

# ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES



Comparative Floristic study on  
Menagesha Suba State Forest on Years  
1980 and 2006

ABATE ZEWDIE BEKA

A Thesis submitted to the School of Graduate Studies  
in Partial Fulfillment for the Degree of Master of  
Botanical Science

May, 2007

## ABSTRACT

A comparative study of vegetation data of Menagesha Suba State Forest between 1980 and 2006 in the central plateau of Ethiopia was conducted. The forest represents a dry evergreen Afromontane Forest. The vegetation data were correlated in previously laid 50 quadrants, each with 20 m x 20 m systematically. The presence and absence of all shrubs and trees in the stands were recorded. Density values for trees and shrubs were registered. Soil pH, altitudes, slopes and aspect were measured. The vegetation data were analyzed using Association Analysis and TWINSpan. Results of the Association Analysis were used for matching the species used as characteristic in the determining the community types in the previous and the current study. TWINSpan outputs are used to identify vegetation types using polythetic hierarchical approach. According to the outputs of TWINSpan Analysis six clusters were recognized. These are: 1. *Cupressus lusitanica*, 2. *Myrsine africana* – *Erica arborea*, 3. *Myrsine africana* – *Olea europaea*, 4. *Olea europaea* – *Sideroxylon gillettii*, 5. *Dovyalis abyssinica* – *Allophylus abyssinicus*, 6. *Lantana trifolia* - *Juniperus procera* . Structural analysis of the forest showed dominance of small sized species.

*Key words* – *community, dry evergreen montane forest, clustering, menagesha suba state forest*

## **ACKNOWLEDGEMENTS**

I would like to express my deepest gratitude and appreciation to my research advisors, Prof. Sebsebe Demissew and Prof. Zerihun Woldu for their help in identifying the topic, their consistent and stimulating advice.

I am thankful to Samuel Yirdaw and Getachew Tena, experts of Menagesha Suba State Forest, who gave me material support and information regarding the forest.

I am highly indebted to my wife Memee Melese for her constant encouragement which contributed to the successful completion of the study.

Above all, I thank God for helping me endure the rigorous of every day life and to overcome the challenges of graduate studies.

# TABLE OF CONTENTS

<b>Contents</b>	<b>pages</b>
ABSTRACT	i
ACKNOWLEDGEMENTS	ii
LIST OF ACRONYMS	i
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF APPENDIXES	viii
1. INTRODUCTION	1
1.1. Back ground and Statement of the Problem	1
1.2. Objective of the Study	8
1.2.1. General Objective	8
1.2.2. Specific Objective	8
1.3. Description of the Study Area	9
1.3.1. Location and General Feature of the Study Area	9
1.3.2. Geology and Climate	11
1.3.3. Ecology	13
1.3.4. Natural Vegetation	15
1.3.5. Conservation Issues	15
2.0 LITERATURE REVIEW	19
2.1. The Forest Vegetation of Ethiopia	19
2.2. Techniques of Vegetation Data Analysis	24
2.3. Classification	24
3.0 METHODS	30

3.1. Floristic Data Analysis	30
3.2. Structural Data Analysis	31
3.3. Soil Analysis method	33
4.0. RESULTS and DISCUSSION	35
4.1. Vegetation Community Classification	36
4.1.1. Comparison of the different groups of stands with the previous studied	43
4.2. Forest Structure and Species Composition	47
5.0. CONCLUSION	55
6.0. RECOMMENDATIONS	58
7.0. REFERENCES	60

## **LIST OF ACRONYMS**

MOARD: Ministry of Agriculture and Rural Development Office.

EFAP: Ethiopia Forestry Action Programme.

IUCN: International Union for the Conservation of Nature and Natural Resource.

EARO: Ethiopia Agricultural and Research Organization

EPA: Environmental Protection Authority.

FAO: Food and Agricultural Organization of the United Nations.

UNEP: United Nations Environmental Programme.

NCS: National Conservation Strategy.

IUFRO: International Union of Forestry Research Organization.

UNDP: United Nations Development Programme.

ECA: Economic Commission for Africa.

JICA: Japan International Cooperation.

SFCDD: State Forests Conservation and Development.

<b>LIST OF TABLES</b>	<b>PAGES</b>
Table 1. Soil pH data of 1980 and 2006 at 10cm depth	25
Table 2. Number, percentage, and life form of collected species in 1980 and 2006	35
Table 3. Comparison of two years species collected (1980 and 2006)	29
Table 4. TWINSpan output	46
Table 5. Species used in dividing stands	50
Table 6. Relative Basal Area, Relative Density, Relative frequency and Importance Value Index of the dominant tree species recorded in the study area	59

## **LIST OF FIGURES**

## **PAGES**

1. Location of Menagesha Suba State Forest	7
2. Fauna and Flora distribution on Menagesha Suba State Forest	10
3. Nursery of Suba which is the first modern nursery in Ethiopia	12
4. a view along the Dhamocha into the crater at the top	12
5. Breaking and grounding fuel wood for the next collection and cut and removed trees by local people	13
6. Map of Menagesha Suba State Forest	22
7. Association Analysis groups	44
7. Five representative patterns of trees density value over DBH classes in the Menagesha Suba State Forest.	48

## **LIST OF APPENDIXES**

Appendix 1: Perception of Local People on Forest.

Appendix 2: Multiple comparison of pH with community for  
TWINSpan output.

Appendix 3: Multiple comparison of pH with community for  
Association Analysis output.

Appendix 4: List of species recorded in the study area.

Appendix 5: Relevé characteristics of Menagesha Suba State Forest.

Appendix 6: Field data collection form.

Appendix 7: List of National Forest Priority Areas (NFAPs).

Appendix 8: Species which were new and not encountered in the plots as  
compare to 1980 studied.

# **1. INTRODUCTION**

## **1.1. Back ground and statement of the problem**

According to EFAP (1994), historical sources indicate that, high forests might have once covered about 35-40 % of the total land area of the country. If the savannah woodlands are included, 66 % of the country was believed to have been covered with forests and woodlands. However, the country's forest and woodland resources have been declining both in size (deforestation) and quality (degradation). As a result, it has been estimated that high forests covered 16 % of the land area in the early 1950's, 3.6 % in early 1980's and only 2.7 % in 1989 (EFAP, 1994). Some 5 million ha savannah woodlands were remaining at that time giving a total forest and woody vegetation area of 7 %. In 1994, it has been estimated that such forests cover less than 2.3 % of the country (EFAP, 1994). With the current annual loss of high forests, estimated at 150,000-200,000 ha (EFAP, 1994), it has been projected that the area covered by high forests may be reduced to scattered minor stands of heavily disturbed forests in accessible areas of the country within a few decades.

Friis (1992) described that the main reasons for deforestation in Ethiopia are clearing of forests and woodlands for expansion of permanently cultivated

areas, uncontrolled exploitation for various purposes, notably for fuel wood, construction materials, shifting cultivation and forest fire. The fact that plantation forestry has been very far from meeting the demand for wood for various purposes indicates inevitability of deforestation. The underlying causes of deforestations are however, closely linked with the vicious cycle of mutually reinforcing factors, i.e. poverty, population growth, poor economic growth and the state of the environment.

According to Kessler (1993), the causes of forest destruction include factors such as conversion of forest areas for agricultural lands, demands for fuel wood, construction material and fodder. EFAP (1994), also supports the idea that destruction of biodiversity is driven by the demand for cropping and grazing land by the growing population.

These demands, coupled with that for fuel wood, are responsible for the loss of forests, woodlands and bushlands. However, according to Shiva (1990) and FTP (1995), communities that live in harmony with their ecosystem always protect their biodiversity. According to EFAP (1994), the displacement of people and the displacement of biodiversity go hand in hand.

As indicated by Ensermu Kelbessa et al. (1992), ecological and environmental problems such as soil degradation, erosion and decrease in biodiversity as well

as the loss of potential natural resources are just some of the negative effects resulting from the destruction of forests. The depletion of the natural vegetation in many parts of the country has also led to the threat and decline in number and area of distribution of many plant species and surprisingly, 120 threatened endemic plant species are known from Ethiopian natural vegetation.

Eshetu Yirdaw (2002) indicated that the other reason for such high rate of forest destruction in Ethiopia is the inadequacy in the use standard forest management practices. The current use of forest resources and exploitation is not based on adequate management plans. With the current population rise of more than 70 million, which is growing at rate of 2.92 per annum, the pressure on the remaining forests is high.

Sebsebe Demissew (1998), pointed out that unless the present trend of exploitation of the remaining forest resources and their conversion into agricultural land is changed, every piece of relict forest remaining will be gone in the very near future. The trend can only be reversed if appropriate measures are taken to halt them.

Environmental degradation, particularly the depletion and degradation of natural forest cover has reached a serious stage (UNEP, 1995). Efforts to conserve the remaining natural forest and rehabilitate and combat

environmental degradation have been in progress during the past few decades (EFAP, 1994). However, the problem is still far from being resolved due to the failure in realizing the importance of direct involvement of local people in planning, monitoring, evaluation and implementation process of the forest resource management (JICA, 1997). Lack of appropriate forest and land tenure policies and restriction of forest development responsibilities to the government alone have greatly hampered the forest conservation and expansion in the past three decades (IUCN, 1994).

Natural resource conservation by government bodies has a shorter history in Ethiopia. But it is clear that a number of communities had traditional resource management practices including some elements of natural resource conservation (EFAP, 1994). However, there seems to be little systematic documentation of such practices. To conserve the remaining natural forest of Ethiopia and the environment for the genetic resources and raw material for the industries, 58 National Forest Priority Areas (NFPA's) covering an area of 3.6 million ha have been selected (SFCDD, 1990). These areas (Appendix 7) comprise natural forests, plantations, and non-forested land and cover a total of 4.8 million ha of which 2.8 million ha have been estimated to be natural forests (Demel Teketay, 1999). Menagesha Suba State forest is one of them.

However, the study carried out by the Ministry of Water Resource for the Abbay River Basin Master Plan Project in 1966 indicated that the protection of these NFPA's had not been effective. This was attributed to the failure to fully recognize the historical and customary rights and interests of local communities in forest products and forestlands (JICA, 1997). Planning efforts in the past have been hampered by the non-inclusion of local communities and their leaders (JICA, 1997). Local communities frequently disregard boundaries established by the forestry sectors on the grounds that these boundaries violated their traditional access to and dependence on the forest.

A study carried out by UNDP/ECA, (1997) in Dibate Wereda in Mitekel Zone (Benishangul-Gumuz Region) indicated that local people set aside natural bamboo stands for particular purposes. Farmers developed rules and regulations governing the use of these bamboo resources and local people agreed on societal norms in relation to the management and utilization of these bamboo resources. Despite the fact that the area has been deforested due to settlement during the past two decades these bamboo patches have still survived. Similar indigenous forest management approaches have been observed elsewhere in some parts of Ethiopia (NCS, 1990).

In order to maintain the ecological equilibrium and to meet the forest resources requirement of the population, scientific information is the basis.

Without a full assessment of the properties of the various sites in a forest and their relation to vegetation growth the management of the forest will be severely handicapped. Therefore, ecological assessment of the existing forests is the basis for meaningful planning to rationally utilize the remaining forest resources.

According to White (1983), the exercise in vegetation description and classification in Africa had mainly relied on physiognomic features. However the merits of having to ascribe floristic elements to phytogeographical areas in which they occur have also been emphasized.

The purpose of vegetation description is to enable people build mental picture of an area and its vegetation and to allow the comparison and ultimate classification of different units of vegetation. Moreover, vegetation description is essential to know what species are present, what their distribution is and what the relative degree of abundance of each species is before any serious of detailed work can be commenced in an area (Kershaw, 1973). Thus the first objective in ecological work is to learn the composition, life form composition, species diversity and structure of vegetation.

Menagesha Suba State Forest could be considered as the oldest park in Africa is one of the few remaining patches of dry evergreen afromontane forest in the central highlands of Ethiopia. The emperor Zera Yacob (1434-1468), designated the forest as one of the “*Crown Forest*” of the country. He arranged for it to be planted with seedlings of the giant *Juniperus* found in Wef Washa a forest between Ankober and Debre Sina. So we know that the biggest trees in Menagesha Suba today are over 500 years old (MOARD, 2002).

According to MOARD (2002), the first national policy for Ethiopia was developed by Emperor Menelik II in the late 1890s. He set aside State Forest Reserves, including Menagesha State Forest. Guards were assigned to protect the forest, and boundaries were demarcated.

A study of Menagesha Suba state Forest was made by Sebsebe Demissew in 1980. However, comparison of the current situation not made since then. Such intermittent comparison with base line data would be useful for the management and rational utilization of the forest resources of the area. Therefore species documentation, classification, description and soil pH of the forests have to be a continuous exercise.

## **1.2. OBJECTIVE OF THE STUDY**

### **1. 2.1. General objective**

- To investigate the difference between the current floristic composition and structure of the vegetation of Menagesha State Forest to that studied by Sebsebe Demissew (1980).

### **1.2.2. Specific objectives**

- To detect the change in vegetation composition between 1980 and 2006
- To obtain an insight of the succession of the vegetation
- To recommend management option.

