

## Interplay of Regeneration, Structure and Uses of Some Woody Species in Chilimo Forest, Central Ethiopia

Teshome Soromessa<sup>1\*</sup> and Ensermu Kelbessa<sup>2</sup>

<sup>1</sup>Centre for Environmental Science, Addis Ababa University, P.O. Box, 1176, Addis Ababa, Ethiopia

<sup>2</sup>Department of Plant Biology and Biodiversity Management, Addis Ababa University, P.O. Box: 1176, Addis Ababa, Ethiopia

### Abstract

Studies on the regeneration, structural and uses of some woody species in Chilimo Forest, one of the dry Afromontane Forests of Ethiopia were conducted. To gather vegetation and environmental data from the study forest, a 900 m<sup>2</sup> (30 m x 30 m) quadrat was laid following the homogeneity of vegetation. Investigation of the seedling density and regeneration of target species has been carried out using the same quadrat size, 30 m x 30 m. In each of these quadrats, the numbers of all seedlings that are up to the height of 150 cm were recorded. Individuals attaining 150 cm and above in height but less than 10 cm thick were considered as sapling and counted. Interview was conducted for the investigation of the various pressures exerted on different species. All together the plant species recorded from Chilimo Forest are 213 which can be categorised into 83 families. Of these, the highest proportion is the angiosperm (represented by 193 species) followed by pteridophyta (16 species); the least represented being the gymnosperms (represented by 2 exotic and 2 indigenous species). Structural and regeneration studies of some woody species indicated that there are species that require urgent conservation measures. To provide a better management and monitoring as well as to maintain the biodiversity, cultural and economic values of the forest unsustainable utility of the forest would be controlled with the various conservation activities in place.

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#### \*Corresponding Author:

Teshome Soromessa

#### E-mail:

teshome.soromessa@aau.edu.et

## INTRODUCTION

Chilimo Forest is one of the Dry Afromontane Forests of Ethiopia. Tsegaye Tadesse (expert served in the forest for 20 years, personal com.) stated that the Chilimo Forest was controlled by the close allies of Minilik after his invasion of the area. One of the close allies of Minilik, a French citizen (Komdor) who provided him with war weapons, was the first to get the forest as a favour. After the departure of Komdor, the forest was passed to Ras Mekonnen who in turn passed it to Hailesillassie. It is believed that Hailesillassie built the building in the forest and upon the birth of Leul Mekonnen he transferred the forest to his wife, Itege Menen. Before the Italian invasion, Itege Menen contracted the forest with five foreign investors and the forest began to produce large scale timbers. After the Italian invasion (i.e., between 1937-1968) the forest had been owned by different foreign investors who used sawmills for the production of numerous timber products. These foreign investors include Jana (between 1937-1941), Kazantay (1942-1945), Mozvold (1946-1951), Fogstan (1952-1953) and Vaskin (1954-1968) (Tsegaye Tadesse, personal comm.). After 1968, all the sawmills were forced to stop operation and protection of this forest came into existence. Albeit the declaration of protecting the forest, not enough had

been done to circumvent 60% loss of this forest in ten years time.

It is not uncommon to mention that Ethiopia had experienced substantial deforestation, soil degradation and an increase in the area of bare land over the years (Logan, 1946). The need for fuel wood, arable land and grazing areas are the main causes of forest degradation, frequently leading to loss of forest cover and biodiversity, erosion, desertification and reduced water resources. Several studies focussing on forests or vegetation of specific regions in Ethiopia (Hedberg, 1951 and 1957; Mooney, 1963; Gilbert, 1970; Coetzee, 1978; Friis *et al.*, 1982; Hailu Sharew, 1982; Zerihun Woldu, 1985; Sebsebe Demissew, 1988; Uhlig, 1988; Zerihun Woldu *et al.*, 1989; Uhlig and Uhlig, 1990; Zerihun Woldu and Backeus, 1991; Haugen, 1992; Mesfin Tadesse, 1992; Tamrat Bekele, 1994; Miede and Miede, 1994; Demel Teketay, 2000 and Teshome Soromessa *et al.*, 2004; Ensermu Kelbessa and Teshome Soromessa, 2008; Teshome Soromessa and Ensermu Kelbessa 2013a and 2013b) have been carried out. Moreover, the vegetation resources of Ethiopia, including forests, woodlands and bush lands, have been studied by several scholars (Russ, 1945 compiled by Woldemichael Kelecha, 1979; Logan,

1946; Pichi-Sermolli, 1957; von Breitenbach, 1961, 1963; Westphal, 1975; Chaffey, 1979; Tewelde Berhan Gebreziabher, 1986, 1988, 1991; Friis, 1986, 1992; Friis and Mesfin Tadesse, 1990; EFAP, 1994) who have employed different methods of vegetation classification. Specific studies pertaining to carbon sequestration potentials of Afromontane forests and genera related ones have been carried out (Teshome Soromessa, 2013; Adugna Feyissa *et al.*, 2013). Almost all the aforementioned studies have made a pencil note about the intractable loss of this natural resource.

## MATERIALS AND METHODS

### The Study Area

The Chilimo Forest (collectively known as Chilimo Gaji Forest) is situated 97 km west of Addis Ababa, 7 km north of the small town of Ginchi and close to the main road running to Ambo (Fig.1). Altitudinally, the forest area ranges between 2170 to 3054 m a.s.l. The forest is a small enclave in the western section of the ridge that stretches from the capital westward to Gedo highlands and covers some ca. 2500 ha though the area allocated as forest is more. The inhabitants of the area are the Oromos with some other ethnic groups settled in the heart of the forest, who came to the area to work as a daily labourers at the time of the operation of the sawmill. According to Tamrat Bekele (1994) and Friis (1992), the Chilimo Gaji Forest belongs to Dry Afromontane forest type. In Ginchi and the surrounding Chilimo area, there are five rainy months extending from May-Sept with the highest peak in July. Ginchi belongs to Type I rainfall regime of Daniel Gamachu's (1977) class.

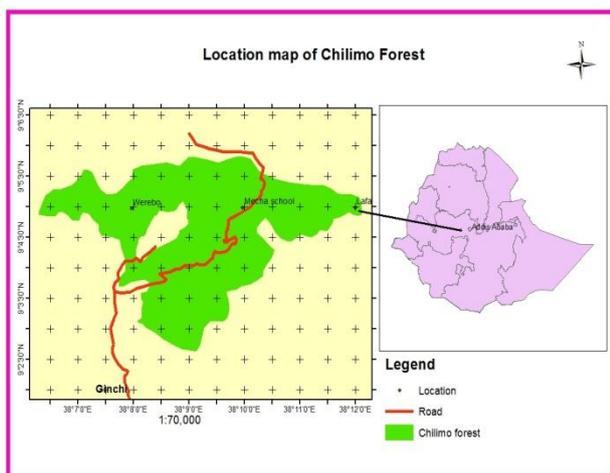


Figure 1: Location map of the study area.

### Geology and Soils

According to Mohr (1971), the geology of Ethiopia was grouped into: a) the Precambrian basement complex of various grades and types of schists, gneiss etc., and to a lesser extent unaltered sedimentary rocks and igneous intrusions, b) the Mesozoic mantle sediments that were deposited during a transgression in the Upper Jurassic when the sea engulfed the country from the south-east and c) the cover deposits.

