Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.8, No.19, 2018

Vegetation Types, Composition and Conservation Status of Forest Ecosystems in Ethiopia

Ayalew Sebsibe Tegene
Department of Biology, Collage of Natural and Computational Science, Madda Walabu University
PO Box 247, Bale Robe, Ethiopia

Introduction

Diversity is unevenly distributed over the surface of the earth. The most conspicuous spatial pattern of species diversity is a latitudinal gradient of decreasing richness of species from equator to poles (Willig *et al.* 2003). This pattern is consistent for several organismal groups such as terrestrial plants (Mutke and Barthlott 2005). However, notable exceptions to this classical pattern are quite common for different taxonomic groups (Heywood 1995). Some taxonomic groups such as vascular plants richness in Africa increases towards temperate latitudes (Heywood 1995), hotspots of gymnosperm diversity are located in Southeast Asia especially in China while tropical Africa is considered as a cold spot of Gymnosperm species diversity (Mutke & Barthlott 2005).

Ethiopia's boundaries encompass the major part of the eastern African highland massif. On the northern and western boundaries lie the foothills of the main massif. The Great Rift Valley cuts diagonally across the country from north east to south, creating a vast depression. The dry areas have isolated the highlands. Thus, there is a great variation of altitude from 116metres below sea level to 4620 meters above sea level. Rainfall also varies widely in amount and distribution. These factors strongly influence Ethiopia's extraordinary range of terrestrial and aquatic ecosystems and have contributed to a high diversity and of endemism (Tesfaye Awas *et al.* 2003).

According to Leul Kidane *et al*. (2010), Ethiopia is one of the centers of plant genetic diversity and that its indigenous vegetations have been depositors of biodiversity including micro-organisms , fungi, soil fauna and flora, medicinal plants , wild animals, birds insects as well as human beings (Tewolde Berhan Gebre Egziabher 1991; Legesse Negash 2002).It was believed that, in early 20th century about 42 million hectares or equivalent of 35% of Ethiopia's land area which is 110 million hectares was covered with high forest. With the inclusion of savannah woodlands, about 66% of the country was covered with forest or/and woodland at that time (EFAP 1994).However, with high population pressure, expansion of urbanization and the increasing demand for agricultural land, the present forest resource is on the verge of complete depletion (Zenebe Gebre Egziabher *et al.* 1998).Forest conservation is currently the top agenda for a number of world conservation organizations, authorities and interest groups. Concern over forest conservation generally hinges on anthropogenic activities that lead to depletion forest resources. Conservation biologists have sought to protect forests using several different strategies from strict protection in National Parks, to sustainable forest management and other integrated conservation and development programs (Bruner et al. 2001).

1. Biodiversity

Biodiversity is defined as the variety of life and its process (Noss and Cooperrider, 1994; Tadesse Woldemariam 1998). It is the totality of genes, species, and ecosystems and human culture that is closely linked to the entire process of totality. Three levels of diversity can be recognized: Genetic diversity (variation of genes within species), species diversity (variety of species within a given bioregion) and ecosystem diversity (refers to the boundary of biological communities in association with species and ecological system). According to this definition, biodiversity includes the variety of living organisms, the genetic diversity, the community and ecosystem in which they occur and the ecological and evolutionary process in which it helps them to keep functioning. Diversity helps in the functioning of ecosystems and interaction between ecosystems. Reduction of diversity will result in the instability of ecosystems. The loss of a certain fraction will result in the disruption of the whole system (BSP 1993).

2. Forest plant diversity

Ethiopia has the fifth largest flora in Africa (Anonymous 1997a, b). The flora is very heterogeneous and has a rich endemic element owing to the diversity in climate, vegetation and terrain. It is estimated to contain between 6,500–7000 species of higher plants, of which about 12% are endemic (Tewolde Berhan Gebre Egziabher 1991).