## 1.3. DESCRIPTION OF THE STUDY AREA

### 1.3.1. Location and General Feature of the Study Area.

Menagesha Suba State Forest could be considered as the ‘*the Oldest Park in Africa*’, which is located in central part of the country 30 km from Addis Ababa. It is found between of  $38^{\circ}31'$  and  $38^{\circ}35'$  E and  $9^{\circ} 89'$  and  $9^{\circ} 00'$  N in Oromia National Regional State (Fig. 1.).

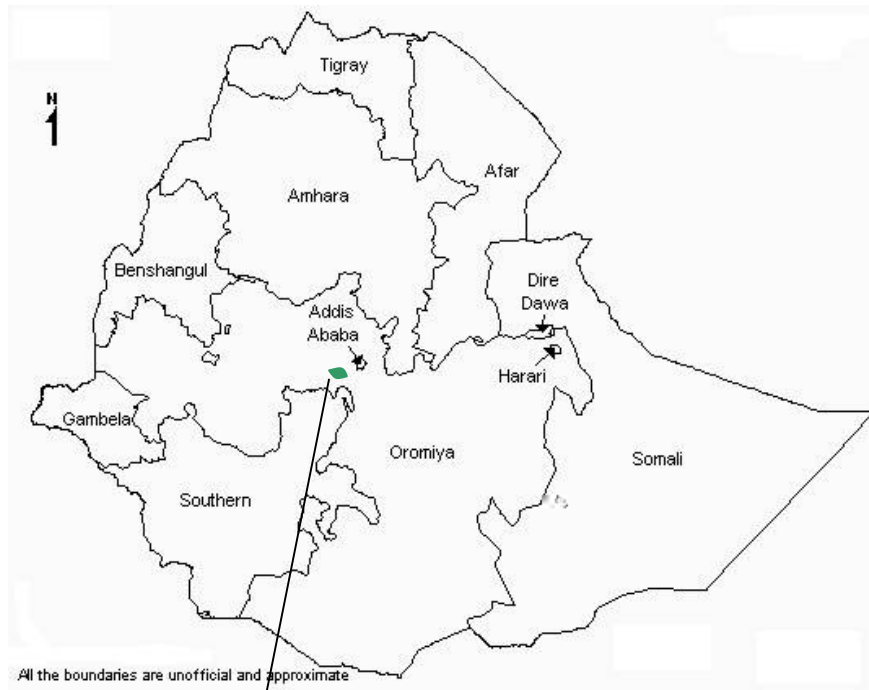
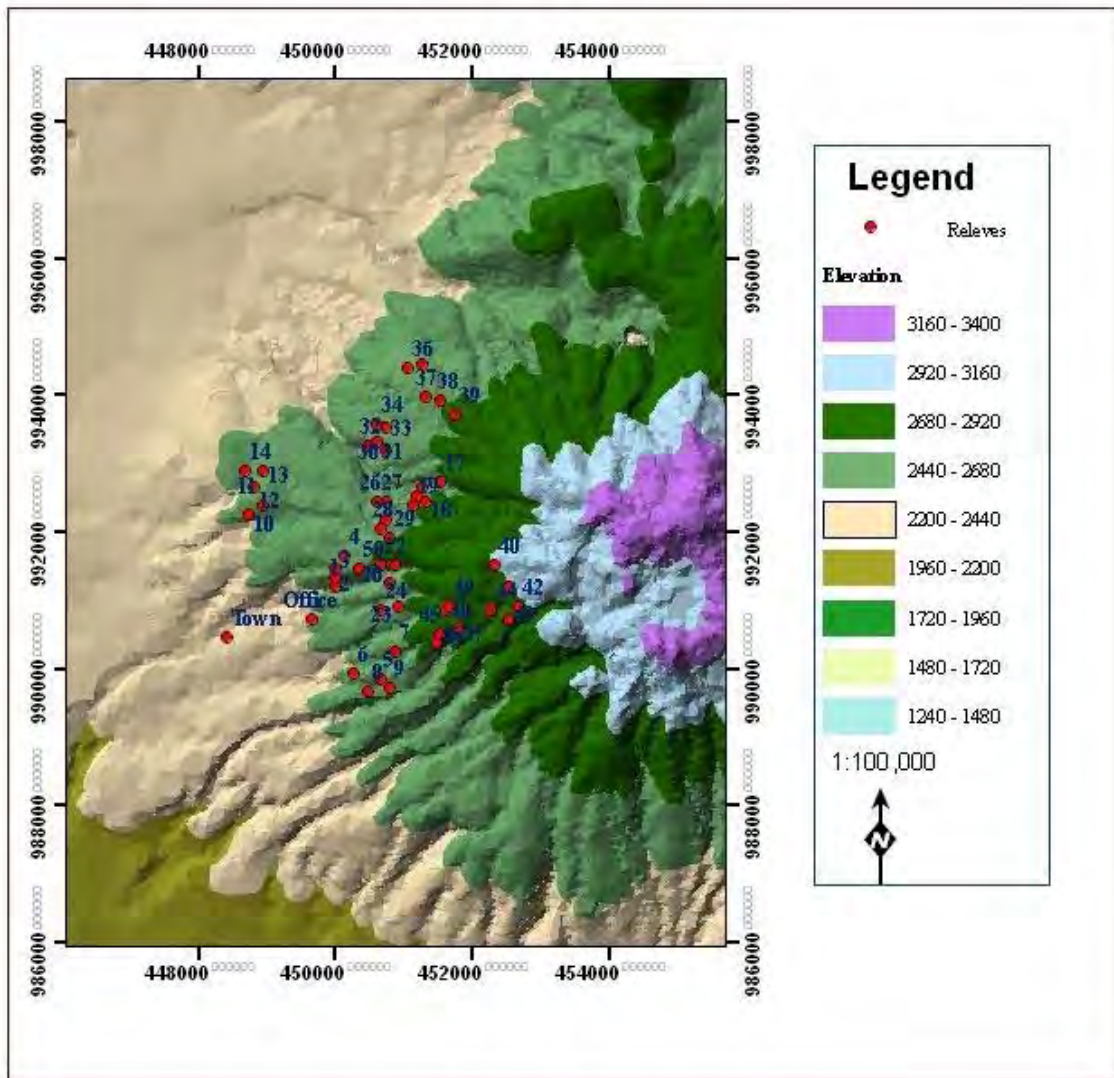


Figure 1. Location of Menagesha Suba State Forest.



**Figure 2.** Satellite map of Menagesha Suba State Forest and 50 (fifty) stands which data were collected

### **1.3.2. Geology and Climate**

The geology of Wachacha has been reported by Miller et al. (1966), cited in Sebsebe Demissew (1980). Wachacha is an extinct volcano situated in a very complex tectonic setting, where the western margin of the main Ethiopian rift is barely defined topographically. NE-SW faulting dominates the region, but without showing on the surface contrasting with the marked escarpments further north east. The rock types vary from a white coarsely porphyritic sandidine trachyte forming the Wachacha summit to an extensive series of pale to dark green or grey trachytes often porphyritic with feldspar phenocrysts at the lower altitudes, white, fine grained trachyte and trachytic tuffs of intermediate hardness at the summit depression and pale-yellow, coarsely porphyritic trachytes which are well developed (hard) on the southern slopes of the volcano. The Wachacha lavas have yielded an average age of  $4.5(s) \pm 0.1m.y.$  Which is places the last phases of volcanic activities in the upper Pliocene.

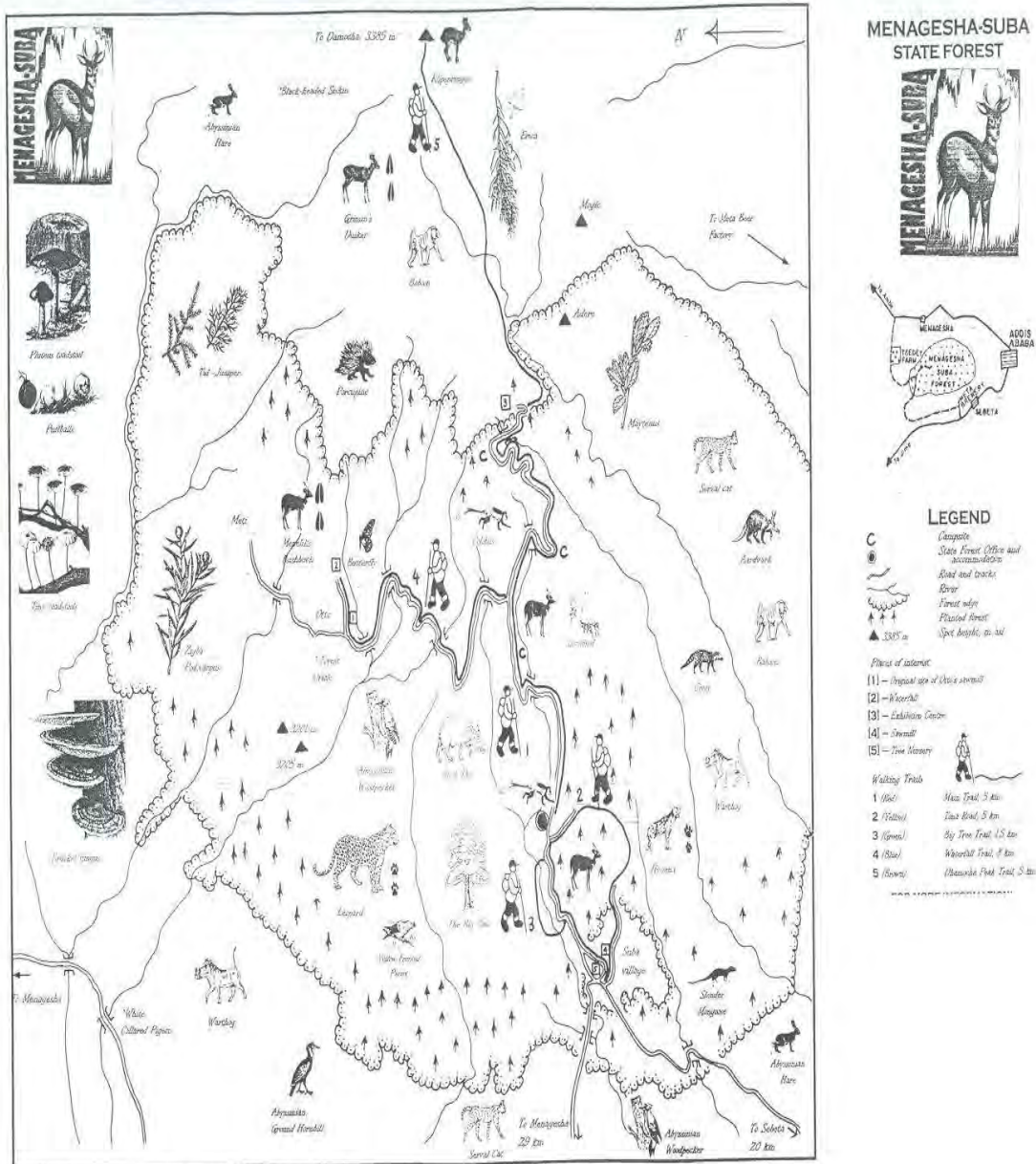
According to MOARD (2002), Menagesha Suba State Forest is found on the southwest facing slopes of Mount Wachacha. This is an extinct volcano. The crystalline cone, Dhamocha, at the summit reaches 3,385 m (plate 2). Below the summit is an intensively farmed crater with scattered homesteads and fields of barely, beans and potatoes. The sides of the mountain slope down to

the Becho plains at 2,200 m to the south. On the east are foothills at around 2,400 m. These are now being built up as suburb of Addis Ababa. Several rivers flow from the mountain, including the Akaki River that runs through Addis Ababa.

Annual rainfall is around 1100 mm with the rains mainly falling from June to September. However, it can rain in any month of the year and the forest gets additional moisture from low clouds and mist. The temperature of the surrounding area is 16<sup>0</sup>C with a mean maximum of 22.5<sup>0</sup>C and mean minimum of 9.5<sup>0</sup>C. In the forest, overall temperatures are cooler with an average of 11<sup>0</sup>C in the upper parts. Frost is common on the mountain outside the forest (MOARD, 2002).

### **1.3.3. Ecology**

Menagesha Suba State Forest is one of the best remaining examples of dry afro-montane forest. This type of forest together with grassland and Acacia woodland once formed a vegetation mosaic across the Ethiopian plateau. The forests and woodlands occur on the better drained soils of the mountains and sides of the valleys while the grassland occupies the heavy clay soils of the valley bottoms. Over the several thousands years since farming started in Ethiopia, most of the natural vegetation has been replaced by the patchwork of homesteads and fields. The officially protected area of the forest used to be 9,248 ha, but only about 2,500 ha of the original forest now remains with a further 1,000 ha under plantation. The rest consists of settlements, farmland and grazing areas. The forest holds different wild life animals including endemic Minilks bushbuck (Fig. 3).