In the central Plateau including Chilimo, basalt constitutes the main rock types that are chemically and mineralogically uniform in composition. It is however, important to note that in most parts of the country, the basement rocks are overlain by more recent rocks (flood

lavas) of the Tertiary period occurring in series and finally formed what is known as the Trap Series. The volcanic rocks of these series include rhyolites, trachytes, tuffs, ignimbrites, agglomerates and basalt forming the substrate of most types of Afromontane forest (Mohr, 1971). With regard to the soil, a generalised account on the Nature and Management of Ethiopian Soils was in Mesfin Abebe (1998), with particular references to their genesis, classification, distribution and sound management aimed at their sustainable utilisation. Others like Logan (1946), Murphy (1958), Westphal (1975), EMA (1988) also made descriptions and surveys of Ethiopian soils. Based on the aforementioned works, it can be said that the major soil types around Chilimo areas are various types of Vertisols, Luvisols and Cambisols dominates in the areas.

### Vegetation

The works of White (1983) and Friis (1992) had eloquently described the forest of Ethiopia with the characteristic species. Consequently, the Chilimo Forest could be categorised in Undifferentiated Afromontane Forest type of Friis (1992), where the forests are either *Juniperus-Podocarpus* Forests, or predominantly *Podocarpus* Forests, both with and element of broad-leaved species.

### Sampling Design

A reconnaissance survey of the study forest was made so as to obtain an impression and visual description of the general vegetation physiognomy and hypothesise vegetation-environment relationships such as altitude, slope and aspect. Discussion pertinent to forest resources was conducted with the local people (particularly the beneficiaries of the forest) in the study area.

### Vegetation and Environmental Data

Data on vegetation and environmental parameters were gathered using a 900 m<sup>2</sup> (30 m x 30 m) quadrat which was laid following the homogeneity of vegetation. Sample plots were selected through preferential means in such a way that the various conditions encountered represented in the study forest. Woody species were counted. Additional tree and shrub species within 10-m distance from the plot boundaries were recorded as present. Diameter at Breast Height (DBH) and height of all woody species that are above 150 cm high and more than 10 cm thick were recorded. DBH was measured using a meter tape and height of individuals was measured using Clinometer.

Investigation of the seedling density and regeneration of target species has been carried out using the same quadrat size, 30 m x 30 m. Partitions were made within the big quadrat so as to make seedling counts easier. In each of these quadrats, the number of all seedlings that are up to the height of 150 cm was recorded. Individuals attaining 150 cm and above in height but less than 10 cm thick were considered as sapling and counted.

Interview was conducted for the investigation of the various pressures exerted on different species. The local people, who are more likely to know plant vernacular names and their detailed uses, were interviewed. The information on vernacular names and the various uses of species were gathered from the informants via repeated field interviews as described in Maundu (1995); Kamatenesi-Mugisha *et al.* (2000) and Kakudidi *et al.*

(2002). Plant specimens were identified at the National Herbarium and in the field. All voucher specimens that were in flowering and/or fruiting stages were brought to the National Herbarium of Addis Ababa University and deposited. Nomenclature of plant taxa follows the published volumes of Flora of Ethiopia and Eritrea.

### Data Analysis

The vegetation and environmental data gathered from the field were fed into a computer for the subsequent analysis of the data. The vertical structure of the forests were described following the International Union for Forestry Research Organisation (IUFRO) classification scheme (Lamprecht, 1989) that categorise the vertical structure as upper, middle and lower storeys. The population structures of some selected species were analysed for the interpretation of the pattern of population dynamics in the forest.

## RESULTS AND DISCUSSIONS

### Diversity of Chilimo Forest

Analysis of the gathered data indicated that there exists a diverse plant species occurring in the forest investigated for the present study. The gathered plant species include pteridophyta, gymnosperms and angiosperms. All together the plant species recorded from Chilimo Forest are 213 and can be categorised into 83 families. As shown in Figure 2, the highest proportion is the angiosperm (represented by 193 species) followed by pteridophyta (16 species); the least represented being the gymnosperms (represented by 2 exotic and 2 indigenous species).

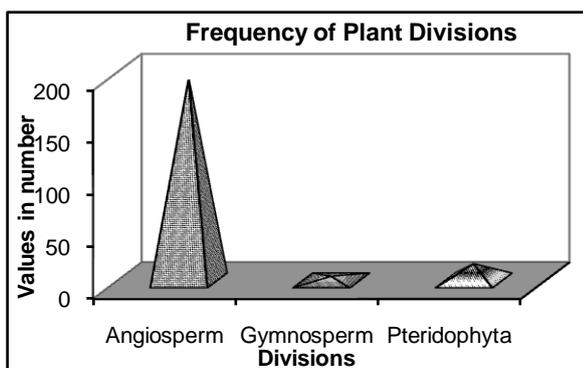


Figure 2: Proportions of angiosperm, gymnosperms and pteridophytes in Chilimo Forest.

Complete lists of the species recorded from Chilimo Forest with their family and local names are provided as Appendix 1. Based on the information presented in Appendix 1, it can be seen that the highest proportion of the habit or form is the herbaceous component. From the same list, however, the dominant family in the forest is Asteraceae that is represented by 28 species making a total proportion of 13% of the total species in the list.

### Floristics

The Chilimo Forest is one of the Afromontane Forests in the country. Despite its proximity to the center, this forest has been studied repeatedly, *inter alia*, Tamrat Bekele (1994) made a significant contribution. Floristically, Juniper and Podo are the emergent species in the forest. Other important species include *Scolopia theifolia*, *Olea europaea*, *Maytenus gracilipes*, *Myrsine africana*, *Allophylus abyssinicus*, *Erica arborea*, *Bersama abyssinica*, *Olinia rochetiana*, *Nuxia congesta*, *Prunus*

*africana*, *Sideroxylon oxyacanthum*, *Osyris quadripartita*, *Plantago palmata*, *Satureja paradoxa*, *S. nilotica*, *Carissa edulis*, *Hypoestes forsskaolii* and *Geranium arabicum*.

### Vertical Structure

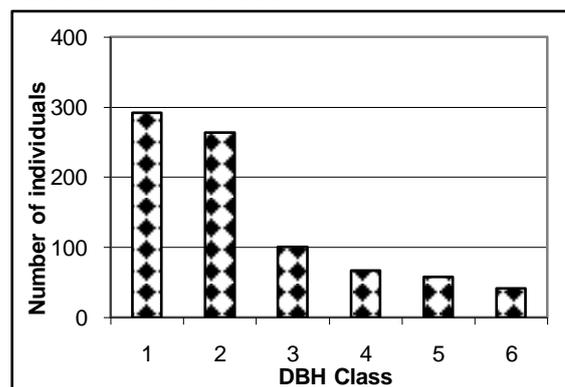
The vertical structure of the woody species occurring in the Chilimo Forest was analysed using the IUFRO classification scheme as cited in (Lamprecht, 1989). The scheme classifies the storey into upper, where the tree height is greater than 2/3 of the top height; middle, where the tree height is in between 1/3 and 2/3 of the top height and the lower storey where the tree height is less than 1/3 of the top height. The top height here is considered as 45 m. Accordingly, in Chilimo Forest, the upper storey of the forest is either *Juniperus* or *Podocarpus* or predominated by both emergent species. In most of these forests, the middle storey is dominated by species like *Olea europaea*, *O. capensis*, *Scolopia theifolia* and *Allophylus abyssinicus*. The lower storey of the forests is largely composed of small trees and shrubs such as *Myrsine africana*, *Teclea nobilis* and *Bersama abyssinica*.

