02	0.017
Paullinia pinnata	7.813	0.01	0.009
Rhoicissustridentata	5.469	0.01	0.009
Dombeya torrid	3.906	0.01	0.008
Rhamnus prinoides	7.813	0.00	0.004
Dracaena steudneri	5.469	0.00	0.004
Hippocratea Africana	5.469	0.00	0.003
Embelia schimperi	6.250	0.00	0.003
Dregea schimperi	6.250	0.00	0.002
Lantana camara	4.688	0.00	0.002
Clematis hirsute	7.813	0.00	0.002
Rubus rosifolius	5.469	0.00	0.001
Rhamnusstaddo	3.906	0.00	0.001
Clematis longicauda	5.469	0.00	0.001
Clerodendrum myricoides	3.125	0.00	0.000
Total	**1314.844**	**102.633**	**100**

Since BA is mainly computed from DBH, plant species that grow to higher size (girth) attaints higher BA than those species with lower size. Thus, *Podocarpus falcatus*, *Syzygium guineense* and *Euphorbia ampliphylla* achieved the highest BA in the sacred forest because they grow to higher size. Likewise, the proportional contribution of density to total BA could be observed for densely distributed species in the sacred forest. For example, the density of *Podocarpus falcatus* and *Teclea nobilis* is 17.65% and

18.7% respectively (Table 1) but the former contributed about 33 times the later for total BA. This illustrates the size of a tree affects its BA considerably. The outcome was comparable with the observation made by Simon and Girma (2004) who remarked species with highest density did not necessarily attain highest BA due to size difference between them.

The IVI, which is calculated from relative density, relative frequency and relative dominance, gives a hint for summarizing vegetation characteristics. The IVI value of top ten woody species of the forest is shown in Table 2.

Table 2. IVI of Top 10 Woody Species in Choyta Kaashsha Sacred Forest

Scientific Name	**Relative Density**	**Relative Frequency**	**Relative dominance**	**I V I**	**IVI Rank**
Podocarpus falcatus	17.706	5.68	65.979	89.37	1
Teclea nobilis	18.657	5.68	2.093	26.43	2
Syzygium guineense	1.783	1.95	11.599	15.34	3
Euphorbia ampliphylla	5.051	4.62	4.764	14.43	4
Clausena anisate	7.487	5.33	0.201	13.02	5
Maytenu sundata	4.278	4.80	0.244	9.32	6
Celtis Africana	3.209	4.09	1.093	8.39	7
Maytenus arbutifolia	3.684	4.26	0.121	8.07	8
Chionanthus mildbraedii	3.743	3.73	0.575	8.05	9
Bersama abyssinica	3.506	4.09	0.330	7.92	10
Total	**100**	**100**	**100**	**300**	

The IVI analysis showed that the sacred forest was remarkably full of *Podocarpus falcatus* which was solely contributed 89.37(29.8%) IVI value (Table 3). This high IVI value was attributed to its high BA, high relative frequency and high relative density. The greatest IVI reflects the extent of dominancy of a given species in relation to the other species in the structure of a forest stand (Simon and Girma, 2004). Thus, *Podocarpus falcatus* with the greatest IVI value is the most dominant woody species of the sacred forest. IVI analysis was used to set priority for species management and conservation practices and helps to identify their status in a certain plant species as dominant or rare species (Kent and Coker, 1992). As a result, all woody plant species in the sacred forest were grouped into four IVI classes based on their total IVI values (Figure 5). About 43 or 89.6 % woody species have IVI value <10.00 (IVI class 0.850-10.00), 3 or 8.3% species have IVI value between 10.01 and

20.00, 1 species have IVI value between 20.01 and 30.00 and 1 species have IVI value ≥30.01 (Figure 5). Research findings of forest studies reveal that species which receive lower IVI values need high conservation efforts while those with higher IVI values need monitoring management (Belayneh *et al*., 2011). Consequently, the species grouped in IVI class 0.850-10.01 need high conservation effort while those grouped in IVI class >30.01 need monitoring management. In general, *Podocarpus falcatus*, *Teclea nobilis*, *Syzygium guineense*, *Euphorbia ampliphylla* and *Clausena anisata* can be regarded as the top five dominant species of the sacred forest since all of them found in the top five of the ranks of basal area, relative density, relative frequency and IVI per hectare of the ten top dominant species (Table 2).