**Figure 3.** Fauna and Flora distribution on Menagesha Suba State Forest. (Source Forest Office).

### **1.3.4. Natural vegetation.**

According to MOARD (2002), The Natural forest of Menagesha Suba State Forest is dominated by *Juniperus procera* that grows to c. 30 m and forms a relatively open canopy. *Olea europea* subsp *cuspidata*, *Allophyllus abyssinicus*, *Maytenus* sp. and *Euphorbia ampliphylla* form the understory, and some *Podocarpus falcatus* trees are scattered throughout the forest. At higher altitudes, smaller *Juniperus procera* are mixed with *Erica arborea*, *Rosa abyssinica* and the endemic *Jasminum stans*. Two giant herbs, *Lobelia giberroa* and *Solanecio gigas* dominate the sides of the valleys; the striking *Scadoxus multiflorus* carpets the forest floor (Fig. 3).

### **1.3.5. Conservation issues**

Due its close proximity to Addis Ababa, Menagesha State Forest has a long history of exploitation and reforestation. As early as the fifteenth century the forest was degraded and then replanted with *Juniperus procera* on the orders of Emperor Zera Yacob. In the 1900s, large scale removal of wood for fuel and construction was noted, with strict protection was put in place and had been maintained until recently. Reforestation started as early as 1949, when logging operations were still in full swing. Since 1991, local people have increasing exploited the forest. Uncontrolled felling of trees continues

unabated and is of major concern for conservation of the forest (plate 3). The wood is sold in the near by towns of Sebeta and Holleta. Wood for construction and fuel is taken to Addis Ababa where there is a high demand. Menagesha Suba State Forest Office employed a number of guards but they were not quite adequate considering the area of the forest.

Trees planting have been done in the area mostly the boarder of the forest and in the middle of open areas. The planted species are mainly *Pinus radiata*, *Cupressus lusitanica*, *Juniperus procera*, *Podocarpus falcatus* and *Hagenia abyssinica*. The first modern tree nursery for the country was set up in 1949 in Suba, which is located near the forest, producing seedling of indigenous and exotic trees (plate 1).



**Plate 1:** Nursery of Suba which is the first modern nursery in Ethiopia



**Plate 2.** A view along the *Dhamocha* into the crater at the top



**Plate 3.** Breaking and grounding fuel wood for the next collection and cut and removed trees by local people.

## **2. LITERATURE REVIEW**

### **2.1. The Forest Vegetation of Ethiopia**

Ethiopia is a country of great geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains. The Great African Rift Valley runs from north to south bisecting the plateau, and in conjunction with the surrounding lowlands, this feature isolates and separates the plateau from other parts of the continent. The varied topography, the rift valley and the surrounding lowlands have given the country a wide spectrum of habitats, and a large number of endemic plants and animals (Demel Teketay, 1999; Zerihun woldu, 1999).

The environment of Ethiopia is very varied. The lowest area in the world is a very dry and very hot salt desert in the Afar Depression that is 200 m below sea level. But about 40 % of the country's just over one million km<sup>2</sup> of land area is above 1,500 m above sea level, the south-western parts of which get rain for about 9 to 10 months per year. Over 80 % of the water of the River Nile comes from Ethiopia (EPA, 2000).

According to modified UNESCO Natural Terrestrial cover classification, forests are areas dominated by trees with a total canopy cover of 61% or more tree crowns usually interlocking. It is a continuous stand of trees, which may attain a height of 50 m or more with crowns touching or intermingling and often interlaced with lianas. Its canopy may be of great thickness and usually consists of several distinct layers stories. Epiphytic plants, including orchids, ferns and mosses are characteristic, especially in the wetter type, and lichens are characteristic of the upland types. The trees have simple and buttressed boles and in most types the majorities are in leaf the year round, although semi deciduous types do also exist.

There has been a lack of unified approach to the description and identification of plant communities in the country so far. Vegetation types in Ethiopia have been described and classified based on physiognomic criteria by Pich Sermolli (1957), Breitenbach (1963), Mesfin Wolde Mariam (1972), Daniel Gamachu (1977), Wilson (1977), Friis et al. (1982), Tewolde Berhan Gebre Egziabher (1986), Friis (1992).

Few vegetation studies have also been based on floristic composition. These include: vegetation of the Erer Gota plain, Harar (Beals, 1969), Menagesha Suba State Forest, Shewa (Sebsebe Demissew, 1980), Jemjem Forest, Sidamo

(Hailu Sharew, 1982), grass-land vegetation of Welmera (Zerihun Woldu, 1980), Harena forest, Bale (Lissanework Nigatu and Mesfin Tadesse, 1989), forest of the central plateau of Shewa (Tamrat Bekele, 1993), Afro alpine vegetation of Senati Plateau, Bale (Menassie Gashaw and Masresha Fetene, 1996), Dess'A Forest, Tigray (Gebremedhin Hadera, 2000), vegetation of Gambella region, southwestern Ethiopia (Tsfaye Awas et al., 2001), afro montane and transitional rainforest vegetation of southwestern Ethiopia (Kumelachew Yeshitla and Tamrat Bekele, 2001), vegetation of Denkoro Forest South Wello (Abate Ayalew, 2003) and vegetation of Dodolla forest, Bale (Kitessa Hundera, 2003). Although most classification is aimed at distinguishing ecological homogenous zones, they differ in one way or another according to the set objectives.

In all cases the works were focused to describe the forest constitution rather than revealing their previous and current status in comparable manner. The current study addresses the current situation in comparison to what was known in 1980 ca. 26 years ago.

According to Friis & Sebsebe Demissew (2001), the Ethiopian vegetation is classified into the following eight types: Desert and Semi-desert scrub; Dry evergreen montane forest; Moist montane forest; Lowland semi evergreen forest; *Acacia-Commiphora* woodland; *Combretum-Terminalia* woodland;

Afroalpine and Sub-afroalpine vegetation and Wetland and Riparian vegetation. The Menagesha Suba State Forest is part of the dry evergreen montane forest of Ethiopia. This is occurring above 2400 m and below 3385 m and has annual temperature and rainfall of 11<sup>0</sup>C to 22.5<sup>0</sup>C and 1100 mm, respectively.

The characteristic plant species in this vegetation type include *Olea europaea* subsp. *cuspidata*, *Juniperus procera*, *Podocarpus falcatus*, *Ilex mitis* and *Erica arborea*. The shrubs occurring in this vegetation type include *Carissa spinarum*, and *Dodonaea angustifolia*. Friis (1992) classified this forest type as follows:

- a. Dry single dominant Afromontane forest which occurs in the NW and NE Ethiopian highlands between altitudes of (1600)/ 2200 ca. 3200 (-3300) m, with annual temperatures from 12-18<sup>0</sup>C and annual rainfall between 500 and 1500 mm.
- b. Undifferentiated Afromontane forest, which are either *Juniperus-Podocarpus* forest, or predominantly *Podocarpus* forest, both with an element of broad-leaved species. They occur in both the NW and SE highlands, especially on the plateau of Shewa, Wello, Sidamo. Bale and Harerge between altitudes of 1500 to 2700 m, with average annual

temperature between 14 and 20<sup>0</sup>C and annual rainfall between 700 and 1100 m.

- c. Dry single dominant Afromontane forest of the escarpments and transition between single dominant Afromontane forest and East African evergreen and semi-evergreen bush land occurring on the eastern escarpment of the NW highlands and on the eastern escarpment of the SE highlands on rocky ground with unimpeded drainage, between altitudes of about 1500 m to 2400 m, annual rainfall between 400-700 mm and average annual temperature between 15-20<sup>0</sup>C.

## **2.2. Techniques of Vegetation Data Analysis**

Quantitative community ecology is one of the most challenging branches of modern environmetrics. Community ecologists sometimes could need to analyze the effect of multiple environmental factors on dozens of species simultaneously. Thus vegetation ecologists have employed a variety of multivariate approaches to study the complex nature of plant communities with the general objectives of summarizing large complex data sets obtained from community samples, aiding in the interpretation of the data and the generation of hypotheses about community structure and variation (Gauch and Whittaker, 1972; Gauch, 1982). The descriptive nature and functional characteristics of vegetation, results from the interaction between the properties of the plant species it contains and the environment in which they occur.

## **2.3. Classification.**

Many studies pointed out that among the multivariate approaches classification is one of the main methods. Classification continues to contribute materially to the elucidating of the complexities within communities. Therefore, the choice of the method to be used depends on the

ecological question to be answered (Gauch and Whittaker, 1972; Gauch, 1982).

Classification is the placement of species and/or sample units in to groups. Classification aims at grouping individual stands in to categories. The members of each category have in common a constellation of attributes, which serve to set them apart from members of another category (Anderson, 1965). The stands which are closely similar with one another form one class, which is separated from other classes that also consist of similar stands (Greig-Smith, 1979). Classification or putting samples into (perhaps hierarchical) classes is often useful when one wishes to assign names to, or to map, ecological communities.

In classification similar samples are combined in the same category, but in ordination the objective is to consider sample differences rather than similarities so as to dispose the samples in a linear or multi dimensional network that reveals the relationships between the samples and their environment (Kumar, 1981).Vegetation classification attempts to identify discrete, repeatable classes of relatively homogenous vegetation communities or association about which reliable statements can be made. Classification assumes either that natural vegetation groupings (communities) do occur or

that it is reasonable to separate a continuum of vegetation in vegetation composition and/or structure in to a series of arbitrary classes.

There are a large number of contrasting algorithms available for the classification of samples clustering strategies may be classified according to whether they are hierarchical or non-hierarchical, divisive or agglomerative and polythetic or monothetic (Lambert and William, 1966; Orloci, 1967; Gauch and Whittaker, 1981). Non-hierarchical techniques partition samples in to a number of clusters but specify no structure inter-relating the clusters. Hierarchical clustering techniques define relationships among the clusters too. A single hierarchical analysis allows one to choose the final number of groups by selecting an appropriate level in the hierarchy, and this choice can be made after seeing what kind of structure the data set has. If the only requirement in a clustering application is that a given number of clusters be formed (but not related to one another), non-hierarchical may be best (Gauch and Whittaker, 1981).

Divisive hierarchical clustering strategies begin with all samples in a single cluster and divide them usually in to two clusters; these clusters are further subdivided until each clusters contains no more than a specified numbers of samples. Agglomerative clustering strategies begin with the individual samples; fuse these in to successively larger cluster until finally a single

cluster contains all samples. Divisive methods have an advantage over agglomerative ones in that they use all available information at the initial stage and are less likely to be irrevocably led astray by chance; the computations are much quicker, since they do not usually continue to the point at which individual classes are recognized as classes (Pielou, 1984).

Monothetic techniques partition on the basis of presence or absence of a single character usually species in the case of community samples. Association analysis was an important early monothetic technique but had an undesirable high rate of misclassification (William and Lambert, 1959; Orloci, 1967). Polythetic techniques partition on the basis of more than one (usually all) species, such techniques use the data as fully as possible it has the obvious advantage over monothetic techniques in that it can be made to take account of as many properties of the vegetation as we wish to measure or record (Noy Meir, 1973; Pielou, 1984). On theoretical grounds, divisive polythetic procedures are superior to both divisive monothetic and agglomerative procedures because a maximum amount of information is used at the major (first) division of hierarchy (Pielou, 1984; Goldsmith et al. 1986).

Two-Way Indicator Species Analysis (TWINSpan) is a polythetic divisive technique (Hill, 1979). The sample division is refined by reclassifications

using species with maximum indicator value. The process is repeated on the two subsets to give four clusters, and so on, until each cluster has no more than a chosen minimum number of members. A corresponding species classification is produced, and the sample and species clusters are used together to produce reordered data matrix. In its emphasis on indicator species (and their fidelity to nodal) the technique has similarities to the approach of Braun-Blanquet (Gauch and Whittaker, 1981). The program TWINSpan produces a hierarchy with integer levels to express relative cluster similarity, but the levels at which clusters are united can be calculated as the average distance between all pairs of samples (within a cluster using all pairs of members, and between clusters using all pairs with one members from each cluster).

The TWINSpan method differs fundamentally from the agglomerative techniques in its divisive strategy, and is usually more informative. Generally, advantages of polythetic divisive (TWINSpan) method are:

1. It uses the original vegetation data, rather than secondary matrix;
2. It orders the sample sequence in Dendrogram;
3. It clusters species also;
4. It produces an ordered data matrix and
5. It is economical in the use of computer time and store.

These advantages make TWINSpan the best general method, and are employed in the present study.

## **3. METHODS**

### **3.1. Floristic data analysis**

The vegetation data matrix analyzed and classified using a computer program TWINSpan, Two-way INdicator SPecies Analysis, version 1.0 (Hill, 1979). TWINSpan is a divisive polythetic method of vegetation classification. It classifies both samples and species.

The following options were chosen:-

- Number of cut levels: 0, 2, 5, 10, 20
- Maximum groups size for division: 5
- Maximum level of division: 6

Association Analysis was also performed for the sake of comparison with the previous studied.

A Germin -12 CX GPS was used to find the plot sampling positions. Since the plot sampling positions were not located using a GPS these positions were estimated with help of the coordinates of the old map. The accuracy of the new positions therefore dependence of the accuracy of the estimations and the precision of the GPS (Fig. 2.).

### **3.2. Structural data analysis**

All individuals of trees and shrubs with a diameter at breast height (DBH) greater than 2 cm, and height greater than 2 m were measured for DBH. Individuals with DBH less than 2 cm, and height less than 2 m were counted. DBH measurement was done with Meter tape.

From the woody species identified all tree species recorded in the sample plots were used in the analysis of structural features (density, diameter, and basal area).