### Density

Density of a given species is expressed as number of stems per hectare. In Chilimo Forest, the highest density was recorded for *Maytenus gracilipes* (258.7 individuals per hectare), which is followed by *Podocarpus falcatus* (120 individuals per hectare) and *Scolopia theifolia* (109.3 individuals per hectare), while the least density of species was recorded for *Gnidia glauca* that contributed less than an individual per hectare.

### DBH and Height Profile

The DBH and Height classes data of the Chilimo Forest are presented in Figures 3 and 4 below. The DBH classes showed continuous decrease in number of individuals with increase in class sizes. Those belonging to DBH classes 1-3 contributed about 79.8% of the number of individuals. This shows that small sized individuals dominate the forest.



Legend: 1=10-20 cm, 2=20.1-50 cm, 3=50.1-80 cm, 4=80.1-110 cm, 5=110.1-140 cm, 6= > 140 cm.

Figure 3: DBH classes versus number of individuals in Chilimo Forest.

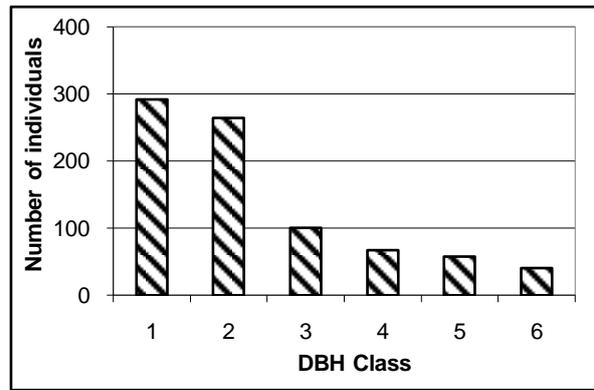
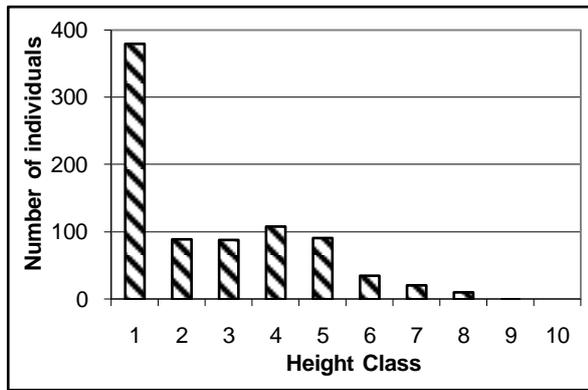
The height of individuals in Chilimo Forest showed a trend where the shorter individuals predominate in the forest. As seen from Figure 4, of trees and shrubs investigated for height in Chilimo Forest, individuals belonging to Height classes 1-5 contribute about 91.7%, while the remaining 8.3 % are those above 18 meters. A slight increase in the number of individuals in the classes 4 and 5 has been contributed by the slight increment of *Juniperus procera*, *Olea europaea* and *Allophylus abyssinicus* species in these classes.

**Table 1:** Alphabetical list of species recorded from Chilimo Forest.

Scientific name	Afaan Oromoo	Family	Habit
<i>Acacia abyssinica</i> Hochst. ex Benth.	Laaftoo Adii	Fabaceae	Tree
<i>Acacia lahai</i> Steud. and Hochst. ex Benth.	Laaftoo Gurraacha	Fabaceae	Tree/shrub
<i>Acanthus sennii</i> Chiov.	Kosorruu	Acanthaceae	Shrub
<i>Achyranthes aspera</i> L.		Amaranthaceae	Herb
<i>Acmella caulirhiza</i> Del.		Asteraceae	Herb
<i>Adiantum thalictroides</i> Willd. ex Schlecht.		Adiantaceae	Fern
<i>Agrocharis melanantha</i> Hochst.	Qurfoo	Apiaceae	Herb
<i>Alchemilla abyssinica</i> Fresen.		Rosaceae	Herb
<i>Allophylus abyssinicus</i> (Hochst.) Radlk.	Sarara	Sapindaceae	Tree
<i>Anthospermum herbaceum</i> L.f.		Rubiaceae	Herb
<i>Apodytes dimidiata</i> E. Mey. ex Arn.	Calalaqa	Icacinaceae	Tree
<i>Arisaema enneaphyllum</i> Hochst. ex A.Rich.		Areceae	Herb
<i>Arundinaria alpina</i> K. Schum.	Shimala	Poaceae	Bamboo
<i>Asparagus africanus</i> Lam.	Sariitii	Asparagaceae	Shrub
<i>Asplenium abyssinicum</i> Fée		Aspleniaceae	Fern
<i>Asplenium aethiopicum</i> (Burm.f.) Bech.		Aspleniaceae	Fern
<i>Asplenium monanthes</i> L.		Aspleniaceae	Fern
<i>Asplenium protensum</i> Schrad.		Aspleniaceae	Fern
<i>Asplenium theciferum</i> (Kunth) Mett.		Aspleniaceae	Fern
<i>Bersama abyssinica</i> Fresen.	Lolchiisaa	Meliantaceae	Shrub/tree
<i>Buddleja polystachya</i> Fresen.		Loganiaceae	Shrub/tree
<i>Calpurnia aurea</i> (Ait.) Benth.	Ceekaa	Fabaceae	Shrub/tree
<i>Carduus leptacanthus</i> R.E. Fries		Asteraceae	Herb
<i>Carduus schimperi</i> Sch. Bip. ex A. Rich	Kosorruu	Asteraceae	Herb
<i>Carex confertus</i> A.Rich.		Cyperaceae	Herb
<i>Carissa spinarum</i> L.	Agamsa	Apocynaceae	Climber
<i>Cassipourea mallossana</i> (Baker) Alston	Gaachan Fullaas	Rhizophoraceae	Tree
<i>Centella asiatica</i> (L.) Urban		Apiaceae	Herb
<i>Cheilanthes farinosa</i> (Forssk.) Kaulf.		Sinopteridaceae	Fern
<i>Chenopodium ambrosioides</i> L.		Chenopodiaceae	Herb
<i>Clausena anisata</i> (Willd.) Benth.	Ulmaa	Rutaceae	Shrub/tree
<i>Clematis simensis</i> Fresen.	Fitiitii	Ranunculaceae	Climber
<i>Clerodendrum myricoides</i> Vatke		Lamiaceae	Shrub
<i>Clutia abyssinica</i> Jaub. and Spach.		Euphorbiaceae	Herb
<i>Commelina africana</i> L.		Commelinaceae	Herb
<i>Conyza bonariensis</i> (L.) Cronq.		Asteraceae	Herb
<i>Conyza hochstetteri</i> Sch.Bip. ex A.Rich.		Asteraceae	Herb
<i>Conyza hypoleuca</i> A.Rich.		Asteraceae	Shrub
<i>Conyza nana</i> Sch.Bip. ex Oliv. and Hiern		Asteraceae	Herb
<i>Conyza pedunculata</i> (Oliv.) Willd.		Asteraceae	Herb
<i>Conyza schimperi</i> Sch.Bip. ex A. Rich.		Asteraceae	Herb
<i>Conyza stricta</i> Willd.		Asteraceae	Herb
<i>Crassula alsinoides</i> (Hook.f.) Engl.		Crassulaceae	Herb
<i>Craterostigma pumilum</i> Hochst.		Scrophulariaceae	Herb
<i>Crotalaria incana</i> L.	Kilkilloo	Fabaceae	Herb
<i>Crotalaria quartiniiana</i> A.Rich.		Fabaceae	Herb
<i>Crotalaria rosenii</i> (Pax) Milne-Redh. ex Polhill		Fabaceae	Herb/shrub
<i>Croton macrostachyus</i> Del.	Makkanniisa	Euphorbiaceae	Tree
<i>Cupressus lusitanica</i> Miller		Cupressaceae	Tree
<i>Cynium humifusa</i> (Forssk.) Engl.		Scrophulariaceae	Herb
<i>Cynodon dactylon</i> (L.) Pers.		Poaceae	Grass
<i>Cynoglossum amplifolium</i> Hochst. ex A.Rich.		Boraginaceae	Herb
<i>Cynoglossum geometricum</i> Bak. and Wright	Maxxaanee	Boraginaceae	Herb
<i>Cyperus bulbosus</i> Vahl		Cyperaceae	Herb
<i>Cyperus niveus</i> Retz.		Cyperaceae	Herb
<i>Cyphostemma cyphopetalum</i> (Fresen.) Decne ex Wild and Drummond		Vitaceae	Climber
<i>Desmodium repandum</i> (Vahl) DC.		Fabaceae	Herb
<i>Dichondra repens</i> J.R. and G. Forest.		Convolvulaceae	Herb
<i>Dichrocephala integrifolia</i> (L.f.) Kuntze		Asteraceae	Herb
<i>Discopodium penninervium</i> Hochst.	Cooqingaa	Solanaceae	Shrub
<i>Dombeya torrida</i> (G.F.Gmel.) P. Bamps	Daannisaa	Sterculiaceae	Tree
<i>Dovyalis abyssinica</i> (A.Rich.) Warp.	Koshommii	Flacourtiaceae	Shrub
<i>Dregea schimperi</i> (Decne) Bullock		Asclepiadaceae	Climber
<i>Dregea schimperi</i> (Decne) Bullock		Asclepiadaceae	Climber
<i>Drynaria volkensii</i> Hieron		Polypodiaceae	Fern
<i>Dryopteris inaequalis</i> (Schlecht.) Kuntze		Aspidiaceae	Fern
<i>Dyschoriste multicaulis</i> (A.Rich.) O. Kuntze		Acanthaceae	Herb
<i>Echinops macrochaetus</i> Fresen.	Kosorruu Harree	Asteraceae	Herb
<i>Ekebergia capensis</i> Sparrm.	Somboo	Meliaceae	Tree
<i>Embelia schimperi</i> Vatke	Aanquu	Myrsinaceae	Climber/(tree)
<i>Epilobium hirsutum</i> L.		Onagraceae	Herb