The forest resources of Ethiopia are grouped in 5 categories, namely, natural closed forests, woodlands, bush lands, plantations and on-farm trees. The current area coverage of each category is not available. It is often reported that, in early 20th century about 42 million hectares or equivalent of 35% of Ethiopia's land area which is 110 million hectares was covered with high forest. With the inclusion of savannah woodlands, about 66% of the country was covered with forest or/and woodland at that time (EFAP 1994).

The total number of woody species of Ethiopia is estimated to be 1017, out of which 29 tree species, 93 shrub species and 2 liana species are endemic. These species represent 104 families and 387 genera (Taye *et al.*

2003).

However, by the early 1950's, high forest was reduced to 19 million hectares or 16% of the total land area and It was reported that the high forest cover was 3.6% by the early 1980's, and about 2.7% by 1989's (WBISPP 2000). The relatively early and extensive deforestation in Ethiopia, coupled with cultivation of steep marginal lands, overgrazing and socio-political instability, has resulted in severe land degradation over large areas of the country.

3. Vegetation Structure and Composition

Vegetation is a general term for the plant life of a region or the ground cover provided by plants. It is a general term, without specific reference to particular taxa, life forms, structure, spatial extent, or any other specific botanical or geographic characteristics (http://www.answers.com/topic/vegetation).

Vegetation is a key factor in determining the structure of any ecosystem. Within a plant community, it determines microclimate, energy budget, photosynthesis, water regimes, surface runoff and soil temperature (Tappeiner and Cernusca 1996).

3.1. Defining Vegetation Structure, Function and Composition

Ecosystems are frequently characterized in terms of their species and genetic composition (Hunter 1999), even though this approach ignores ecological processes (natural disturbance, the decomposition of woody debris, the cycling of nutrients etc.), which are critical for the maintenance of biodiversity (Noss 1990). An alternative approach, first suggested more than two decades ago, (Franklin *et al.* 1981), is to describe forest ecosystems by attributes relating to ecosystem structure and function in addition to those describing composition (Franklin *et al.* 2002; Noss 1990; Franklin 1988). In this approach:

Structure refers to the spatial arrangement of the various components of the ecosystem, such as the heights of different canopy levels and the spacing of trees.

Function refers to how various ecological processes, such as the production of organic matter, are accomplished and to the rates at which they occur.

Composition refers to the identity and variety of elements, as characterized by species richness and abundance.

These three attribute groupings operate over a range of scales from landscape to individual. Noss (1990) used these scales to arrange the attribute groupings into a nested hierarchy, in which organization at the scale of species or populations provided the basis for many larger scale patterns. While this approach does not imply that there is a single scale of organization which is fundamental to the maintenance of biodiversity, it does highlight the importance of attributes and variation at a local, or stand scale (Noss 1999).

3.2. Structural attributes

The structural, functional and compositional attributes of a stand are often interdependent, so that attributes from one group may also be a surrogate for attributes from another group (Franklin *et al.* 2002, Ferris and Humphrey 1999; Noss 1990).

For example a structural attribute such as dead wood may also be a good indicator of functional attributes such as decomposition and nutrient cycling processes. Similarly compositional attributes, such as species composition and abundance can be indicators of structural attributes such as hollow bearing trees, or of functional attributes such as flowering and bark shedding (Franklin *et al.* 2002, Kavanagh 1987).

The division of attributes into three groupings is by no means a clear and distinct categorization. In order to define structure in an unambiguous manner, the structural, functional and compositional attributes are pooled into a single category simply called structural attributes.

3.3. Vegetation Patterns

Vegetative gradients are expressions of differential species responses to a multidimensional environmental complex of interrelated factors and effects (Bray and Curtis 1957). Species interactions also play an important role in determining vegetation patterns (Mueller-Dombois and Ellenberg 1974). Numerous environmental variables are important in the formation of vegetation gradients, including climate, soils, and time. These factors ultimately control species distributions on a global scale (Braun 1950; Geis and Boggess 1970). Topography, water availability, flooding, and canopy cover affect vegetation patterns on a local scale. Major topographic changes affect tree distribution by influencing forest microclimate and soil depth, texture, and nutrient and water contents (Mowbray and Costing 1968). Minor variation in relief influences vegetation mainly through changes in water availability or susceptibility to flooding (Wikum and Wali 1974; Gauch and Stone 1979).