Density: the number of individuals of size class in the stand is important to characterize vegetation. Density is determined by counting the number of individuals of each size class of each sample plot. Tree density was computed by converting the count from the total quadrates in the hectare basis.

DBH (Diameter at Breast Height): DBH is the most frequent measured variable in vegetation surveys and has multiple uses. Over bark diameter measurements at breast height (1.3 m from the ground) are quick, easy, inexpensive, relatively accurate, and usually correlated with other variables such as basal area.

Basal Area: Basal Area is the horizontal (cross-sectional) area occupied by the trunk of a species or size class. Basal area calculations were made on the diameter measurements the stem with DBH's of two centimeter and above. It expressed in square meter/ hectare.

Frequency: frequency is the number of times a particular species is recorded in the sample area.

For all individuals of tree having  $\geq 2$  cm DBH, Relative density, Relative frequency, Relative basal area and Importance Value Index (IVI) (Curtis and McIntosh, 1950) were calculated for each tree species using the following formula.

- Relative density = number of individuals of species  
 $A/\text{total number of individuals of all species} * 100$
- Relative frequency = number of plots occurrence/  
total number of plots \* 100. Frequency is the chance of finding a species in a particular area in a particular trial sample. The frequency value obtained

reflects the pattern of distribution as well as diversity

- Relative basal area = total basal area of all individuals of a species/total basal area of all species \* 100. Basal area is the cross-sectional area of the tree at point 1.3 meter above the ground.
- Importance Value Index (IVI) = Relative density + Relative frequency + Relative basal area.

### **3.3. Soil Analysis Method**

The dried soil specimens were sieved through a 2 mm sieve to remove pebbles, coarse sand and large parts of the plant material. Then the following pH measurement were done: A soil water mixture in the ratio of 1: 2.5, that is 10 gm of soil mixed with 25 ml of distilled water, was used, the contents were stirred for 20-30 minutes and then pH was measured using pH meter (EARO, 2000).

ANOVA was used performed to detect significance differences among the different means of factor of each community type. Tukey's error rate test was performed to test significant contrast between clusters.

## 4. Results and Discussion.

A total of 82 species of vascular plant representing 44 families were recorded from the tree, shrub, and field layers (Appendix 4.). Number, percentage and life form of the species indicated in table 1.

Table 1. Number, percentage and life form of collected species.

Ser. no	Life	Number	Percentage
1	Trees	27	33
2	Shrubs	25	30.5
3	Climbers	8	9.76
4	Giant herb	2	2.44
5	Herbs	18	21.9
6	Grasses	2	2.4

92.68 % of the families were Dicots, while 7.32 % Monocots. The families with the highest number of species were *Asteraceae* (14 species), *Myrsinaceae* ( 4 species), *Flacourtiaceae* (4 species), *Oleaceae* (4 species), *Lamiaceae* (3 species), *Rosaceae* (3 species), *Anacardiaceae* (3 species), *Rubiaceae* (3 species), *Fabaceae* (2 species), *Ericaceae* (2 species), *Euphorbiaceae* (2 species), *Rutaceae* (2 species), *Scrophulariaceae* (2

species), *Malvaceae* (2 species), *Celastraceae* ( 2 species), *Poaceae* (2 species), the rest families hold one species, these were *Amaranthaceae*, *Adiantaceae*, *Sapindaceae*, *Icacinaceae*, *Araceae*, *Asparagaceae*, *Aspleniaceae*, *Meliantaceae*, *Simaroubaceae*, *Apocynaceae*, *Cyperaceae*, *Meliaceae*, *Hypericaceae*, *Aquifoliaceae*, *Cuppressaceae*, *Crassulaceae*, *Verbenaceae*, *Campanulaceae*, *Myricaceae*, *Loganiaceae*, *Santalaceae*, *Asclepiadaceae*, *Podocarpaceae*, *Rhamnaceae*, *Sapotaceae*, *Smilcaceae*, *Menispermaceae* and *Oliniaceae*. Vernacular names are in Oromiffa and Amharic.

#### **4.1. Vegetation community classification**

Six clusters could be recognized from the TWIINSPAN output. The community types were further refined in a twin res. txt., which shows the community types in detail.

Twin res. txt. values for each tree and shrub species and the six major clusters identified in the TWIINSPAN output are shown in Table 2. Communities can be defined using various characteristics. One of these approaches is classification by dominant species. Community types defined by their dominant species can be termed dominance-type, but often they are called

simply “types” (Whittaker, 1967). Based on this formation each cluster distinguished in this study was described as types and named after two or three dominance species.



A description of the six community type is given as follows:

**1. Juniperus procera – Carissa spinarum** Type: This community is a single stand and is found at altitude of 2570. m a s l. This community is found on the side of the forest road and highly exposed to degradation.

**2. Myrsine africana – Erica arborea** Type: This community is found at altitudes from 2390-2870 m a s l. Other species commonly occurring includes *Olea europaea*, *Olinia aequipetala*, *Myrsine melanophloeos* and *Jasminum stans*. Soil pH of the community is the least from community four and five and statistically significant at  $p = 0.05$ . (Appendix 2.).

**3. Myrsine africana – Olea eurpaea** Type: This community is found at altitudes from 2480-2740 m a s l. Other species commonly occurring includes *Juniperus procera*, *Olinia aequipetala*, *Scolopia theifolia*, *Sideroxylon gillettii*, *Myrsine melanophloeos* and *Dovyalis abyssinica*. Soil pH of community three is statistically significant with community four and five at  $p = 0.05$ .

**4. Dovyalis verucos – Scolopia theifolia** Type: Both species occurred in all stands of the community. This community is found at altitudes range between 2440 and 2670 m a s l. Other species, which occurred in this community, are *Dovyalis abyssinica*, *Juniperus procera*, *Myrsine africana*, *Nuxia congesta*, *Maytenus obscura* and *Osyris arborea*. Soil pH is the highest from community two and three and statistically significant at  $P = 0.05$ .

**5. Myrsine melanophloeos – Dovyalis verucosa** Type: This community is found at altitude from 2600-2750 m a s l. Other species commonly occurred includes *Myrsine africana*, *Juniperus procera*, and *Bersama abyssinica* *Jasminum stans*, *Osyris arborea*, *Maytenus obscura*, and *Nuxia congesta*. Soil pH of community 5 is statistically significant with community type two and three.

**6. Juniperus procera – Lantana trifolia** Type: this community is found at altitudes range between 2670 – 2680 m a s l. other species commonly occurring includes *Acacia abyssinica*, *Maesa lanceolata*, *Carissa spinarum* and *Dovyalis abyssinica*. Soil pH is not statistically significant with any of the community at  $p = 0.05$ .

**Juniperus procera – Carissa spinarum** type is found beside the forest road and it is severely disturbed by human interference with different means. It is

only a single stand and compare to the previous studied pH and species composition reduced. The reduction of pH may be due to by the destruction of natural forest and opening of the forest that leads to erosion and result in the washing up of some metals like calcium, magnesium and potassium which increase the pH (Etherington, 1975 cited in Sebsebe Demissew). In 1991 at the time of transition of the government has a great value for the destruction of the area even though the destruction is not stopped until now.

Community type 2 holds species *Olinia aequipetala*, *Smilax anceps*, *Myrsine melanophloeos*, *Rosa abyssinica*, and *Olea europaea*, which showed very good regeneration. Some seedlings of *Maesa lanceolata*, *Rhus glutinosa* and *Myrica salicifolia* were encountered. On the other hand no young trees of *Rhamnus prinoides* and *Prunus africana* were observed.

**Myrsine africana - Olea europaea** type holds species *Juniperus procera*, *Olinia aequipetala*, *Sideroxylon gillettii*, and *Myrsine melanophloeos* showed very good regeneration. Some seedlings of *Bersama abyssinica*, *Carissa spinarum* and *Nuxia congesta* were encountered. On the other hand no young trees of *Rhamnus prinoides* and *Prunus africana* were observed.

**Dovyalis verucosa – Scolopia theifolia** type occupied larger area of the forest. This is characterized by medium sized trees with more or less interlocked canopies. The ground layer is covered a thick layer of litter that is in different stage of decay. This will create a suitable condition for the rapid circulation of nutrients between the soil and the vegetation.

**Myrsine melanophloeos – Dovyalis verucosa** is nearest to the forest office. Most matured, over matured and felled old *Juniperus* tree species are common in this community and preserved well.

**Juniperus procera – Lantana trifolia** type is found at the boarder of the forest. It is severely disturbed by human interference and changed to *Juniperus procera* and *Hagenia abyssinica*.

**4.1.1. Comparison of the different groups of stands with the previous studied.**

**Table 3.** Species used in dividing stands

Species Number	Species Name
14	<i>Dovyalis verucosa</i>
52	<i>Scolopia theifolia</i>
43	<i>Osyris arborea</i>
30	<i>Juniperus procera</i>
40	<i>Nuxia congesta</i>
39	<i>Myrsine melanophloeos</i>
21	<i>Galliniera saxifrage</i>
3	<i>Allophyllus abyssinicus</i>
55	<i>Sideroxylon gillettii</i>
13	<i>Dovyalis abyssinica</i>
41	<i>Olea europaea</i>
17	<i>Erica arborea</i>

The Association Analysis gave four major clusters.

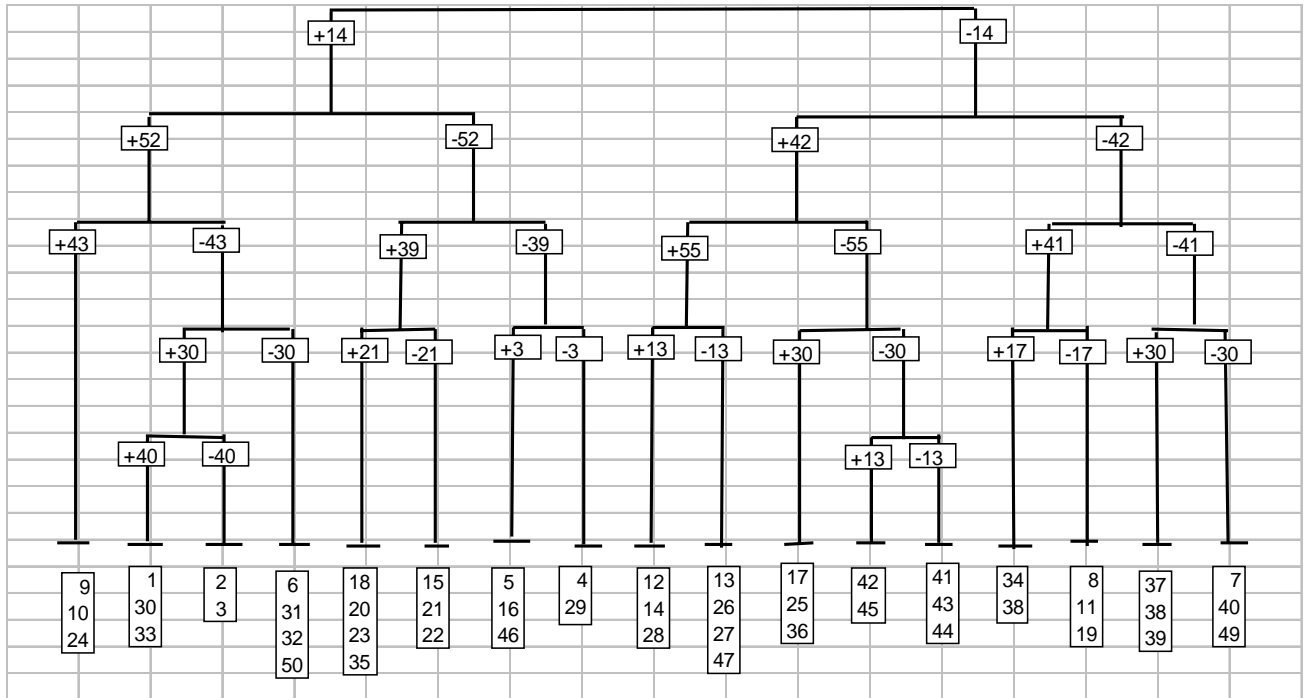
Cluster one – species 14 and 52 present

Cluster two – species 14 present and 52 absent

Cluster three – species 14 absent and species 42 present

Cluster four – species 14 and 42 absent.

The Dendrogram showing the Association Analysis is given in Fig. 4.



**Figure 4.** Association Analysis groups.

The first division for the 50 stands (see Fig. 4) was made by *Dovyalis verucosa*. 24 stands have + *D. verucosa*. The others 26 are without *D. verucosa*. Where as in the previous studied the first division for the 50 stands was made by *Erica arborea*. 18 stands have + *E. arborea*. This shows how much important *Dovyalis verucosa* species in the current studied.

Groups of stands with + *D. verucosa* have higher soil pH than the – *D. verucosa*. Their statistical tests of significance with probabilities of at  $p = 0.05$ . are shown on Appendix 3.

In previous studied + *E. arborea* have lower soil pH, conductivity, calcium and magnesium both at the soil surface and on the soil average than the - *E. arborea* stands (Sebsebe Demissew, 1980). + *E. arborea* stands were further subdivided by *Rhus glutinosa*. In the current studied *D. verucosa* subdivided by *Scolopia theifolia*. This shows the change in the constitution of the species in the forest. In groups + *S. theifolia* and – *S. theifolia* statistically not significant at  $p = 0.05$  in soil pH.