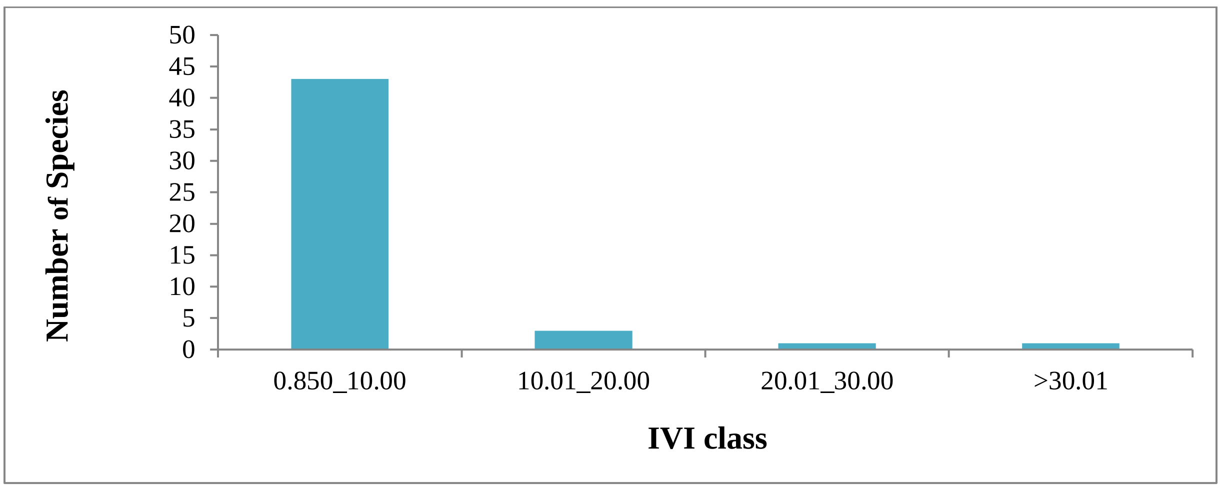

Figure 5: IVI Classes and Number of Woody Species

Plant Community Types

The PC-ORD based vegetation analysis was based on the cover abundance data matrix of 48 woody species recorded from 32 quadrates. Four plant community types were derived from hierarchical cluster analysis (Figure 6) whereas community names were given after two species having the highest mean cover abundance value