3.4. Major category of vegetation types of Ethiopia

Using vegetation as the main distinguishing factor, there are 9 broadly recognized terrestrial ecosystems in Ethiopia (Tesfaye *et al* 2003; Friis and Sebsebe 2001; Zerihun 1999; Sebsebe *et al* 1996; Anonymous 1992).

3.4.1. Afroalpine and Subafroalpine Vegetation
The areas which on the average higher than 3200 meters above sea level (m.a.s.l) are generally referred to as the Afroalpine and Subafroalpine (Hedberg 1957). The lower limit of the afroalpine belt falls at about 3500 m, while the upper limit of vascular plants lies around 5000 m (Hedberg 1964), and subafroalpine areas ranges between 3200- 3500 m. These areas include chains of mountains, mountain slopes and tops of highest mountains in the country. The highest peak in Ethiopia is Ras Dashen (4533 m a.s.l), where an alpine climate near 0°C persists all year round, sometimes even with a snow cover lasting a couple of days (Hurni and Ludi 1998). Ethiopia has the largest extent of afroalpine habitats in Africa (Yalden 1983). This ecosystem is characterized by the most eye-catching giant herb, a lobelia (*Lobelia rhynchopetalum*), the evergreen tree heather (*Erica arborea*) and shrubby and herbaceous everlasting flowers (*Helichrysum* spp.*)* (CBD 2009).

3.4.2. Montane Grassland Vegetation
The Montane grassland vegetation is found at altitudes between 1,500 and 3,200 meters above sea level (m.a.s.l) and it is distinguished from other types of ecosystems by its physiognomy, floristic composition and ecology. It consists of herbaceous stratum usually not higher than 30 - 80 cm, very rich in perennial grasses and species of Cyperaceae, but also with sub-shrubs and perennial herbs, among which bulbous and rhizomatous plants occur (Pichi-Sermolli 1957). The original climax vegetation on the montane grassland of Ethiopia was supposed to be a dry evergreen montane forest intermingled with small areas of grassland (Zerihun Woldu 1988).

The montane grassland in most places derived from forest and other woody vegetation types. The relict patches of forest associated with the grassland ecosystem consists of species of *Juniperus procera, Olea europaea* sub sp. cuspidata and *Afrocarpus falcuatus* (Zerihun Woldu 1988). The environmental factors determining the variation in vegetation types in the montane grassland ecosystem are moisture, topography and human activity.

Characteristic species of the montane grassland ecosystem include species of: *Pennisetum shimperi, Pennisetum glabrum, Pennisetum mezanu, Hyparrhenia rufa, Cynodon dactylon, Eragrostis tennifolia, Eragrostis japonica, Pennisetum clandestinum, Panicum maximum, Cymbopogon spp. Chloris spp.,* and *Andropogon spp.* (Tewolde Berhan Gebre Egziabher 1991). The various types of grass species are interspersed with trees such as *Acacia abyssinica, Acacia nigri, Prunus africana, Juniperus procera, Olea europaea, Allophylus abyssinica, Celtis africana, Croton macrostachyus, Milletia ferruginea, Measa lanceolata, Buddelja polystachia, Erythrina brucei, Myrsine africana, Calpurnia aurea, Dovyalis abyssinica, Draceana afromontanum*.

Besides these growth forms shrubby species such as Acokanthera shcimperi, *Carissa edulis*, *Rosa abyssinica* and *Maytenus arbutifolia* (Zerihun Woldu 1988).

3.4.3. Dry Evergreen Montane Forest and Evergreen Scrub
The Ethiopian highlands contribute to more than 50 % of the land area with Afromontane vegetation, of which dry montane forests form the largest part (Yalden 1983; Tamrat Bekele 1994). The evergreen scrubland vegetation occurs in the highlands of Ethiopia either as an intact scrub, i.e. in association with the dry evergreen montane forest or usually as secondary growth after deforestation of the dry evergreen montane forest.