The average number of *E. arborea* per stand in group + *E. arborea* in previous studied is nine and the average number of *Juniperus procera* trees per stand is eight. In the current studied the average number of *E. arborea* per stand in group + *D. verucosa* is one and the average number of *J. procera* trees per stand is seven.

For the – *D. verucosa* groups of stands subdivision was made by *Olinia aequipetala*. Group + *O. aequipetala* and – *O. aequipetala* have no statical significance at  $p = 0.05$  with soil pH. + *O. aequipetala* and + *S. theifolia*; + *O.*

*aequipetala* and – *S. theifolia* groups have statistically significant at  $p = 0.05$ .  
– *O. aequipetala* and + *S. theifolia*; - *O. aequipetala* and – *S. theifolia* groups have statistically significant at  $p = 0.05$  with soil pH.

- *D. verucosa* groups have lower pH than + *D. cerucosa*. Low pH values have the effect of reducing the cation absorption capacity by competitive inhibition. Since  $H^+$  ions occupy many sites of the uptake mechanisms. More over low pH soils are often coarse textured, and this together with their low cation absorption capacity will render them leached easily (Etherington, 1975 cited in Sebsebe Demissew, 1980). Low pH in soils will also reduce the microbial activity, thus mineralization of the organic matter will be retarded (Buckman et al, 1969 cited in Sebsebe Demissew, 1980).

The average number of *E. arborea* per stand in group – *E. arborea* in previous studied is zero and the average number of *Juniperus procera* trees per stand is four. In the current studied the average number of *E. arborea* per stand in group – *D. verucosa* is five and the average number of *Juniperus procera* per stand is five. This implies that the change in the distribution of the above species from the two different years studied.

The local people of Menagesha Suba State forest has the right to graze their animals and collect fuel wood from the forest, which brings regular and frequent disturbance on the forest and may lead to abnormally small tree sizes. This further retards regeneration of the trees and shrubs. Human disturbances in the forest are manifested by the presence of abundant *Achyranthes aspera* population in the herb layer. This species is known to be indicator of previous human disturbance (Mathooko and Kariuki, 2000). Pressure on the resources from human population could intensify and impose more rapid and more degenerative changes. Recognizing these issues as a possible future scenario underlines the need for management interventions to increase the quality of regeneration being recruited and to accelerate the growth of the young plants already present.

## **4.2. Forest Structure and Species composition**

A total of 82 species belonging to 44 families were identified in the present study. Average density was 971 mature stems/ha. Total number of trees in each DBH class decreased with and increasing tree diameter classes (Fig. 5). This relationship was also reported by Pande and Bishet (1988). Accordingly, *Olea europaea*, *Olinia aequipetala*, *Juniperus procera*, *Scolopia theifolia* and *Podocarpus falcatus* are the dominant species.

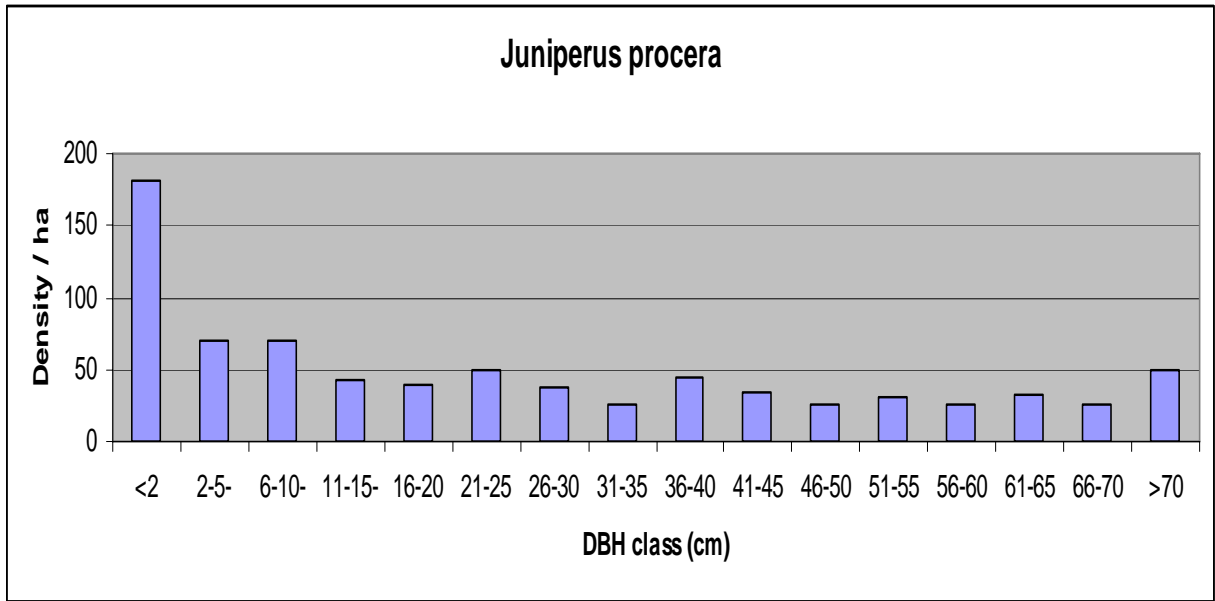


Fig. 5a. Population structures of *Juniperus procera*

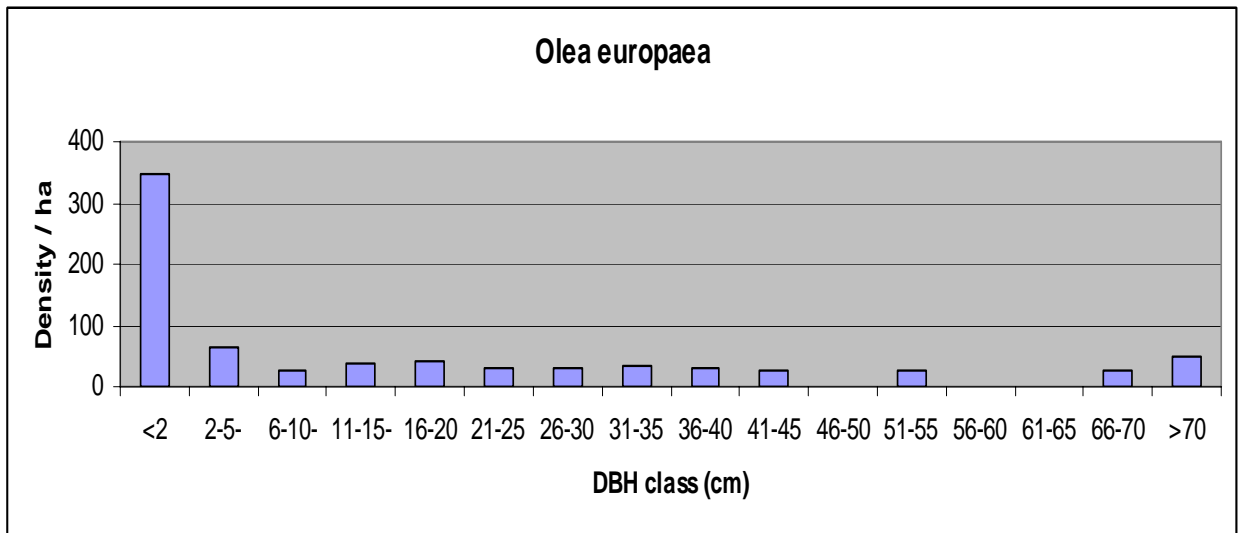


Fig. 5b. Population structure of *Olea europaea*

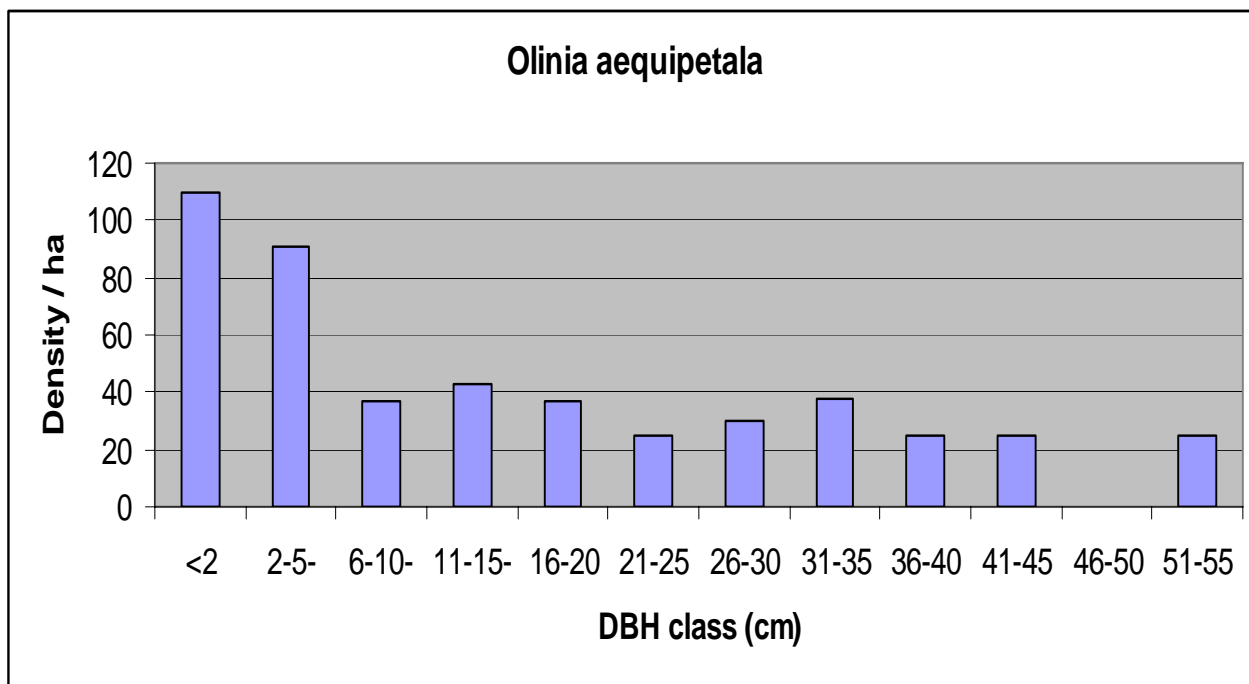


Fig. 5c. Population structure of *Olinia aequipetala*

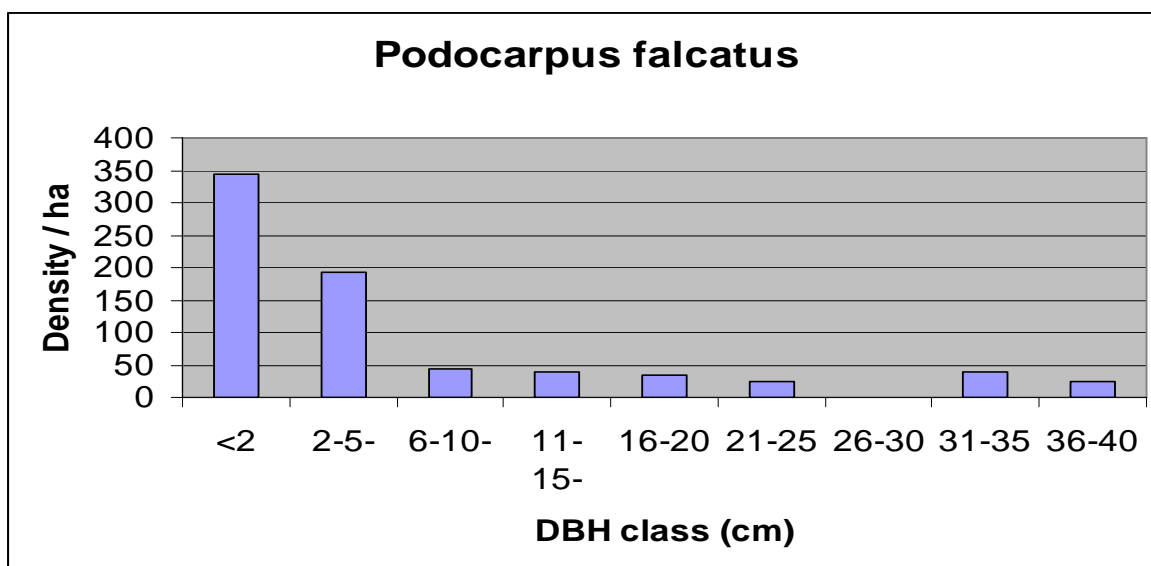


Fig. 5d. Population structure of *Podocarpus falcatus*

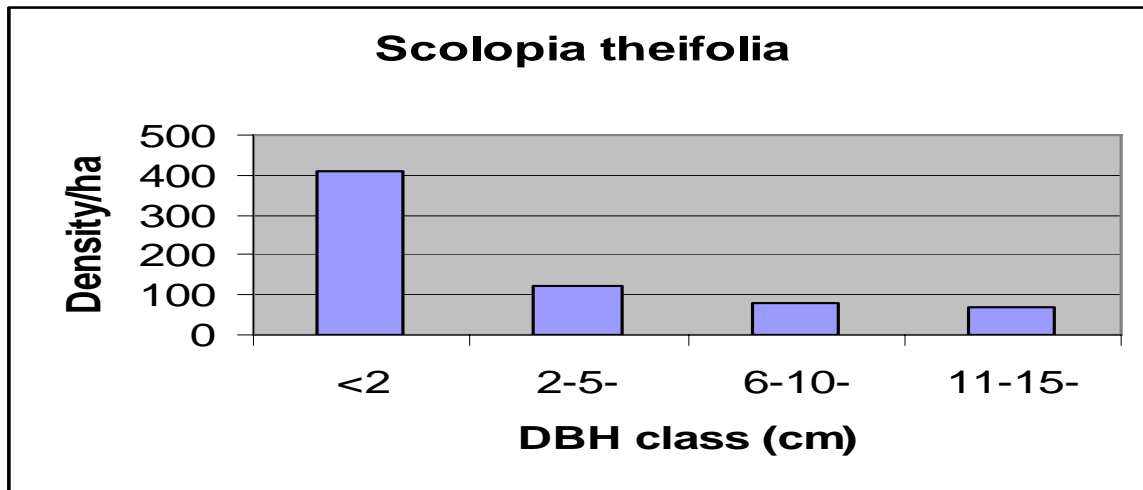


Fig. 5e. Population structure of *Scolopia theifolia*

Figure 5. Five representative patterns of trees density value over DBH classes in the Menagesha Suba State Forest