Scientific name	Afaan Oromoo	Family	Habit
<i>Eragrostis schweinfurthii</i> Chiov.		Poaceae	Grass
<i>Erica arborea</i> L.	Maxaaxee	Ericaceae	Tree/shrub
<i>Eucalyptus globulus</i> Labill.		Myrtaceae	Tree
<i>Euphorbia platyphlos</i> L.	Ichima	Euphorbiaceae	Herb
<i>Ficus sur</i> Forssk.	Harbuu	Moraceae	Tree
<i>Galiniera saxifraga</i> (Hochst.) Bridson	Buniitii	Rubiaceae	Tree/shrub
<i>Galinsoga parviflora</i> Cav.		Asteraceae	Herb
<i>Galium spurium</i> L.	Saam'ee	Rubiaceae	Herb
<i>Geranium arabicum</i> Forssk.		Geraniaceae	Herb
<i>Girardinia bulbosa</i> (Steudel) Wedd.	Doobbii	Urticaceae	Herb
<i>Gnidia glauca</i> (Fresen.) Gilg.	Diddiksaa	Thymelaeaceae	Shrub/tree
<i>Hagenia abyssinica</i> (Bruce) G.F. Gmel.	Heexoo	Rosaceae	Tree
<i>Haplocarpha schimperi</i> (Sch.Bip.) Beauv.		Asteraceae	Herb
<i>Harpachne schimperi</i> Hochst. ex A.Rich.		Poaceae	Grass
<i>Helichrysum forskoolii</i> (G.F.Gmel.) Hilliard and Burt		Asteraceae	Herb
<i>Heracleum abyssinicum</i> (Boiss.) Norman		Apiaceae	Herb
<i>Hypericum peplidifolium</i> A.Rich.		Clusiaceae	Herb
<i>Hypericum quartianum</i> A.Rich.	Hindhee	Clusiaceae	Shrub/tree
<i>Hypericum revolutum</i> Vahl		Clusiaceae	Shrub/tree
<i>Hypoestes forskoolii</i> (Vahl) R.Br.		Acanthaceae	Herb
<i>Hypoestes triflora</i> (Forssk.) Roem. and Schult.		Acanthaceae	Herb
<i>Hypoxis villosa</i> L.f.		Hypoxidaceae	Herb
<i>Ilex mitis</i> (L.) Radlk.	Mi'eessaa	Aquifoliaceae	Tree
<i>Impatiens hochstetteri</i> Warp.		Balsaminaceae	Herb
<i>Impatiens rothii</i> Hook.f.		Balsaminaceae	Herb
<i>Indigofera arrecta</i> Hochst. ex A.Rich.		Fabaceae	Shrub
<i>Isoglossa somalensis</i> Lindau		Acanthaceae	Herb
<i>Jasminum abyssinicum</i> Hochst. ex A.Rich.	Michilbee	Oleaceae	Climber
<i>Juniperus procera</i> L.	Gaattiraa	Cupressaceae	Tree
<i>Justicia schimperiana</i> (Hochst. ex Nees) T. Anders.	Dhummuugaa	Acanthaceae	Shrub
<i>Kalanchoe densiflora</i> Rolfe	Bosoqqee	Crassulaceae	Herb
<i>Kalanchoe petitiiana</i> A.Rich.	Bosoqqee	Crassulaceae	Herb
<i>Lagenaria siceraria</i> (Molina) Standl.	Buqqee Seexanaa	Cucurbitaceae	Climber
<i>Laggera crispata</i> (Vahl) Hepper and Wood		Asteraceae	Herb
<i>Leucas argentea</i> Gurke		Lamiaceae	Herb
<i>Leucas punctata</i> (Benth.) Briq.		Lamiaceae	Herb
<i>Lippia adoensis</i> Hochst. Ex Walp.	Kasee	Verbenaceae	Shrub
<i>Lobelia giberroa</i> Hemsl.	Faaggaa	Lobeliaceae	Herb
<i>Loxogramme lanceolata</i> (Swartz) Presl.		Polypodiaceae	Fern
<i>Maesa lanceolata</i> Forssk.	Abbayyii	Myrsinaceae	Tree/shrub
<i>Maytenus addat</i> (Loes.) Sebsebe		Celastraceae	Tree/shrub
<i>Maytenus arbutifolia</i> (A.Rich.) Wilczek		Celastraceae	Shrub/tree
<i>Maytenus gracilipes</i> (Welw. ex Oliv.) Exell	Qarxamnee	Celastraceae	Shrub/tree
<i>Mikaniopsis clematoides</i> (A.Rich.) Milne-Redh.		Asteraceae	Climber
<i>Mimulopsis solmsii</i> Schweinf.		Acanthaceae	Herb
<i>Myrica salicifolia</i> Hochst. ex A.Rich.	Barooddoo	Myricaceae	Tree
<i>Myrsine africana</i> L.	Qacama	Myrsinaceae	Shrub/tree
<i>Myrsine melanophloeos</i> (L.) R.Br.		Myrsinaceae	Tree/(shrub)
<i>Nuxia congesta</i> R.Br. ex Fresen.	Qawwisa	Loganiaceae	Tree/shrub
<i>Oenanthe palustris</i> (Chiov.) Norman	Goojjiiyee	Apiaceae	Herb
<i>Oldenlandia monanthos</i> (A.Rich.) Hiern		Rubiaceae	Herb
<i>Olea capensis</i> L. subsp. <i>macrocarpa</i> (C.A.Wright) Verdc.	Gagamaa	Oleaceae	Tree
<i>Olea europea</i> L. subsp. <i>cuspidata</i> (Wall. ex G.Don) Cif.	Ejersa	Oleaceae	Tree
<i>Olea welwitschii</i> (Knobl.) Gilg and Schellenb.		Oleaceae	Tree
<i>Olinia rochetiana</i> A.Juss.	Daalachoo	Oliniaceae	Shrub/tree
<i>Oplismenus hirtellus</i> (L.) P. Beauv.	Qacaa	Poaceae	Grass
<i>Orobanche minor</i> Smith		Orobanchaceae	Herb
<i>Osyris quadripartita</i> Decne	Waatoo	Santalaceae	Shrub/tree
<i>Oxalis corniculata</i> L.		Oxalidaceae	Herb
<i>Oxalis procumbens</i> Steud. ex A.Rich.		Oxalidaceae	Herb
<i>Pavetta abyssinica</i> Fresen.		Rubiaceae	Shrub
<i>Pavonia urens</i> Cav.		Malvaceae	Shrub
<i>Pellaea quadripinnata</i> (Forssk.) Prantl.		Adiantaceae	Fern
<i>Pennisetum clandestinum</i> Chiov.	Saardoo	Poaceae	Grass
<i>Pennisetum sphacelatum</i> (Nees) Th.Dur. and Schinz	Migira	Poaceae	Grass
<i>Pentas schimperiana</i> (A.Rich.) Vatke		Rubiaceae	Shrub/herb
<i>Peperomia abyssinica</i> Miq.		Piperaceae	Herb (epiphyte)
<i>Periploca linearifolia</i> Quart.-Dillon and A.Rich.	Aannannoo	Asclepiadaceae	Climber
<i>Persicaria nepalensis</i> (Meisn) Miyabe		Polygonaceae	Herb
<i>Persicaria setosula</i> (A.Rich.) K.L. Wilson		Polygonaceae	Herb
<i>Peucedanum mattirolii</i> Chiov.		Apiaceae	Herb
<i>Peucedanum petitianum</i> A.Rich.		Apiaceae	Herb
<i>Phragmenthera macrosolen</i> (A.Rich.) M. Gilbert		Loranthaceae	Semi-parasite
<i>Phytolacca dodecandra</i> L'Herit.	Andoodee	Phytolaccaceae	Shrub