3.4.3.1. Dry Evergreen Montane Forest
Dry Evergreen Montane Forest is a very complex vegetation type occurring in an altitudinal range of 1500-2700 m (Friis 1992). This type of forest develops in areas of relatively high humidity, but not much rain, and where there is a prolonged dry season.

Dry Evergreen Montane Forest is multi-storeyed forest vegetation. The top storey consists of a non-uniform, non-compact layer of tall trees. These trees are known as emergents because they project above the vegetation mass. Below the layer of emergents is a mass of shorter trees of various heights.

Still lower is a stratum of short trees and large shrubs, much less dense than the second stratum. Finally, there is the lowest stratum of shrubs, suffrutescents, and herbs. Epiphytes, lianas and parasites are common (Zerihun Woldu 1999; Anonymous 1992). *This vegetation is characterized by Olea europea subsp. africana, Juniperus procera, Celtis kraussiana, Euphorbia amplipylla, Dracaena spp. Carissa edulis, Rosa abyssinca, Mimusops kummel, Ekebergia capensis, Arundinaria alpine, Afrocarpus falcatus, , Prunus africana, Apodytes dimidiataEuphorbia abovalifolia, Rapanea simensis, Olinia aequipetala, Discopodium penninervium, Myrsine africana, calpurina aurea, Dovyalis Abyssinica,Rubia cordifolia, Urera hypselodendron, Embelia schimperi, Jasminum floribundum.*

3.4.3.2. Evergreen Scrub Vegetation
The evergreen scrub vegetation consists of both the montane evergreen thicket and the montane evergreen scrub. This vegetation occurs as a secondary re-growth on steep plateau slopes where there had been intense deforestation of large trees or montane forests. The montane evergreen thicket consists of dense growth of small evergreen shrubs, lianas and sparsely spaced small trees. The evergreen scrubs are expanding as a result of the deterioration of the areas that used to be forests.

In the western volcanic ash areas of central Ethiopia, the gullies are becoming evergreen scrub (Zerihun

Woldu, 1999). Characteristic species occurring in this vegetation are: *Acokanthera schimperi, Carissa edulis, Scolopia theifoliaand, Euclea schimperi, Rhamnus staddo, Myrsine africana, Dodonaea angustifolia, Rhus* spp., *Calpurnia aurea, Jasminum abyssinicum, Osyris quadripartita, Ximenia americana, Protea gaguedi, Teclea nobilis, Croton macrostachyus, Bersama abyssinica, Olea europaea, Juniperus procera, Ficus* spp., *Euphorbia abyssinica, Euphorbia candelabrum, and Dracaena spp.,* and *Pterolobium stellatum* (Zerihun Woldu 1999; Anonymous 1992).

3.4.4. Moist Montane Forest

The montane moist forest ecosystem comprise the high forests of the country and are found mostly on the southwestern plateau, with an altitudinal range between 800 to 2,500 masl. The montane moist forest ecosytem is the most diverse ecosystem in composition, structure and habitat types. This ecosystem lies on mountainous area which allows the existence of wide ecological gradients along the altitudes. As a result, large complexes of mountain forest exist forming several distinct vegetation units.

The montane moist forest ecosystem is distinguished by supporting luxuriant growing epiphytes Canarina, Orchids, Scadoxus and fern plants such as Platycerium and Drynaria. Mosses also occur in the wettest porton of forests associated to major branches and barks of trees. In terms of the woody plant diversity, more than 160 species from the southwestern plateau and 200 from the southeastern plateau forests are recorded (Kumlachew Yeshitila 1997; Lisanework Nigatu and Mesfin Tadesse 1989).