Densities in size classes in the study area show that there is dominance of small sized individuals (Fig. 5a-e). The pattern of such density can be an indicator for community dynamic in the forest. The forest pattern is formed by the species structure with reversed 'J' shape in DBH class. More than 50 % of the individuals in the forest have DBH in the range between 0-2 cm indicating the potentiality of the forest for future production and improvement capability of all the species if appropriate management practice is going to be applied. Species represented by the broken up inverted 'J' curve structure also show good regeneration but discontinuous recruitment in to larger size (Fig. 5b, c and d). One of the possible reasons for the discontinuity in this type of structure could be the local disturbance (natural as well as human). This is particularly true for *Olea europaea*, *Olinia aequipetala* and *Podocarpus*

*falcatus* as it is among the species that were highly affected by the disturbance in the forest. On the other hand the low stocking level of mature trees confirmed that the forest affect by collection of fuel wood, for household consumption, for sale and construction poles.

Studies on forest dynamics, particularly patterns of population structure of the species in the forest enrich our knowledge that can help to understand the status of species, and thereof, natural regeneration (Harper, 1977). Population structure of species can show whether the population has a stable distribution that allows continuous regeneration to take place or not. If regeneration were taking place then the species would have a stable population distribution with reverse J in shape, which is an indicator of healthy regeneration. Such population structure (reverse “J” shape) is common in natural forests where external disturbances are limited. However, several forests and forest tree species of Ethiopia had shown variation in their population structure, for example, some with little or no recruitment at the middle or upper size classes implying hampered regeneration as a result of previous disturbance (Tamrat Bekele). Human caused disturbance such as intensive removal of trees for timber, construction and fuel can place significant pressure on regeneration status of the selectively removed species. Population structures of trees in the forest and factors affecting their potential regeneration have significant

implications to the management, sustainable utilization and conservation of the forest.

Relative density, Relative frequency, Relative basal area and Importance value index were computed for all trees having  $DBH \geq 2$  cm. The species *Olea europaea*, *Olinia aequipetala*, *Juniperus procera*, *Podocarpus falcatus* and *Scolopia theifolia* hold the largest relative density as compare to other trees.

Relative basal area of tree species ranges from 0.01 to 62.04 %. The contribution of each tree species to the basal area is different from one another. Species such as *Olea europaea*, *Olinia aequipetala*, *Juniperus procera*, *Podocarpus falcatus* and *Scolopia theifolia* have the highest basal area percentage ranging from 1.35-62.04 % being *Olea europaea* and *Juniperus procera* are showing high Importance Value Index (Table 4.).

On the other hand, the density distributions over DBH classes of the five tree species do not follow the same trend as that of the relative basal area. *Juniperus procera* attains the highest sizes with a relative basal area of 62.04 followed by *Olinia aequipetala* and *Olea europaea* which are dominant tree in the study area. As the basal area provides a better measure of the relative

importance of tree species than simple stem counts (Cain and Castro, 1959 cited in Tamrat Bekele, 1994), species with the largest contribution in basal area can be considered as the most important trees in the forest.

**Table 4. Relative Basal Area, Relative Density, Relative Frequency and Important Value Index of the dominant tree species recorded in the study area.**

Species Name	Relative Basal Area	Relative Frequency	Relative Density	Importance Value Index
<i>Allophyllus abyssinica</i>	0.14	34	0.97	35.11
<i>Bersama abyssinica</i>	0.01	48	1.00	49.01
<i>Erica arborea</i>	0.29	36	3.18	39.47
<i>Galiniera saxifraga</i>	0.04	12	0.31	12.35
<i>Ekebergia capensis</i>	0.02	14	0.25	14.27
<i>Maytenus obscura</i>	0.25	24	0.47	24.72
<i>Nuxia congesta</i>	0.13	48	0.78	48.91
<i>Olea europaea</i>	16.61	82	10.11	108.72
<i>Olinia aequipetala</i>	16.89	76	4.31	97.2
<i>Juniperus procera</i>	62.04	58	6.29	126.33
<i>Podocarpus falcatus</i>	1.35	28	5.73	35.08
<i>Scolopia theifolia</i>	2.08	38	7.88	47.96
<i>Rhus ruspolii</i>	0.04	34	0.68	34.72
<i>Teclea nobilis</i>	0.03	14	0.62	14.65
<i>Rhus glutinosa</i>	0.08	14	0.19	14.27

## 5. Conclusion

As compare to the previous studied Out of 82 species, which were recorded 28 of them new to the stands and 9 were not encountered in the stands (Appendix 8). This may be due to the time of collection, encroachment of people and animals and forest destruction.

The vegetation of the boarder area especially the higher altitudes are different from the central and around the Forest Office, which include plot number 6,7,11,25,37,38,39 and 40 (Fig. 2), they have been subjected to intense and uninterrupted destruction. Due to human impact the plot which described above changed to homogenous plantation.

The increment of people and other social problems, the natural forest is highly destructing for their income and the coverage is declining from time to time.

The dominant tree species showed the following variation in number: *Scolopia theifolia* showed an increment in all size, *Juniperus procera* showed an increment in small size, and decreased from larger size due to aged, by cutting local people for coverage of honey beehives and other purposes, *Olea europaea*, *Olinia aequipetala* and *Podocarpus falcatus* showed an increment

in small size, *Allophyllus abyssinicus*, *Bersama abyssinica*, *Galiniera saxifraga*, *Ekebergia capensis*, *Nuxia congesta*, *Teclea nobilis* and *Rhus glutinosa* have not great variation, and *Erica arborea* specially medium size and above showed a decreasing in number. Soil pH identified except in one community there is no great variation.

*Olea europaea*, *Olinia aequipetala*, *Nuxia congesta*, *Scolopia theifolia* and *Juniperus procera* are the dominant tree species in the forest area. Others well represented species were *Podocarpus falcatus*, *Allophyllus abyssinicus*, *Bersama abyssinica*, and *Erica arborea*.

Analysis of species population structure pointed out the variability of population dynamics in the forest. It confirmed at least the existence of two major types of woody species: species able to regenerate in the forest understory and large and old trees with difficulties to reproduce in the understory environments.

Due to the vicinity of to Holleta, Sebeta, Addis Ababa, the increment of population and shortage of cultivated land rise to pressure on forest. In most part of the forest evidence of exploitation (e.g. stumps and pit sawing) have been observed. The vegetation of the Menagesha Suba State Forest is

disturbed through grazing and browsing by domestic livestock and other humans' uses, these further regeneration processes of the trees and shrubs. Pressure on the resources from human populations could intensify and impose more rapid and more degenerative changes. Recognizing these issues as possible future scenario underlies the need for management intervention to increase quality of regeneration being recruited and to accelerate the growth of the young plants already present

## 6. Recommendations

Effective utilization of the forests on sustainable basis requires effective management. The Menagesha Suba State Forest is one of the National Forest Priority Areas (NFPAs) and is distinctive in that it is *Juniperus* dominated forest, due attention has to be given to its conservation and management.

The vegetation on Menagesha Suba State Forest could be treated for biodiversity conservation. Rational use of the vegetation has to consider the requirements of local people and the production capacity of the environment. Biodiversity potential and threats in this area should receive high attention.

Area closure studies are strongly recommended for rehabilitation of vegetation. Regeneration survey should also be conducted to see the potential for the replacement of the indigenous vegetation. To overcome the problems it is crucial to develop benefit sharing mechanism with the local communities. Certainly this calls for better land use as a means to avoid conflict of interest between the future utilization of the resource of the area and other development activities. This requires a multidisciplinary technical co-operation. It should not be the task of the government alone, but should also require the social, environmental and other sectors.

Eventually to conserve the forest genetic resources, to improve the natural diversity and structure and to gain optimal ecological and economical benefit further investigation on the patterns of ecosystem functioning, social aspect, soil seed banks, germination characteristics, and establishing legally protected in-situ and ex-situ conservation stands are also recommended.

## 7. References:

- Abate Ayalew. (2003). Floristic composition and structural analysis of the Denkoro Forest. Addis Ababa University M. Sc. thesis, Addis Ababa. Mimeographed.
- Anderson, D. J. (1965). Classification and Ordination in Vegetation Science: Controversy over non-existent problem. *J.Ecol.* 53: 521-526.
- Beals, E. W. (1969). Vegetation of Erer-Gota Plain, Ethiopia. *J. Ecol.* 57: 655-667.
- Bonnefille, R., Buchet, G., Fiis, I., Ensermu Kelbessa and Mohammed, M.U. (1993). Modern pollen rain on an altitudinal ranges of forests and Woodlands in southwest Ethiopia. *Opera Bot.* 121: 71-84.
- Breitenbach, F. Von. (1963). Forests and wood lands of Ethiopia, a geobotanical contribution to the knowledge of the principal plant communities of Ethiopia, with special regard to forestry. *Ethiop. For. Rev.* 1: 5-16.
- Crawley, M. J. (1986). The structure of plant communities. In: Michael, and Crawley, (ed.) *Plant Ecology* Black well, Oxford pp.

1-50.

Curtis, J. T. and McInosh, R. P. (1950). The interrelation of certain analytical and synthetic phytosociological characters.

*Ecology*, 31: 434-455.

Daniel Gamachu (1977). Aspect of Climate and Water Budget in Ethiopia. Addis Ababa University Press, Addis Ababa.

Demel Teketay (1999). Past and present activities, achievement and Constraints in forest genetic resources conservation in Ethiopia.

In: Edwards, S., Abebe Demissie, Teye Bekele and Haase,

G. (Eds.). Forest genetic Resources conservation; principles strategies and actions, PP.49-72. IBCR and GTZ, Addis Ababa.

Denslow, J. S. (1987). Tropical rainforest gaps and tree species diversity.

*Ann. Rev. Ecol. Syst.* 18: 431-451.

EFAP (1994). The challenge for development. Ethiopian Forestry Action Program. EFAP, Addis Ababa.

Ensermu Kelbessa, Sebsebe Demissew, Zerihun Woldu and Edward, S.

(1992). Some threatened endemic plants of Ethiopia. NAPRECA Monograph Series 2: 35-55.

EPA (2000). The Conservation Strategy of Ethiopia. Addis Ababa, Ethiopia

Eshetu Yirdaw (2002). Restoration of the native woody-species diversity,

- Using plantation species as faster trees in the degraded high  
Land of Ethiopia Ph.D. thesis, University of Helsinki, Finland.
- EARO (2000). Procedure for Soil and Plant Analysis. Addis Ababa,  
Ethiopia.
- Friis, I., Rasmussen, F. N. and Vollesen, K. (1982). Studies in the Flora  
and Vegetation of Southwest Ethiopia. *Opera Botanica*.  
63: 8-70.
- Friis, I. (1992). Forests and forest trees of northeast tropical Africa. Kew  
Bulletin, Additional Series XV, 396 pp.
- Friis, I. & Sebsebe Demissew (2001). Vegetation maps of Ethiopia and  
Eritrea. A review of existing maps and the need for a new  
map for the Flora of Ethiopia and Eritrea. In: I. Friis and  
O. Ryding (eds.). *Biodiversity Research in the Horn of Africa  
Region, Proceedings of the 3<sup>rd</sup> International Symposium on  
the Flora of Ethiopia and Eritrea*. Biol. Sdrif. 54: 399-439.
- FTP (1995). The Historical Matrix breaking away from static analysis.  
Newsletter No. 26/27.
- Gauch, H.G. and Whittaker, R.H. (1972). Comparison of ordination  
techniques. *Ecology* 53: 868-875.
- Gauch, H. G. and Whittaker, R. H. (1981). Hierarchical Classification of  
Community Data. *J. Ecol.* 69: 135-152.