Scientific name	Afaan Oromoo	Family	Habit
<i>Pinus patula</i> Schlecht. and Chamiso		Pinaceae	Tree
<i>Pittosporum viridiflorum</i> Sims		Pittosporaceae	Tree/shrub
<i>Plantago lanceolata</i> L.	Qorxobbii	Plantaginaceae	Herb
<i>Plantago palmata</i> Hook.f		Plantaginaceae	Herb
<i>Plectranthus garckeianus</i> Vatke		Lamiaceae	Herb
<i>Plectranthus punctatus</i> L'Herit		Lamiaceae	Herb
<i>Pleopeltis macrocarpa</i> (Willd.) Kaulf.		Polypodiaceae	Fern
<i>Pleopeltis phlemodes</i> (Mett.) Pici-Serm.		Polypodiaceae	Fern
<i>Podocarpus falcatus</i> (Thunb.) Mirb.	Birbira	Podocarpaceae	Tree
<i>Polygala sphenoptera</i> Fresen		Polygalaceae	Herb
<i>Polystachya rivae</i> Schweinf.		Orchidaceae	Herb
<i>Prunus africana</i> (Hook.f.) Kalkm.	Hoomii/Gurraa	Rosaceae	Tree
<i>Pseudognaphalium luteo-album</i> (L.) Hilliard and Burt		Asteraceae	Herb
<i>Pseudognaphalium richardianum</i> (Cuf.) Hilliard and Burt		Asteraceae	Herb
<i>Pteris cretica</i> L.		Adiantaceae	Fern
<i>Pteris dentata</i> Forssk.		Adiantaceae	Fern
<i>Pterolobium stellatum</i> (Forssk.) Brenan		Fabaceae	Climber
<i>Ranunculus multifidus</i> Forssk.		Ranunculaceae	Herb
<i>Rhamnus staddo</i> A.Rich.	Qadiidaa	Rhamnaceae	Shrub/tree
<i>Rhus glutinosa</i> A.Rich. subsp. <i>neoglutinosa</i> (M.Gilbert) M.Gilbert	Xaaxessaa	Anacardiaceae	Shrub/tree
<i>Rhus glutinosa</i> A.Rich. subsp. <i>glutinosa</i>		Anacardiaceae	Shrub/tree
<i>Rhus vulgaris</i> Meikle	Daboobessa	Anacardiaceae	Shrub/tree
<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek		Brassicaceae	Herb
<i>Rosa abyssinica</i> Lindley	Inqooxoo	Rosaceae	Shrub/climber
<i>Rubus steudneri</i> Schweinf.	Goraa	Rosaceae	Shrub
<i>Rumex abyssinicus</i> Jacq.		Polygonaceae	Herb
<i>Rumex nepalensis</i> Spreng.	Tuultii	Polygonaceae	Herb
<i>Rumex nervosus</i> Vahl		Polygonaceae	Shrub
<i>Salix mucronata</i> Thunb.	Alaltuu	Salicaceae	Tree
<i>Salvia nilotica</i> Juss. ex Jacq.	Qoricha Michii	Lamiaceae	Herb
<i>Sanicula elata</i> Buch.-Ham. ex D. Don		Apiaceae	Herb
<i>Satureja abyssinica</i> (Benth.) Briq.		Lamiaceae	Herb
<i>Satureja biflora</i> (Ham. ex Don) Briq.		Lamiaceae	Herb
<i>Satureja paradoxa</i> (Vatke) Engl.	Baadu Furdis	Lamiaceae	Herb
<i>Scadoxus multiflorus</i> (Martyn) Raf.	Ija Dhukkubsituu	Amaryllidaceae	Herb
<i>Schefflera abyssinica</i> (Hochst. ex A.Rich.) Harms	Arfattuu	Araliaceae	Tree
<i>Schefflera volkensii</i> (Engl.) Harms		Araliaceae	Tree
<i>Schoenoxiphium sparteum</i> (Whal.) Kuk		Cyperaceae	Herb
<i>Schrebera alata</i> (Hochst.) Welw.		Oleaceae	Tree/shrub
<i>Scolopia theifolia</i> Gilg	Gaallee	Flacourtiaceae	Tree
<i>Selaginella abyssinica</i> Spreng.		Selaginellaceae	Fern
<i>Sida schimperiana</i> A.Rich.		Malvaceae	Herb
<i>Sideroxylon oxyacanthum</i> Baill.	Biitee	Sapotaceae	Shrub/tree
<i>Smilax aspera</i> L.	Harangamaa	Smilacaceae	Climber
<i>Solanecio gigas</i> (Vatke) C. Jeffrey	Bosoqa	Asteraceae	Shrub/tree
<i>Solanecio mannii</i> (Hook.f.) C. Jeffrey		Asteraceae	Shrub/tree
<i>Solanecio tuberosus</i> (Sch.Bip.) C. Jeffrey		Asteraceae	Herb
<i>Solanum anguivi</i> Lam.		Solanaceae	Herb
<i>Solanum incanum</i> L.		Solanaceae	Shrub
<i>Solanum marginatum</i> L.f.	Iddii Baddaa	Solanaceae	Shrub
<i>Solanum nigrum</i> L.		Solanaceae	Herb
<i>Sphaeranthus sauveolens</i> (Forssk.) DC.		Asteraceae	Herb
<i>Stellaria sennii</i> Chiov.		Caryophyllaceae	Herb
<i>Stephania abyssinica</i> (Dill. and A.Rich.) Warp.	Kalaalaa	Menispermaceae	Climber
<i>Tagetes minuta</i> L.		Asteraceae	Herb
<i>Teclea nobilis</i> Del.	Hadheessa	Rutaceae	Tree/shrub
<i>Thalictrum rhynchocarpum</i> Dill. and A.Rich.		Ranunculaceae	Herb
<i>Thymus schimperii</i> Ronn.	Xoosanyii	Lamiaceae	Herb
<i>Torilis arevensis</i> (Hudson) Link		Apiaceae	Herb
<i>Trifolium semipilosum</i> Fresen.		Fabaceae	Herb
<i>Uebelinia abyssinica</i> Hochst.		Caryophyllaceae	Herb
<i>Urera hypselodendron</i> (A.Rich.) Wedd.	Laanqisaa	Urticaceae	Climber
<i>Urtica simensis</i> Steudel	Saammaa	Urticaceae	Herb
<i>Vernonia amygdalina</i> Del.	Heebicha	Asteraceae	Tree
<i>Vernonia leopoldi</i> (Sch.Bip.) Vatke	Reejii	Asteraceae	Shrub
<i>Vernonia rueppellii</i> Sch.Bip. ex Walp.		Asteraceae	Shrub
<i>Vernonia urticifolia</i> A. Rich.		Asteraceae	Herb
<i>Veronica abyssinica</i> Fresen.		Scrophulariaceae	Herb