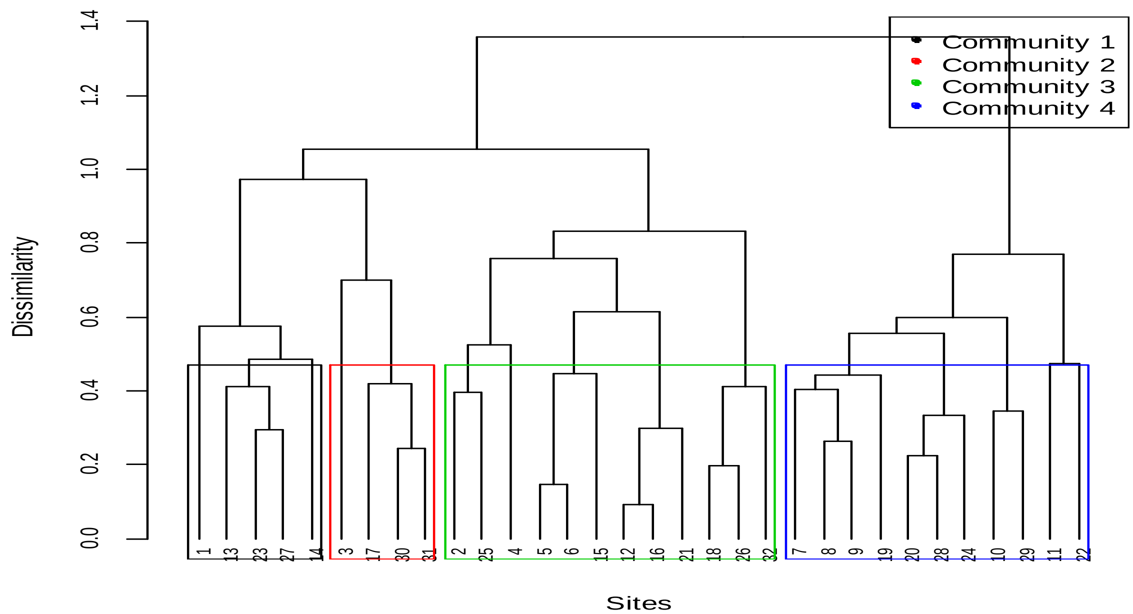

Figure 6: Dendrogram of vegetation data from hierarchical cluster analysis of Choyta Kaashsha Sacred Forest

Community 1: Quadrates 1, 13, 23, 27, 14

Community 2: Quadrates 3, 17, 30, 31

Community 3: Quadrates 2, 25, 4, 5, 6, 15, 12, 16, 21,18,26,32

Community 4: Quadrates 7, 8, 9, 19, 20, 28, 24, 10, 29, 11, 22

C$_1$. *Euphorbia ampliphylla – Celtis africana* Community Type

This community type consists of 5 quadrates and 34 species. *Euphorbia ampliphylla*, *Celtisa fricana*, *Podocarpus falcatus*, *Ziziphus mucronata*, *Bersama abyssinica* are species existing on the upper canopy while *Clausena anisata*, *Calpurnia aurea* and *Teclea nobilis* are species seen on the lower layer of this community type.

C$_2$. *Podocarpus falcatus - Millettia ferruginea* Community Type

This community type 4 quadrates and 45 species. It is the second community in terms of species richness. *Podocarpus falcatus*, *Millettia ferruginea*, *Euphorbia ampliphylla*, *Bersama abyssinica* and

Celtis africana are species frequently occurred in the upper storey in this community type. Other species easily observed in the lower layer of the forest are *Clausena anisata*, *Maytenus arbutifolia*, *Maytenus undata* and *Teclea nobilis*.

C_3. *Ficus thonningii - Podocarpus falcatus* Community Type

This community type covers the entire sacred forest having 12 quadrates and 40 species. *Ficus thonningii*, *Podocarpus falcatus*, *Euphorbia ampliphylla*, *Bersama abyssinica*, *Ziziphus mucronata*, *Croton macrostachyus* and *Celtis africana* are frequently observed species in this community type.

C_4. *Syzygium guineense - Bersama abyssinica* Community Type

This community type is the richest in species number, consisting of 47 woody species distributed across 11 quadrates. The only species missing in this community type is *Trichocladus ellipticus*. *Syzygium guineense, Bersama abyssinica, Podocarpus falcatus, and Euphorbia ampliphylla* occur in the upper storey whilst all the remaining species exist in the middle and lower storey.

Species Diversity and Evenness of Plant Community types

Shannon-Wiener diversity index and Evenness were computed for the four plant communities. Table 3. Indices of Diversity and Evenness of Plant Community Types

Community type	Species richness (S)	Diversity (H’)	H’ max (lnS)	Evenness (J) (H’/H’max)
C_1	34	2.91	3.53	0.83
C_2	45	3.12	3.81	0.82
C_3	40	3.18	3.69	0.86
C_4	47	3.16	3.85	0.82

(C_1: *Euphorbia ampliphylla – Celtis africana*, C_2: *Podocarpus falcatus - Millettia ferruginea*, C_3: *Ficus thonningii - Podocarpus falcatus*, C_4: *Syzygium guineense - Bersama abyssinica*)

Community type 4 has the highest species richness (47 species) followed by community type 2 (45 species). The highest species richness of community type 4 might be related to its relatively higher number of quadrates (11) that covers most part of the sacred forest. In contrast, the species richness of community type 2 (only 4 quadrates) might be attributed to the location of quadrates on the center of forest where there was no disturbance. Community type 3 exhibited the largest number of quadrates (12) nevertheless its species richness is 40. The diversity and evenness indices of plant communities were generally comparable except community type. The rationale for this might be associated with either altitudinal ranges of community types, nonexistence of disturbance and conservation status as the sacred forest has been protected for centaury. The least diversity index of community type 1 could have been mainly resulted from disturbance and edge effect as some of the quadrates laid along roadside (Mamo *et al*., 2013).