Where still standing, this forest vegetation is stratified into four different layers, namely, upper canopy, sub-canopy, shrub layer and the ground layer. The upper canopy is occupied by the spectacular emergent trees of *Pouteria adolfi-friedericii. Podocarpus falcatus* is important in the mixed broad-leaved forests of the Bale Mountains. Other characteristic species in the canopy include *Olea capensis* subsp. *welwitschii* and subsp. *hochstetteri*, *Prunus africana*, *Albizia schimperiana*, *Milletia ferruginea* and *Celtis africana*. Others such as *Polyscias fulva*, *Schefflera volkensii, Trilepisium madagascariense*, *Schefflera abyssinica*, *Bersama abyssinica*, *Mimusops kummel* are also found. Sub-canopy species include, among others, *Croton macrostachyus*, *Cordia africana*, *Dracena steudneri*, *Syzygium guineense* subsp. *afromontanum*, *Sapium ellipticum*, *Ilex mitis*, *Erythrina brucei, Rothmannia urcelliformis* and the tree fern, *Cyathea manniana*. The shrub layer consists of species such as *Coffea arabica*, *Galiniera saxifraga*, *Teclea nobilis*, *Ocotea kenyensis*, *Clausena anisata*, *Maesa lanceolata* and *Maytenus* spp.

Examples of woody climbers are *Urera hypselodendron*, *Landolphia owarensis*, *Embelia schimperi* and *Jasminum* spp. (Zerihun Woldu *et al*. 1989; Kumlachew Yeshitila 1997)

Epiphytes include many species of orchids, the endemic *Scadoxus nutans*, *Peperomia* spp., ferns and fern allies such as *Lycopodium*.

The ground vegetation is mainly made up of herbaceous plants including species of *Acanthus*, *Justicia*, *Impatiens*, various species of Urticaceae and Zingiberaceae, some grass and sedge species (Lisanework Nigatu and Mesfin Tadesse 1989; Mesfin Tadesse 1986; Zerihun Woldu *et al*. 1989; Kumlachew Yeshitila 1997)

3.4.5. *Acacia-Commiphora* (small-leaved deciduous) woodland

The *Acacia-Commiphora* ecosystem is found 900-1900 meters above sea level. The Acacia-Commiphora ecosystem is known for its varying soils, topography, and diverse biotic and ecological elements. These plant species are with either small deciduous leaves or leathery persistent ones. The density of trees varies from high, in which they form a closed canopy to scattered individuals to none at all forming open grasslands. The grasses do not exceed more than one meter, thus, no true savannah is formed. This ecosystem is characterized by drought resistant tree and shrub species with small leaves and which are usually deciduous. The characteristic woody species are *Acacia senegal, A. seyal, A. tortilis, Balanites aegyptiaca, Commiphora africana, C. boranensis, C. cilliata, C. monoica* and *C. serrulata*. The ground layer is rich in *Acalypha, Barleria, Aerva, Aloe* and grass species (CBD 2009).

3.4.6. *Combretum-Terminalia* (Broad-leaved deciduous) woodland

The topography/terrain is rugged; the upper limits about 1900 meters above sea level and the lower about 500 meters above sea level. This ecosystem is characterized by *Cmbretum spp., Terminalia spp., Oxytenanthera abyssinica, Boswellia papyrifera, Anogeissus lieocarpa, Sterospermem kuntianum, Pterocarpus lucens, Lonchocarpus laxiflorus, Lannea spp. Albizia malacophylla* and *Enatada africana.* These are small trees with fairly large deciduous leaves, which often occur with the lowland bamboo- *Oxytenanthera abyssinica.* The understory is a combination of herbs and grasses. The herbs include *Justecia spp., Barleria spp., Eulophia, chlorophytum, Hossolunda opposite* and *Ledeburia spp.*

The grasses include *Cymbopogon, Hyparrhenia, Echinochla, Sorghum, Pennisetum, (*Tesfaye Awas *et al.* 2001). Usually the herbs dominate the ground layer at the beginning of the rainy season while grasses dominate toward the end of the rainy season. The vegetation in this ecosystem has developed under the influence of fire. Thus, trees have very tick bark to cop with fire while most herbs have perennial bulbs (Menassie Gashaw 2000).