- Gauch, H. G., Jr. (1982). *Multivariate Analysis and Community Structure*. Cambridge University Press, Cambridge.
- Getachew Eshete(1998). The impact of different land use systems on structure, regeneration, and some soil properties of Abernosa Acacia woodland (Eastern Shoa, Ethiopia). M. Sc. thesis work submitted to Swedish University of Agricultural Sciences, Faculty of Forestry, Sweden
- Gold-Smith, F.B., Harrison, C. M. and Morton, A. J. (1986). Description And analysis of vegetation: In: Moore, P.D. and Chapman. S.P. (ed.) *methods in plant ecology* 2<sup>nd</sup> edition. Blackwell Scientific Publication, Oxford.
- Greig-Smith, P. (1979). The development of numerical classification and ordination. *Vegetatio*. 42: 19-26.
- Hailu Sharew (1982). An ecology study of forest in Jemjem. Sidamo. M. Sc. thesis Addis Ababa University, Addis Ababa. Mimeographed.
- Hamilton, A. C. (1974). Distribution patterns of forest trees in Uganda and their historical significance. *Vegetation* 29: 21-35.
- Harper, J. L. (1977). *Population Biology of Plants*. Academic Press, London. 892pp.
- Hill, M. O. (1979). TWINSpan-AFORTRAN Programme for arranging

- Multivariate data in an ordered two-way table by classification of individuals and attributes Cornell University, Ithaca, New York.
- ICRAF (1988). Agro forestry in dry land Africa, Nairobi, Kenya.
- IUCN (1994). The IUCN Sahel studies 1991. The World Conservation Union, Gland, Switzerland.
- IUFRO (1995). Dry land Forestry Research Proceeding of an IFS/IUFRO Workshop, Stockholm, Sweden.
- JICA (1997). Forest resources management study in the southwestern part of Ethiopia, Draft Final Report, Addis Ababa.
- Kershaw, K. A. (1964). Quantitative and dynamic ecology. Edward Arnold Publishing Co. Ltd, 183 pp.
- Kessler, J.J and Breman, H. (1993). The Role of Woody Plants in Agro-ecosystems in Semi-arid Regions, Springer-Verlag, Berlin.
- Kitessa Hunera (2003). Floristic composition and structure of the Dodolla forest, Bale Zone, Oromia Regional State. M. Sc. thesis, Addis Ababa University, Addis Ababa. Mimeographed.
- Kumar, H.D. (1981). Modern Concept of Ecology. 2<sup>nd</sup> ed. Vicas publishing House Private Ltd, Delhi.
- Kumelachew Yehitela and Tamrat Bekele (2001). Plant community Analysis and Ecology of afro-montane and transitional rainforest vegetation of southwestern Ethiopia. SINET: Ethiop. J. Sci. 25(2):

155-175.

- Lambert, J.M. and Williams, W. T. (1966). Multivariate methods in plant ecology. Comparison of information-analysis and associations-analysis, *J. Ecol.* 54: 635-664.
- Lisanework Nigatu and Mesfin Tadesse (1989). An ecological study of the vegetation of the Harena Forest Bale, Ethiopia. *SINET: Ethiopia. J.Sci.*, 12(1): 63-93.
- Mathooko, Jude M. and Kariuki, Samuel T. (2000). Disturbances and species distribution of the riparian vegetation of a rift valley stream. *African Journal of Ecology* **38 (2)**: 123-138.
- Maydell, H.J.Von. (1990). Appraisal of practices to manage woody plants in Semi- arid Environments. Wentorf, Germany.
- Melaku Werede (1990). The importance of preserving Ethiopia's Biological diversity in the context of Natural Resources Management. Addis Ababa, Ethiopia.
- Menassie Gashaw and Masresha Fetene (1996). Plant communities of the afroalpine Vegetation of Sanetti plateau. Bale Mountains, Ethiopia. *SINET: Ethiop. J. Sci.* 19 (1): 65-88.
- Mesfin Wolde Mariam (1972). An introductory geography of Ethiopia. Berhanena Selam Printing Press, Addis Ababa.

MOARD (2002). Menagesha Suba State Forest Pamphlet, Addis Ababa.

NCS(1990).Ethiopian Experience in Conservation and Development,  
National Conservation Strategy Vol.3, Addis Ababa.

Noy-Meyir, I. (1973). Divisive Polythetic classification of vegetation  
data optimized division and ordination components.

*J. Ecol.* 61: 753-760.

Orloci, L. (1967). Agglomerative classification of plant communities. *J.*  
*Ecol.* 55: 193-206.

Pande, P. K. and Bischt, A. P. S. (1988). Regeneration behavior of some  
tree species of some forested ecosystems. *Journal of Tropical*  
*Forests* 4(1): 78-84.

Pichi - Sermolli, R. E. G. (1957). Una carta geobotanica dell Africa  
Orientale (Eritrea, Ethiopia, Somali) *Webbia* 12:15-132.

Pielou, E. C. (1984). The interpretation of ecology data: a primer on  
classification and ordination Wiley, New York.

Pullan, R.A. (19734). Farmed parklands in West Africa Savannah, 3(2):  
119-115.

Richard, P., and Little, P. (1994). Biodiversity in African Human  
Landscape: Concept paper prepared for the Biodiversity  
Workshop. AAC and SSRC, Nairobi, Kenya.

- Sebsebe Demissew (1980). A Study of on the Structure of a Montane Forest. The Menagesha Suba State Forest. Addis Ababa University. M. Sc. thesis. Mimeographed.
- Sebsebe Demissew (1998). A study of the vegetation and floristic Composition of Southern Wello. Ethiopia J. Ethop. Stud. 32: 159-192.
- SFCDD (1990). Ethiopian forest Resource base identification, Conservation and Rational use in Ethiopia. State Forestry Conservation and Development Department Addis Ababa.
- Shiva, V. (1990). Biodiversity, A Third World Perspective, Third World Network, Pulau Penang, Malaysia.
- Spurr, S.H. and Barnes, B.V. (1980). Forest Ecology third. Jhon Wiley & Sons.
- Tamrat Bekele (1993). Vegetation ecology of remnant afromontane Forests on the central plateau of Shoa, Ethiopia. Alta Phytogeogra. Suec. 79: 1-61.
- Tamrat Bekele (1994). Studies on Remnant Afromontane Forests on the Central Plateau of Shewa, Ethiopiia. Comprehensive Summaries of Uppsala Dissertations from the Faculty of Sciences and Technology, 23: 59 pp
- Tesfaye Awas, Tamrat Bekele, and Sebsebe Demissew (2001). An

- ecological study of the vegetation of Gambella region,  
southwestern Ethiopia. *SINET: Ethiop. J. Sci.* 24(2): 213-228.
- Tewolde Berhan Gebre Egizabeher (1986). Vegetation and the  
Environment of the mountains of Ethiopia: Implications  
to economic use and conservation. *Mountain .Res. Dev.*  
8: 211-216.
- UNDP/ECA (1997). Forestry Development program for Benshangul –  
Gumuz National Regional State Vol. VII Addis Ababa.
- UNEP (1995). Global biodiversity assessment, Nairobi
- Whittaker, R. H. (1962). Classification of natural communities. *Botanical  
Review* 28: 1-239.
- Whittaker, R. H. (1967). Gradient analysis of vegetation. *Biol. Rev.* 42:  
207-264
- Whittaker, R. H. (1970). *Communities and Ecosystems*. The Macmillan  
Company, London. 158 pp
- William, W. T. and Lambert, J. M. (1959). Multivariate methods in plant  
ecology. I. Association analysis in plant communities.  
*Ecol.* 47: 83-101.
- Wilson, R. T. (1977). The Vegetation of Central Tigre, Ethiopia, in  
relation to its land use. *Webbia* 32: 235-270.
- Zerihun Woldu (1980). The grassland vegetation of Welmera. M. Sc.

thesis, Addis Ababa University. Mimeographed.

Zerihun Woldu (1999). Forests in the vegetation types of Ethiopia and their status in the geographical context. In: Edwards, S., Abebe Demissie Taye Bekele & Haase, G. (Eds.) Forest Genetic Resources Conservation; Principles, Strategies and Actions, pp. 1-38. IBCR & GTZ. Addis Ababa.

## Appendix 1. Perception of Local People on Forest

1. Compare a natural and plantation forest and which one does you think is more important to your house hold and why ? \_\_\_\_\_

---

---

---

2. What do you think are the most destructive activities to Menagesha Suba State Forest ? \_\_\_\_\_

---

---

---

3. what do you benefit from this forest ? \_\_\_\_\_

---

---

---

**Appendix – 4.** List of species in Menagesha Suba State Forest: T=trees; S= shrubs; H= herbs; C= climbers; F= fern.

Scientific name	Local Name	Family Name	Life
<i>Acacia abyssinica</i> Hochst. ex. Benth.	Lafto	Fabaceae	T
<i>Achyranthes aspera</i> L.	Dergu	Amaranthaceae	H
<i>Adiantum thalictroides</i> Schlechtend		Adiantaceae	H
<i>Agauria salicifolia</i> (Lam.) Oliv.	Aleltu	Ericaceae	T
<i>Ajuga integrifolia</i> var. <i>canescens</i> (Hochst. ex Benth.) Cufod.		Lamiaceae	H
<i>Allophyllus abyssinicus</i> (Hochst.) Radlk.	Lekakumea	Sapindaceae	T
<i>Apodytes dimidiata</i> E. Mey. ex. Benth		Icacinaceae	T
<i>Arisaema enneaphyllum</i> Hochst. ex. A. Rich.		Araceae	H
<i>Asparagus africanus</i> Lam.		Asparagaceae	S
<i>Asplenium monanthes</i> L.	Edokorbecha	Aspleniaceae	F
<i>Bersama abyssinica</i> Fresen.	Lolchessa	Melanthaceae	T
<i>Bidens pilosa</i> L.		Asteraceae	H
<i>Brucea antidysenterica</i> J.F. Mill.	Komengaw	Simaroubaceae	T
<i>Calpurnea aurea</i> Benth.	Checka	Fabaceae	T
<i>Carissa spinarum</i> L.	Agemssa	Apocynaceae	S
<i>Cirsium schimperi</i> (Vatke) C. Jeffrey ex. Cufod		Asteraceae	H
<i>Clausena anisata</i> (Willd.) J. D. Hook. ex. Benth	Wulma	Rutaceae	S
<i>Crepis ruepellii</i> Sch. Bip.		Asteraceae	H
<i>Croton macrostachyus</i> Del.	Bekenissa	Euphorbiaceae	T
<i>Cyperus rotundus</i> L.		Cyperaceae	H
<i>Dovyalis abyssinica</i> (A. Rich.) Warb.		Flacourtiaceae	S
<i>Dovyalis verucosa</i> (Hochst.) Warb.	Lekemea	Flacourtiaceae	S
<i>Echinops Pappii</i> Chiov.	Kosheshella	Asteraceae	H
<i>Ekebergia capensis</i> Sparrm.	Sombo	Meliaceae	T
<i>Embelia schimperi</i> Vatke	Inkoko	Myrsinaceae	C
<i>Erica arborea</i> L.	Asta	Ericaceae	T
<i>Euphorbia ampliphylla</i> Pax.		Euphorbiaceae	T
<i>Flacourtia indica</i> (Burm.f.) Merr.		Flacourtiaceae	T
<i>Galium simense</i> Fresen		Rubiaceae	H
<i>Galliniera saxifraga</i> (Hochst.) Bridson	Bunette	Rubiaceae	T
<i>Halleria lucida</i> L.	Kemetea	Scrophulariaceae	S
<i>Helichrysum cymosum</i> (L.) Less		Asteraceae	S
<i>Helichrysum foetidum</i> (L.) Moench	Keskesea	Asteraceae	S
<i>Helichrysum meyeri-johannis</i> Engl.		Asteraceae	S
<i>Hibiscus ludwigii</i> Eckl. & Zeyh.		Malvaceae	S
<i>Hypericum revolutum</i> Vahl	Hine	Hypericaceae	S
<i>Ilex mitis</i> (L.) Radlk.		Aquifoliaceae	T
<i>Inula confertiflora</i> A. Rich.	Encheber	Asteraceae	H
<i>Jasminum abyssinicum</i> Hochst. ex. DC.	Neche Hreg	Oleaceae	C
<i>Jasminum stans</i> Pax.	Kechemea arba	Oleaceae	S
<i>Juniperus procera</i> Hochst. ex. A. Rich.	Getera	Cuppressaceae	T