Table 4: List of Mean cover Abundance Value of Woody Species

	Community types			
	1	**2**	**3**	**4**
	Number of Quadrates			
Species	5	4	12	11
Allophylus abyssinicus	0.60	0.25	0.50	0.45
Apodytes dimidiate	0.20	0.42	0.25	0.45
Becium filamentosum	0.20	0.17	1.50	0.36
Bersama abyssinica	1.00	2. 42	2.25	**4. 50**
Calpurnia aurea	1.60	0.58	0.50	0.18
Carissa spinarum	0.80	0.75	0.75	0.82
Catha edulis	0.20	0.33	0.25	0.09
Celtis Africana	**5.60**	2.08	2.25	0.91
Chionanthus mildbraedii	1.20	0.83	0.50	0.73
Clausena anisate	2.00	1.33	1.25	1.27
Clematis hirsute	0.20	0.25	0.25	0.27
Clematis longicauda	0.20	0.25	0.00	0.18
Clerodendrum myricoides	0.00	0.08	0.25	0.18
Croton macrostachyus	0.00	1.42	2.50	0.91
Dombeya torrida	0.00	0.17	0.00	0.09
Dracaena steudneri	0.40	0.17	0.00	0.09
Dregea schimperi	0.20	0.08	0.50	0.18
Ekebergia capensis	0.20	0.42	0.00	0.09
Embelia schimperi	0.00	0.25	0.25	0.27
Euphorbia ampliphylla	**5.87**	3.43	4.50	2.30
Ficus thonningii	0.00	0.00	**6.00**	0.36
Grewia ferruginea	0.80	0.92	0.50	0.55
Hippocratea Africana	0.00	0.25	0.00	0.27
Lantana camara	0.00	0.17	0.25	0.18
Maytenus arbutifolia	0.80	0.67	0.50	1.18
Maytenus senegalensis	0.20	0.08	0.50	0.18
Maytenus undata	0.60	1.50	1.50	1.36

Millettia ferruginea	0.00	**7.75**	0.25	1.36
Myrsine Africana	0.00	0.25	0.25	0.27
Paullinia pinnata	0.20	0.25	0.25	0.27
Pittosporum viridiflorum	0.20	0.50	1.25	0.45
Podocarpus falcatus	5.20	**8.42**	**5.80**	4.70
Premna schimperi	0.00	0.33	0.00	0.45
Prunus Africana	0.80	0.00	1.00	0.64
Psydrax schimperiana	0.20	0.25	0.25	0.09
Rhamnus prinoides	0.00	0.33	0.25	0.18
Rhamnus staddo	0.00	0.08	0.50	0.18
Rhoicissus tridentata	0.20	0.17	0.25	0.09
Rhus ruspolii	0.40	0.67	0.50	0.18
Ritchiea albersii	0.20	0.17	1.00	0.55
Rothmannia urcelliformis	0.40	0.67	0.50	0.18
Rubus rosifolius	0.00	0.17	0.50	0.18
Schefflera abyssinica	1.40	1.58	1.25	1.18
Syzygium guineense	0.10	0.01	0.00	**5.73**
Teclea nobilis	1.60	1.58	1.00	1.18
Trichocladus ellipticus	0.20	0.17	0.50	0.00
Vernonia sp.	0.20	0.33	0.00	0.91
Ziziphus mucronate	1.80	0.33	3.00	1.55