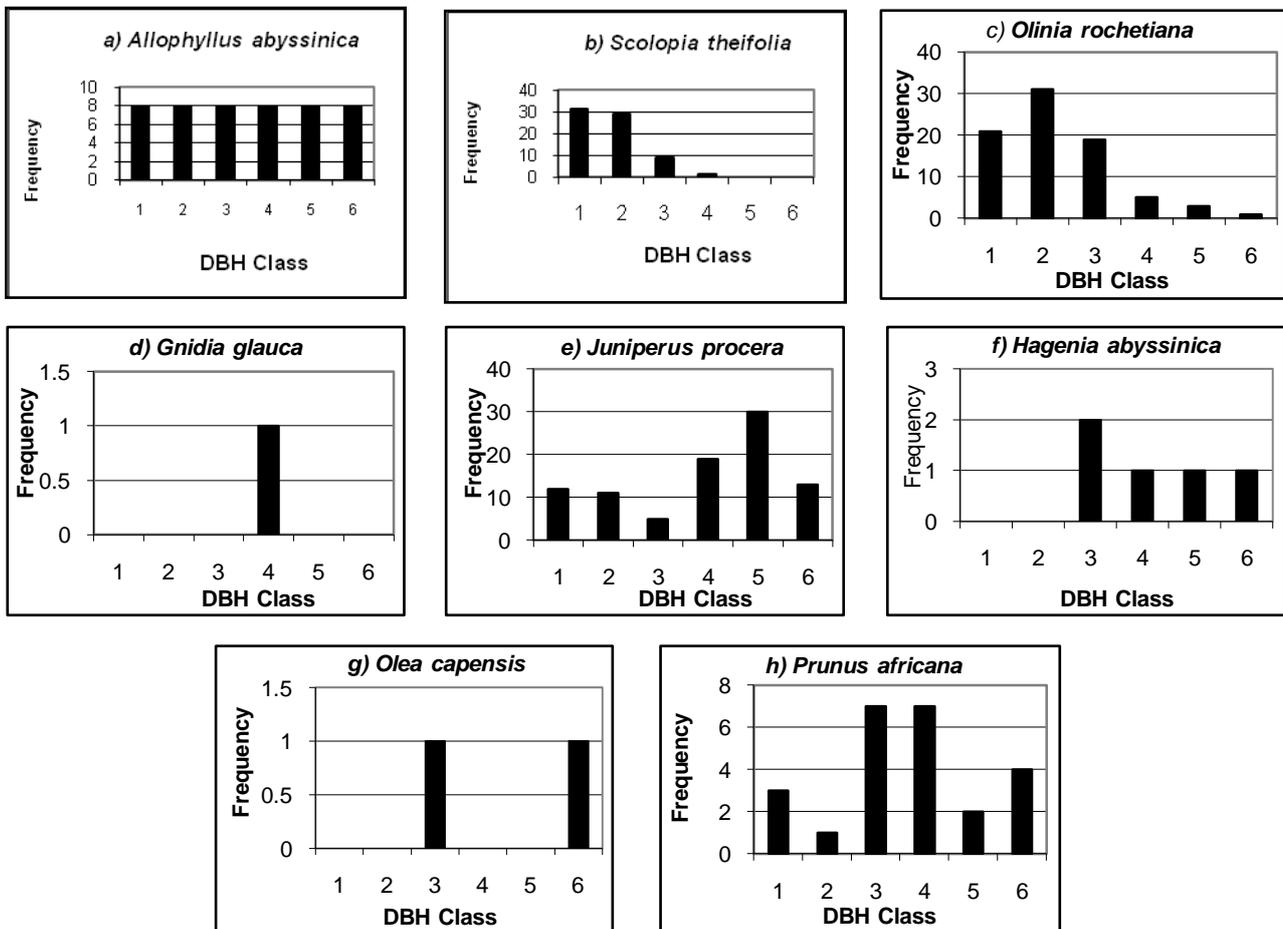


Legend: 1=1.5-6 m, 2=6.1-9 m, 3=9.1-12 m, 4=12.1-15 m, 5=15.1-18 m, 6=18.1-21 m, 7=21.1-24 m, 8=24.1-27 m, 9=27.1-30 m, 10=> 30m  
**Figure 4:** Height classes versus number of individuals in Chilimo Forest.

In general, the differences observed in DBH and Height classes' distribution could be attributed to the exploitation histories of the forest. These data suggest that the forest was not free from exploitation. However, the extent of exploitation varies from one-forest patches to another. Particularly, the presence of sawmill in this forest for longer period had reduced it to small patches of secondary forest vegetation. Intensive and selective cutting of timber species was believed to be intensified during the Italian occupation where the Forest was in the hand of foreign investors.