<i>Kalanchoe petitiiana</i> A. Rich.	Endawella	Crassulaceae	H
<i>Lantana trifolia</i> L.	Kussaye	Verbenaceae	S
<i>Linocira giordanii</i> Chiov.		Oleaceae	S
<i>Lobelia giberroa</i> Hemsl.	Gibera	Campanulaceae	H
<i>Maesa lanceolata</i> Forssk.	Abeyee	Myrsinaceae	S
<i>Maytenus obscura</i> (A.Rich.) Cuf.	Odobeda	Celasteraceae	T
<i>Maytenus undata</i> (Thunb.) Blackelock	Wontofulasa	Celasteraceae	T
<i>Mikaniopsis clematoides</i> (A.Rich.) Milne- Redhead	Katissa	Asteraceae	C
<i>Myrica salicifolia</i> Hochst ex. A. Rich.	Kateba	Myricaceae	T
<i>Myrsine africana</i> L.	Kechemo	Myrsinaceae	S
<i>Myrsine melanophloeos</i> (L.) R. Br.	Algae	Myrsinaceae	T
<i>Nuxia congesta</i> R. Br. ex Fresen.	Irba	Loganiaceae	T
<i>Olea europaea</i> L. sub sp. <i>cuspidata</i> (Wall. ex. G. Don.) Cif.	Agerssa	Oleaceae	T
<i>Olinia aequipetala</i> (Del.) Cuf.	Dalecho	Oliniaceae	T
<i>Osyris arborea</i> Wall. ex. Wight	Watto	Santalaceae	S
<i>Pentas lanceolata</i> (Forssk) Dellers		Rubiaceae	H
<i>Penisetum schimperi</i> A. Rich.	Megera	Poaceae	G
<i>Periploca linearifolia</i> A. Rich.	Yewettet Hareg	Asclepiadaceae	C
<i>Podocarpus falcatus</i> (Thunb) Mirb.	Birbirssa	Podocarpaceae	T
<i>Prunus africana</i> Hook. f.	Mukea-guracha	Rosaceae	T
<i>Rhamnus prinoides</i> L' Her.	Kedida	Rhamnaceae	S
<i>Rhus glutinosa</i> Hochst. ex. A. Rich.		Anacardiaceae	T
<i>Rhus ruspolii</i> Engl.	Tatecha	Anacardiaceae	T
<i>Rhus vulgaris</i> Meikle		Anacardiaceae	S
<i>Rosa abyssinica</i> Lindley	Kega	Rosaceae	Cr
<i>Rubus apetalus</i> Poir.		Rosaceae	Cr
<i>Satureja biflora</i> (Ham. ex. Don.) Briq.		Lamiaceae	H
<i>Scolopia theifolia</i> Gilg.	Kolfa	Flacourtiaceae	T
<i>Senecio gigas</i> (Vatke) C. Teffrey		Asteraceae	
<i>Senecio myriocephallus</i> Sch. Bip.	Charee	Asteraceae	H
<i>Sida tenuicarpa</i> Vollesen	Buffee	Malvaceae	S
<i>Sideroxylon gillettii</i> Hutch. & Bruce	Betea	Sapotaceae	S
<i>Smilax anceps</i> Willd	Goressa	Smilacaceae	C
<i>Solanecio gigas</i> (Hook.f.) C. Jeffrey	Yeshekoko Gomen	Asteraceae	H
<i>Stephania abyssinica</i> (Dill. and Rich) Walp.	Kelala	Menispermaceae	C
<i>Teclea nobilis</i> Del.	Adecha	Rutaceae	T
<i>Thymus schimperi</i> Ronn.	Tossign	Lamiaceae	H
<i>Tripogon leptophyllus</i> (A. Rich) Cuf.	Kekeba	Poaceae	G
<i>Verbascum sinaiticum</i> Benth.	Gura-hare	Scrophulariaceae	H
<i>Vernonia amygdalina</i> Del.	Gerawa	Asteraceae	S
<i>Vernonia leopoldii</i> Vatke	Sokea-gogorea	Asteraceae	S

**Appendix – 5. Releve Characteristics of Menagesha Suba State Forest**

Releve	Geographical locations		altitudes	Number of species
1	991200 N	450000 E	2500	16
2	991333.33 N	450000 E	2520	13
3	991466.66 N	450000 E	2560	17
4	991666.66 N	450133.33 E	2590	10
5	989866.66 N	450666.66 E	2540	18
6	989933.33 N	450266.66 E	2500	10
7	990266.66 N	450866.66 E	2570	4
8	989666.66 N	450466.66 E	2530	13
9	989733.33 N	450800 E	2530	21
10	992266.66 N	448733.33 E	2460	15
11	992400 N	448933.33 E	2480	10
12	992666.66 N	448800 E	2480	18
13	992900 N	448933.33 E	2480	21
14	992900 N	448666.66 E	2440	13
15	992533.33 N	451200 E	2610	17
16	992666.66 N	451266.66 E	2440	13
17	992733.33 N	451533.33 E	2630	17

18	992466.66 N	451333.33 E	2620	19
19	992400 N	451133.33 E	2620	20
20	991266.66 N	450800 E	2630	18
21	991533.33 N	450866.66 E	2630	17
22	991533.33 N	450666.66 E	2600	17
23	990933.33 N	450933.33 E	2630	18
24	990866.66 N	450666.66 E	2620	21
25	992200 N	450733.33 E	2650	8
26	992466.66 N	450733.33 E	2650	19
27	992466.66 N	450600 E	2640	16
28	992066.66 N	450666.66 E	2650	19
29	991933.33 N	450800 E	2670	10
30	993200 N	450733.33 E	2550	13
31	993333.33 N	450600 E	2540	12
32	993266.66 N	450466.66	2520	11
33	993533.33 N	450733.33 E	2550	16
34	993600 N	450600 E	2560	16
35	994466.66 N	451266.66 E	2620	24
36	994400 N	451066.66 E	2600	16
37	994000 N	451333.33 E	2640	13

38	9939333.33 N	451533.33 E	2670	7
39	993733.33 N	451733.33 E	2680	11
40	991533.33 N	452333.33 E	2890	5
41	991200 N	452533.33 E	2870	15
42	990933.33 N	452666.66 E	2870	17
43	990733.33 N	452533.33 E	2850	15
44	990866.66 N	452266.66 E	2850	16
45	990533.33 N	451533.33 E	2730	17
46	990400 N	451466.66 E	2720	18
47	990600 N	451800 E	2740	14
48	990866.66 N	451600 E	2770	19
49	990933.33 N	451666.66 E	2750	11
50	991466.66 N	450333.33 E	2620	11

## Appendix – 6. Field Data Collection Form.

### I. Site description

1. Plot number. \_\_\_\_\_
2. Altitude. \_\_\_\_\_
3. Slope %. \_\_\_\_\_
4. Locality. \_\_\_\_\_
5. Aspect. \_\_\_\_\_
6. Position. \_\_\_\_\_

### II Biological impact

1. Human impact
  - 1.1. None. \_\_\_\_\_
  - 1.2. Low. \_\_\_\_\_
  - 1.3. Moderate. \_\_\_\_\_
  - 1.4. High. \_\_\_\_\_
2. Browsing and Grazing.
  - 2.1. None. \_\_\_\_\_
  - 2.2. Low. \_\_\_\_\_
  - 2.3. Moderate. \_\_\_\_\_
  - 2.4. High. \_\_\_\_\_

## Appendix 7: List of National Forest Priority Areas (NFPAs)

Name of forest	Region	High Forests		Plantation	Other Land	Total Area
		Slightly Disturb.	Heavily Disturb.			
1. Arba Gugu	Arsi		6,300	1,600	13,500	21,400
2. Chilalo Gallema	Arsi			1,400	20,600	22,000
3. Munessa-shashemane	Shewa	7,000	10,200	6,800	74,200	98,200
4. Aloshe-Batu Dodola-Ababa	Bale		10,000	1,700	28,300	40,000
5. Logo	Bale	5,000	16,400	900	36,700	59,000
6. Goro Bele	Bale	9,800	50,000	200	40,000	100,000
7. Harena-Kokossa	Bale	20,000	70,000		92,000	182,000
8. Kubayo	Bale	5,000	17,900	300	55,200	78,400
9. Mena-Angetu	Bale	20,000	50,000	200	119,800	190,000
10. Bulki-Malakoza	Gamo Gofa			500	10,500	11,000
11. Gidole-Camba	Gamo Gofa	15,000	5,000		10,000	30,000
12. Gidole-Gamba	Gamo Gofa			1,200	14,800	16,000
13. Guangua-Kahtas.	Gojam		32,000	2,800	21,700	56,500
14. Sekela-Mariam	Gojam			2,000	8,000	10,000
15. Butugi-Melka-Jebdu	Harerge			3,800	41,400	45,200
16. Din Din-Arbag.	Harerge		3,300	5,900	57,600	66,800
17. Gara-Muleta	Harerge		2,600	2,000	2,400	7,000
18. Jalo-Muktar-Metakesha-Add.	Harerge		2,500	4,100	14,700	21,300
19. Jarso-Gursum	Harerge		1,500	4,500	46,300	52,300
20. Abobo-Gog	Illubab	150,000	45,000	100	22,900	218,000
21. Gebre Dima	Illubab	50,000	82,000		33,000	165,000
22. Godere	Illubab	40,000	100,000	500	19,500	160,000
23. Sele-Anderacha	Illubab	100,000	115,000	700	9,300	225,000
24. Sibo-Tale Kobo	Illubab	28,000	50,000	1,900	20,100	100,000
25. Sigmo Geba	Illubab	67,700	190,000	2,300	20,000	280,000
26. Yayu	Illubab	20,000	100,000	300	29,700	150,000
27. Yeki	Illubab	10,000	100,000	500	11,500	122,000
28. Wangus.	Illubab	329,900			85,100	415,000
29. Mesengo	Illubab	292,350		650	32,000	325,000
30. Abelti-Gibe	Keffa		4,700	1,300	4,000	10,000
31. Babya-Fola	Keffa		45,000	900	28,400	74,300
32. Belete-Gera	Keffa	76,500	35,200	1,100	35,700	148,500
33. Bonga	Keffa	7,000	10,000	2,100	142,300	161,400
34. Gura Ferda	Keffa	80,000	35,100	800	224,100	140,000
35. Tiro Boter Becho	Keffa	16,000	23,300	2,300	44,200	85,800
36. Butagira	Shewa			1,600	13,400	15,000
37. Chilmo-Gaje	Shewa		2,000	800	23,200	26,000

38. Gedo	Shewa	2,000	3,000		5,000	10,000
39. Jibat-Mute-Jegenfo	Shewa		5,000		33,500	38,500
40. Menagesha-suba	Shewa		3,600	1,300	4,900	9,800
41. Wof-Washa	Shewa		2,000	4,200	2,700	8,900
42. Yerer-Dire-Gerbicha Zukuala	Shewa	300	3,800	1,700	3,800	9,600
43. Anferara-Wadera	Sidamo		13,000	3,700	89,900	106,600
44. Bore-Anferara	Sidamo		33,000	1,400	182,900	217,300
45. Megada	Sidamo	5,000	10,000	1,300	4,500	20,800
46. Negele	Sidamo		1,200	300	16,300	17,800
47. Yavelo-Arero	Sidamo		8,000	150	41,750	49,900
48. Des-A	Tigraye				20,000	20,000
49. Chato-Sengi-Dengeb	Welega		5,000	60	39,800	44,860
50. Gergeda	Welega	20,000	20,000	1,000	96,400	137,400
51. Gidame	Welega		10,000		7,000	17,000
52. Jurgo-Wattu	Welega		15,000	200	4,700	19,900
53. Komto Waja Tsege	Welega		1,000	1,200	6,900	9,100
54. Konchi	Welega	10,000	5,000		8,000	13,000
55. Linche Dali Gewe	Wello		15,000		25,000	50,000
56. Denkoro	Wello		2,300		3,000	5,300
57. Gumburda Grakaso	Wello		11,500	2,200	12,300	26,000
58. Yegof-Erike	Wello		2,800	8,400	6,800	18,000
Total		1,385,550	1,385,200	84,860	1,921,250	4,777,860

**Appendix 8. Species which were new and not encountered in the stands  
as compare to 1980 studied.**

Ser.no.	New recorded species on the stands	Not encountered in the stands
1	<i>Acacia abyssinica</i>	<i>Barleria ventricosa</i>
2	<i>Achyranthes aspera</i>	<i>Crotalaria lachnocarpa</i>
3	<i>Ajuga intgritola</i>	<i>Dryopteris inaequalis</i>
4	<i>Apodytes dimidiate</i>	<i>Euphorbia obovalifolia</i>
5	<i>Arisaema enneaphyllum</i>	<i>Gnidia glauca</i>
6	<i>Asparagus africanus</i>	<i>Hypericum lanceolatum</i>
7	<i>Bidens pilosa</i>	<i>Otestegia minuccii</i>
8	<i>Cirsium schimperi</i>	<i>Pteropterus frutescans</i>
9	<i>Crepis ruepellii</i>	<i>Urera hypsloendron</i>
10	<i>Croton macrostachyus</i>	
11	<i>Cyperus rotundus</i>	
12	<i>Echinops spinosus</i>	
13	<i>Euphorbia ampliphylla</i>	
14	<i>Flacourtia indica</i>	
15	<i>Galium simens</i>	
16	<i>Helichrysum foetidum</i>	
17	<i>Helichrysum meyeri-johannis</i>	
18	<i>Hibiscus ludwigii</i>	
19	<i>Hypericum revolutum</i>	
20	<i>Inula confertiflora</i>	
21	<i>Kalanchoe petitiiana</i>	
22	<i>Lantana trifolia</i>	
23	<i>Linocira giordanii</i>	
24	<i>Mikaniopsis clematoides</i>	
25	<i>Penisetum schimperi</i>	
26	<i>Rhus ruspolii</i>	
27	<i>Thymus schimperi</i>	
28	<i>Tripogon leptophyllus</i>	

## DECLARATION

I, the undersigned, declare that this thesis is my work and that all sources of material used for thesis have been duly acknowledged.

Name Abate Zewdie Beka

Signature \_\_\_\_\_

Place and date of submission

Addis Ababa University

July, 2007