Traditional Conservation Practices of the Sacred Forest

The resources of the sacred forest were managed and utilized according to the ***Eeqa-Gaca*** customary rule. In early days, local people were confined to traditional norms set by ***Eeqa-Gaca*** (ritual leader, believed as a custodian of rain and thunder) and ***Halaqa*** (periodically elected political leaders). Both ***Eeqa-Gaca*** and ***Halaqa*** had their own contribution in regulating the resources of the sacred forest as the former was responsible for traditional worshipping and management of resources while the latter acts as a mediator between local community and ritual leader. The sacred forest has been protected mainly for its socio-cultural and spiritual values as it has dual functions: being a religious ritual site and a burial ground of the ***Eeqa-Gaca*** clan. The religious rituals were performed annually in order to get favorable rainfall and thereby optimal environmental conditions. The customary rule of ***Eeqa-Gaca*** permits the use of dried wood of the sacred forest only once in a year, during the ***Yohoo Masqqala***. The notion associated with this practice was that as the dead body of human being was buried, the same should be applied for the dried tree logs. The ***Yohoo Masqqala*** is a socio-cultural ceremonial event that indicates the beginning of a new year and celebrated in a series of feasts among the local communities. Since the festivity period (mid-September - early October) is the coldest season in the region, local residents could not go far away to collect firewood. At this particular juncture, they prepare and arrange many types of cultural foods, drinks and therefore, they need high consumption of firewood that was obtained from the sacred forest. When collecting wood products from the sacred forest, local inhabitants were not allowed to use tools such as axes, knives and sickles within the sacred forest. Instead, they bring dried parts of trees to outside the forest and use such tools. The prohibition of using such implements, though originated from religious ground, have contributed to conservation of the sacred forest by avoiding cutting of live trees and excessive harvesting of dried wood. Maximum of two days were required for wood collection while, the collected wood should be brought out of the sacred forest before starting date of the ***Yohoo Masqqala*** celebration, and might be hoarded at the forest margin for transport to the homestead at a later date as per convenience. In addition, women are not allowed to enter anytime into the sacred forest. Collecting and using dead logs or any other forest materials at another time was prohibited due to ***Gome*** (moral code, equivalent to taboo) while violating such social rule would bring inexcusable social sanctions locally termed as ***Hiigo*** (ostracism). Such restriction appeared to have contributed to the maintenance of the sacred forest by avoiding excessive exploitation of the forest resources.

The contribution of social taboos and religious prohibition in managing resources and thereby conserving biodiversity was reported by researchers in Ethiopia (Desalegn, 2007; Zerihun 2009; 2014; Desalegn and Healey; 2015). Feleke (2011) reported the total restrictions of grazing cattle in the religious ritual sites assisted the Basketo landscapes to retain their remnant montane evergreen forests. Likewise, Yonas (2005) reported the traditional belief systems intertwined with natural resources among the ***Kafechos*** and ***Manjos*** played a great role in maintaining distinct agro-ecological features like dense forests, wide vegetation cover, beautiful wildlife and perennial rivers in the Kaffa region. Similarly, the religious sanction referred to as ***Gizet*** was recognized as the main mode of protection for Church forests in the South Gonder region (Alemayehu, 2007), while Colding and Folke (1997; 2001) carried out detail investigation on the significance of taboos in protecting Indian sacred sites. Informants revealed that the sacred forest provides important ecological services; as they cultivate tuber crops all the year unlike other kebeles on a similar altitude and their cattle gets cool water from the spring of the sacred forest. They accredited that owing to the sacred forest, the earth gives crop, the spring gives cool water, the cattle gives milk, there is a green grass, and there is no drought in the kebele. They consider the old-aged *Podocarpus falcatus* as symbol of their long life, strength and unity (interview). As the oldest respondents described, "Matured trees of *Podocarpus falcatus* species are as important as the grey-haired fathers in the village." This finding strongly agrees with that of Zerihun (2014) who investigated the belief and respect of local community on the figurative tree *Podocarpus falcatus* (Dagucho) and its socio-cultural value in Wonsho Sacred Sites, Sidama, which maintained the wellbeing of the areas.