**Population Structure of Some Species**

Thirty-seven woody species were investigated for population structure in Chilimo Forest. The structural analysis showed four major patterns as reproduced in Figs.5 a-h. *Allophylus abyssinicus* and *Prunus africana* form the first pattern (Fig. 5a), which have even distribution of species in the different classes. The second pattern (Fig. 5b) is the pattern formed by *Scolopia theifolia* and *Maytenus gracilipes*. In this pattern more individuals are in the lowest DBH classes.



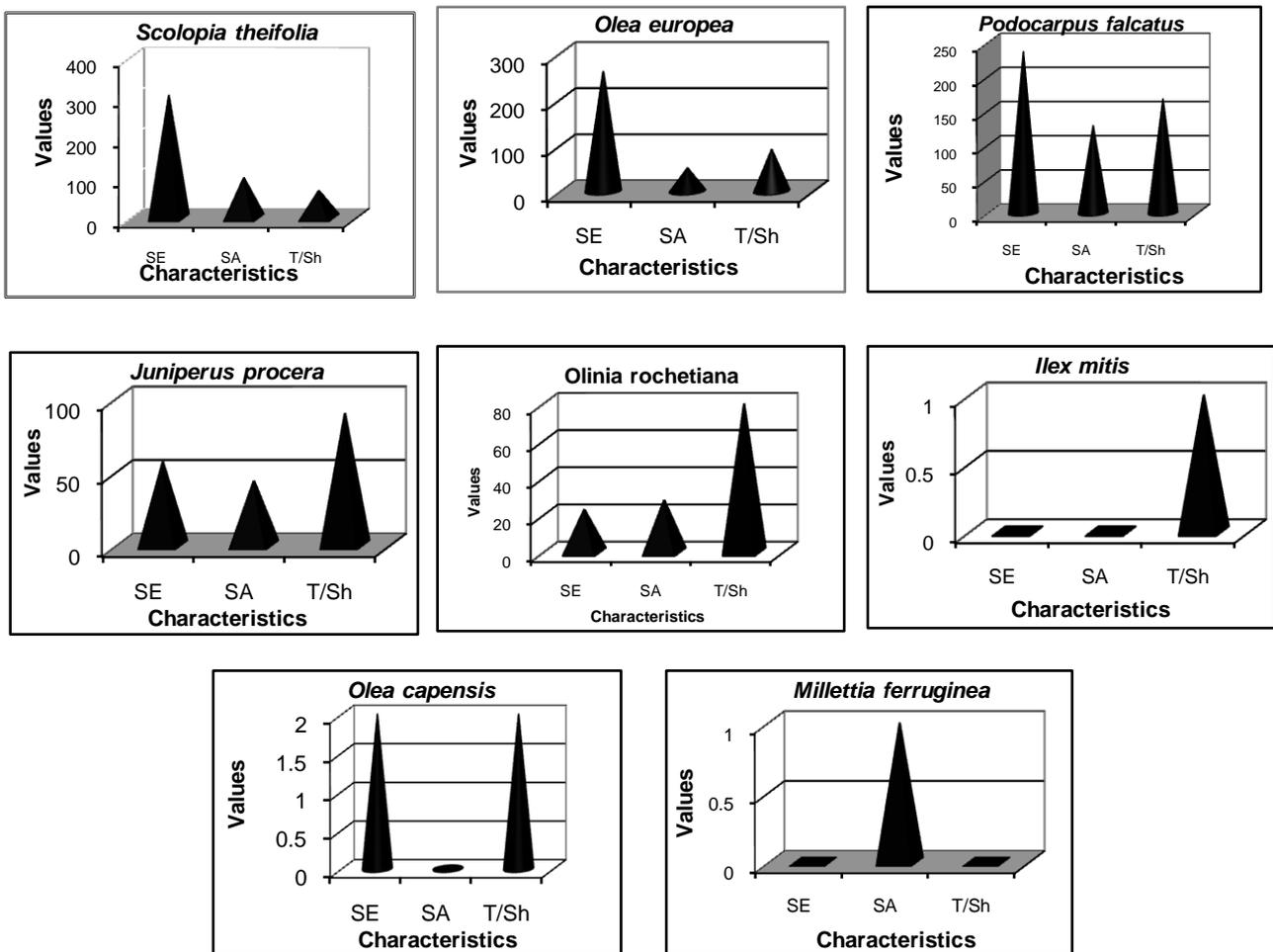
**Figure 5 (a-h).** Four representative patterns of woody species over the DBH classes in Chilimo Forests.

*Olea europaea* and *Olinia rochetiana* form the third pattern (Fig. 5c). In this pattern the number of individuals is lower in the first class and increases in the second followed by gradual decrease towards the higher classes. The fourth pattern (Fig. 5d) is a pattern with only few individuals represented in certain classes. *Maytenus addat* and *Gnidia glauca* belong to this pattern in this forest. On top of other factors, such pattern may suggest the rarity of a species in the forest as well. The fifth pattern is a pattern exhibited by *Juniperus procera* (Fig. 5e). This pattern shows that selective cutting of Juniper has been taking place on DBH classes 3 and 6 in the forest. It is important to note here that the structure of a given species could vary from forest to forest depending on the status and the history of that forest. Perhaps, this shows that there has been a special preference of

different size individuals of a species for different purposes by the people living in and around the forests.

**Regeneration Status of Some Woody Species**

The Chilimo Forest was also investigated for the regeneration status of some selected woody species. Some species are represented by their seedlings while others by their saplings. The highest seedling was recorded for *Maytenus gracilipes* followed by *Allophylus abyssinicus* and *Bersama abyssinica* (see Table 4). The highest sapling was recorded for *Maytenus gracilipes* followed by *Podocarpus falcatus* and *Scolopia theifolia*. The highest tree/shrub number was that of *Podocarpus falcatus* denoting that this species is in a better condition in Chilimo Forest. Based on the data gathered from the field seedlings, saplings and tree/shrub distribution of some selected species are presented in Figure 6.



**Figure 6:** Seedlings, saplings and tree/shrub distribution of some selected species occurring in Chilimo Forest.

**Use Values of Some Selected Species**

An interview on the uses of some major plant species was made so as to deduce the extent of pressure on a particular species. The participants have pointed out the major uses of wood products and non-wood products extracted from the forest. The use of plants by the local people can be grouped into a number of non-restrictive categories. For the purposes of simplicity, the following use categories of the plants were considered here: timber, construction, farm implements, firewood, charcoal, spices,

medicinal, bee forage and for hive hanging purposes. Thirty-eight species were included in the interview. Of these 13 were identified as timber species, 14 for construction, another 14 for farm implements, 35 species for firewood, 21 species for charcoal production, 13 species for medicinal purposes, 25 species for bee forage and 25 species as used for hive hanging (Figure 7). In Chilimo a given species could serve different purposes. For example, *Olea europaea* and *Prunus africana* serve 6 different purposes (Table 4).