Threats to the Sacred Forest

Even though the sacred forest has been maintained in sustainable manner for many years, these days the forest is exposed to several threats derived from anthropogenic pressures. Population growths coupled with lack of alternative resources pushe local people to use sacred forest products. During focus group discussion, it was claimed that young people who cultured through contemporary knowledge disregard the socio-religious-ritual value of the sacred forest. An issue worth mentioning in connection to this was the increasing tendency to neglect the social taboo, ***Gome***, which has been central to protect the sacred forest. Equally, some members of Christian religious institutions consider the rituals related the sacred forest as a curse and condemn it. They violate social taboos and traditional religious prohibitions that have maintained the sacred forest.

All these hurt the social cohesion among community members that developed over many years and also the attachment of local people to the sacred forest. Ownership and administrative matters were emerging as a problem with potential impact on the sacred forest. At present, the involvement of ***Eeqa-gaca*** in ritual ceremony was partially restricted. Informants indicated that there was disagreement between ***Eeqa-gaca*** and the kebele administration concerning the ritual ceremony and ownership of the sacred forest. Of course, kebele administration has employed guardian but, it was observed that social taboos and religious sanctions are more effective (Colding and Folke, 1997, 2001).

4. CONCLUSIONS

The local belief system, customary rule of ***Eeqa-Gaca*** traditional institution, local resource use norm and associated social taboo, ***Gome***, had contributed for the preservation of the sacred forest biodiversity. The frequent occurrence of *Podocarpus falcatus* in all communities might be related to its social, religious and ritual value. The fact that small sized individuals of tree species occur in higher density in the lower DBH and height classes as well as maintenance of very tall trees imply that the forest is well protected and also high regeneration potential. However, the situation that most of the BA was contributed by a few tree species indicates that some species deserve more attention.

The sacred forest provides various functions to the local people with the most important use have been its role as religious ritual place. Nevertheless, there have been changes with respect to this attachment, and the sacred forest that has been considered as source of all good is confronted with the threat of degradation and timely interventions are essential.

The concerned bodies should encourage the existing traditional institutions with conservation value, instead of totally replacing them with new approaches. This, of course, should involve recognition of the role of the local spiritual leaders in managing the forest and also encouraging ritual and other local religious ceremonies.

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APPENDICES

Appendix 1 List of Plant Species Collected in Choyta Kaashsha Sacred Forest.

No.	Scientific Name	Family	Vern. Name (Gamogna)	Habit	Coll. No.
1	*Allophylus abyssinicus* Hochst. Radlkofer	Sapindaceae	Michchacco	T	FF 019
2	*Apodytes dimidiate* E. Mey. ex Arn.	Icacinaceae	Doongo	T	FF 017
3	*Beciumfilamentosum*	Oleaceae	Shinkaa	T	FF 003
4	*Bersama abyssinica* Fresen.	Melianthaceae	Margidie	T	FF 009
5	*Calpurnia aurea* Ait. Benth.	Fabaceae	Maayllo	T	FF 007
6	*Carissa spinarum*L.	Apocynaceae	Laade	L	FF 013
7	*Catha edulis* Vahl Forssk. ex Endl	Celastraceae	Jima	T	FF 026
8	*Celtis Africana* Burm.f.	Ulmaceae	Shishsha	T	FF 001
9	*Chionanthus mildbraedii* Gilg & Schellenb. Stearn	Oleaceae	Hasso	T	FF 005
10	*Clausena anisata* Willd. Benth.	Rutaceae	Tsiqqotte	S	FF 006
11	*Clematis hirsute* Perr. & Guill	Ranunculaceae	Sooga	L	FF 046
12	*Clematis longicauda* Steud. ex A. Rich	Ranunculaceae	Tsoqqoma	L	FF 047
13	*Clerodendrum myricoides* Hochst. Vatke	Verbenaceae	Alga	S	FF 043
14	*Croton macrostachyus* Del.	Euphorbiaceae	Anka	T	FF 016
15	*Dombeya torrid* J.F.Gmel. P. Bamps	Sterculiaceae	Loollashie	S	FF 036
16	*Dracaena steudneri* Engler	Dracenaceae	_____	S	FF 048
17	*Dregea schimperi* Decne. Bullock	Asclepiadaceae	Gaasulla	L	FF 034
18	*Ekebergia capensis* Sparrm.	Meliaceae	Awulancho	T	FF 041
19	*Embelia schimperi* Vatke	Myrsinaceae	Wonqoqo	L	FF 044
20	*Euphorbia ampliphylla* Pax	Euphorbiaceae	Akirssa	T	FF 012
21	*Ficus thonningii* Blume	Moraceae	Shshagna	T	FF 020
22	*Grewiaferruginea* Hochst. Ex A. Rich	Tiliaceae	Phaare	T	FF 027
23	*Hippocratea africana* Willd. Loes.	Celastraceae	Giricha	L	FF 030

24	*Lantana camara* L.	Verbenaceae	Shaasha	S	FF 045
25	*Maytenus arbutifolia* A. Rich. Wilczek	Celastraceae	Tsutso	S	FF 010
26	*Maytenus senegalensis* Lam. Exell	Celastraceae	Meegaaraa	T	FF 022
27	*Maytenus undata* Thunb. Blakelock	Celastraceae	Gershsho	T	FF 015
28	*Millettia ferruginea* Hochst. Bak.	Fabaceae	Zaage	T	FF 018
29	*Myrsine africana* L.	Myrsinaceae	Xaanqarssa	S	FF 025
30	*Paullinia pinnata* L.	Sapindaceae	______	L	FF 029
31	*Pittosporum viridiflorum* Sims	Pittosporaceae	Shieato	T	FF 024
32	*Podocarpusfalcatus* Thunb. R. B. ex Mirb.	Podocarpaceae	Ziga	T	FF 002
33	*Premna schimperi* Engl.	Lamiaceae	Chachchuwaa	S	FF 028
34	*Prunus africana* Hook.F. Kalkm.	Rosaceae	Onththa	T	FF 033
35	*Psydrax schimperiana* Spermacoce L.	Rubiaceae	Gayye	T	FF 039
36	*Rhamnus prinoides* L´Herit.	Rhamnaceae	Geshsho	S	FF 032
37	*Rhamnus staddo* A. Rich.	Rhamnaceae	Xanddo	S	FF 042
38	*Rhoicissus tridentate* Wild & Drummond	Vitaceae	Geegello	L	FF 037
39	*Rhus ruspolii* Engl.	Anacardiaceae	Chichichie	T	FF 023
41	*Ritchiea albersii* Gilg.	Capparidaceae	Qara	T	FF 021
40	*Rothmannia urcelliformis* Hiern Robyns.	Rubiaceae	Goonasse	T	FF 014
42	*Rubus rosifolius* Sm.	Rosaceae	Girima	L	FF 038
43	*Schefflera abyssinica* Forst. & Forst. f	Araliaceae	Passalla	T	FF 008
44	*Syzygium guineense ssp. afromontanum*	Myrtaceae	Ochcha	T	FF 031
45	*Teclea nobilis* Del.	Rutaceae	Gaallo	T	FF 004
46	*Trichocladus ellipticus* Eckl. & Zeyh	Hamamelidaceae	Esiligalba	T	FF 040
47	*Vernonia sp.*	Asteraceae	Wuussango	T	FF 035
48	*Ziziphus mucronata* Wild.	Rhamnaceae	Hagile	T	FF 011

Key: T= tree, S= shrub, L= liana, Vern. Name=Vernacular name in Gamogna, Coll.No. Collection number

Plate 1 When DBH was measured

Plate 2 Young *Podocarpus falcatus* species Indicates the Regeneration Potential

Plate 3 Threat: Illegal firewood collectors within the Sacred Forest (Photo: Fantaye Fekede)

Notice;

A/ Kids with a tool on their hand indicates disrespect of ***Gome*** that forbids such action among some members of local community.

B/ The wind thrown dried tree on which they sat down indicates the **Taboo** of using even such dried remains of the sacred forest products among some members of local community