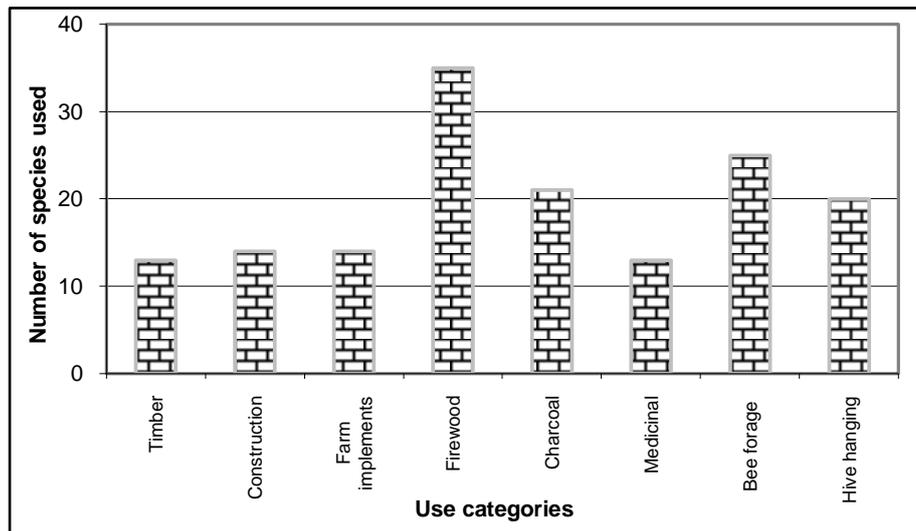


Figure 7: Use categories and number of species used in Chilimo Forest.

On top of the aforementioned uses in Chilimo Forest, there is a seed collection practice in the area. Seeds are collected from different species and sold as a means to generate income for the local people. The seed of some species are quite expensive. For example, 1 kg of the seed of *Juniperus procera* costs 50 Birr (see Table 2). In fact these extractions of seeds promote the multiplication of these species and are considered as a trend to be promoted in other places. However, care must be taken not to over-exploit the concerned species and reduce their genetic variety.

Table 2: Current cost of the seeds of some species in Chilimo as indicated by farmers.

No	Seeds of species (in kg)	Cost in Birr*
1	<i>Juniperus procera</i>	50
2	<i>Prunus africana</i>	7
3	<i>Podocarpus falcatus</i>	20
4	<i>Ekebergia capensis</i>	10
5	<i>Allophylus abyssinicus</i>	7
6	<i>Olea capensis</i>	7
7	<i>Apodytes dimidiata</i>	7
8	<i>Dombeya torrida</i>	12
9	<i>Hagenia abyssinica</i>	12
10	<i>Erythrina brucei</i>	10

### Endemism

There are a number of flowering plant species in Chilimo forest that are endemic. Information on the endemic flowering plant species of Ethiopia and the levels of threat to them has been published in Ensermu et al. (1992), and Vivero et al. (in press). Based on the published Flora volumes and the lists of species in this forest, the endemic species and the levels of threat on each taxon are given in Table 3 below.

Table 3 shows that 17 endemic species have been recorded from Chilimo Forest. Based on the IUCN Criteria of level of threat, 1 species is endangered (EN) and 2 species have been evaluated as vulnerable (VU), 4 other species have been categorised as not threatened (NT). The remaining ten species have been found to be categorized as species of least concern (LC).

Table 3: Endemic species occurring in Chilimo Forest.

No	Scientific name	Status	Family
1	<i>Acanthus sennii</i>	NT	Acanthaceae
2	<i>Conyza nana</i>	EN	Asteraceae
3	<i>Crotalaria rosenii</i>	NT	Fabaceae
4	<i>Impatiens rothii</i>	LC	Balsaminaceae
5	<i>Kalanchoe petitiiana</i>	LC	Crassulaceae
6	<i>Lippia adoensis</i>	LC	Verbanaceae
7	<i>Maytenus addat</i>	NT	Celastraceae
8	<i>Mikaniopsis clematoides</i>	LC	Asteraceae
9	<i>Phragmenthera macrosolen</i>	LC	Loranthaceae
10	<i>Polystachya rivae</i>	VU	Orchidaceae
11	<i>Rhus glutinosa</i> subsp. <i>glutinosa</i>	VU	Anacardiaceae
12	<i>Rhus glutinosa</i> subsp. <i>neoglutinosa</i>	LC	Anacardiaceae
13	<i>Satureja paradoxa</i>	NT	Lamiaceae
14	<i>Solanecio gigas</i>	LC	Asteraceae
15	<i>Thymus schimperi</i>	LC	Lamiaceae
16	<i>Vernonia leopoldi</i>	LC	Asteraceae
17	<i>Vernonia rueppellii</i>	LC	Asteraceae

### Status of Some Selected Species

Some woody species of the Chilimo Forest are used for many purposes. Moreover, these species are not represented (if represented by few individual) by the various stages of development. It is then quite clear that such species that have been over utilized and lack replacement would eventually disappear from the forest. For example, *Gnidia glauca*, *Ilex mitis* and *Maytenus addat* (see Table 4) are not represented by either seedling or sapling stages, showing that these species are those that need immediate conservation measures. Contrary to this fact, some species though over utilized are represented by better individuals (e.g., *Podocarpus falcatus* and *Scolopia theifolia*) at different stages. Species that are used for various purposes and yet bearing pattern II type of population structure are those that have good reproduction and recruitment (e.g. *Scolopia theifolia*). Such species are those that don't need urgent conservation attention.

**Table 4:** Status of some selected species of the Chilimo Forest. Note that the structure of these species is the one discussed under population structure previously.

Species	Seedlings	Saplings	Tree/ Shrub	Structural pattern	No. of uses
<i>Allophylus abyssinicus</i>	404	21	40	Pattern I	4
<i>Apodytes dimidiata</i>	9	1	5	IV	4
<i>Bersama abyssinica</i>	365	33	20	III	2
<i>Calpurnea aurea</i>	8	5	6	IV	3
<i>Ekebergia capensis</i>	22		18	II	1
<i>Galiniera saxifraga</i>	22		6	III	2
<i>Gnidia glauca</i>			1	IV	4
<i>Hagenia abyssinica</i>	43		5	IV	4
<i>Ilex mitis</i>			1	IV	2
<i>Juniperus procera</i>	57	44	90	V	4
<i>Maytenus addat</i>			2	IV	2
<i>Maytenus gracilipes</i>	907	162	72	II	2
<i>Myrica salicifolia</i>	2		3	IV	4
<i>Nuxia congesta</i>	14	11	20	III	3
<i>Olea capensis</i>	2		2	IV	5
<i>Olea europaea</i>	259	50	90	III	6
<i>Olinia rochetiana</i>	23	28	80	III	5
<i>Podocarpus falcatus</i>	236	128	167	II	5
<i>Prunus africana</i>	28	1	25	III	6
<i>Scolopia theifolia</i>	306	107	69	II	3
<i>Sideroxylon oxyacanthum</i>			10	II	5

## CONCLUSIONS

Chilimo Forest is one of the remaining Afromontane forests harbouring many endemic species. This forest is ecologically, socially, economically and culturally very important for the inhabitants residing near by who are mostly dependent on forest product to make their living. Loss of such a forest and the various threatened species would have great implications for the environment, biodiversity and socio-economic setup of the communities. This forest harbours species that economically and ecologically important. Yet some of these species had population structures that showed patterns with no or few individuals at lower size classes. Such species requires urgent conservation measures that will enhance healthy regeneration and guarantee sustainable uses of these species. Some other economically important species of this forest were not represented in the seedling or sapling stages denoting that they are under threat. It is therefore mandatory to implement conservation measures (both in-situ and ex-situ) for such species of the forest. Although *Juniperus procera* and *Podocarpus falcatus* are both common in Chilimo Forest, the former has been more affected than the later being extracted for timber. However, the condition seems improving, at least in forest patches situated away from the urban centre. It has been observed that the second most important timber tree species, *Podocarpus falcatus* is regenerating at an alarming rate, while *Juniperus procera* also shows encouraging recovery.

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