3.4.7. Lowland Tropical Forest

This is a lowland semi-evergreen forest ecosystems restricted to the lowlands of the eastern Gambella Region, and adjacent areas in the Sudan. This forest occurs on well-drained sandy soils with an altitudinal range of 450 to 800 masl. The forest has more than 106 woody plant species including lianas (Anonymous 2001). The characteristic species of this forest are *Baphia abyssinica* and *Tapura fischeri* (Chaffey 1979; Friis 1992; Tesfaye *et al*. 2001).

The common species in the upper canopy include Celtis gomphophylla, Celtis toka, Lecaniodiscus fraxinifolius, Zanha golungensis, Trichilia prieureana, Alistonia boonei, Antiaris toxicaria, Malacantha alnifolia, Zanthoxylum lepreurii, Diospyros abyssinica, Milicia excelsa, Baphia abyssinica, Vepris dainellii and Celtis zenkeri. The common species in the middle layer include Acalyphla neptunica, Erythroxylum fischeri, Tapura fischeri, Ziziphus pubescens and Xylopia parviflora (Chaffey 1979; Friis 1992; Tesfaye et al. 2001).

The common species in the shrub layer include Whitfieldia elongata, Argomuellera macrophylla, Alchornea laxiflora, Mimulopsis solmsii, Oncoba spinosa, Oxyanthus speciosus, Rinorea ilicifolia (Friis, 1992), Chazaliella abrupta (Tesfaye et al. 1997) and Acalypha acrogyna (Tesfaye et al. 2001). Lianas including Hippocratea africana and H. pallens are found in this ecosystem (Tesfaye et al. 2001).

3.4.8. Desert and Semi-desert Scrubland

These ecosystems occur below 500masl.These ecosystems are a very dry zone vulnerable to wind and water erosion even with little or no pressure on the vegetation from grazing. The vegetation consists of deciduous shrubs, dominated by Acacia sp. interspersed with less frequent evergreen shrubs and succulents. Highly drought tolerant shrubs, some succulents and few grasses characterize the ecosystem. The Characteristic species are: *Acacia spp., Boscia sp., Cadaba sp., Commiphora sp., Maerua sp., Ziziphus sp., Aloe sp., Commelina sp., Dactyloctenium spp.,* and *Euphorbia spp.* (Zerihun Woldu 1999; Demel Teketay 1999).

On rocky outcrops where succulents predominate may be found *Euphorbia spp., Aloe spp.*, *Caralluma spp., Sansevieria spp., Cissus spp*., *Commiphora spp., Dracaena ombet, Withania somnifera, Aenium spp*., etc. In areas where the run-off from the surrounding higher areas makes the condition suitable, a semi-desert thicket develops with *Acacia spp*., *Commiphora spp*., *Ziziphus spp*., *Cadaba spp*., *Malruna spp., Jatropha spp., Sansevieria spp.* (Zerihun Woldu 1999; Demel Teketay 1999).

Scattered shrubs and grasslands cover large part of the semi-desert areas. The shrubs are *Grewia spp*., *Commiphora spp*., *Acacia spp*. and *Balanites spp*. The most widely distributed grasses are *Chrysopogon aucheri* and *Aristida spp*. *Blepharis spp*. and *Abutilon spp*. are some of the herbs occurring in this ecosystem. In grasslands with saline soils, the occurrence of shrub species such as *Atriplex spp., Suaeda spp., Limoniuin spp.,* clumbs of *Tamarix spp*. indicate the presence of ground water (Zerihun Woldu 1999; Demel Teketay 1999).

3.4.9. Wetland Vegetation

Ethiopia possesses a great diversity of wetland ecosystem as a result of formation of diverse landscape subjected to various tectonic movements, a continuous process of erosion, and human activities.

The Ramsar Convention (Article 1.1) defined wetlands as: areas of marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide doesn't exceed six meters.

Typical characteristic species of wetland ecosystems include those of aquatic macrophytes including Cyperus, Eleocharis, Scirpus, Echinochloa, Panicum, Alisma, Nymphaea, Typha, Paspalidium, Potamogeton, Wolffia, Aeschynomene, Phragmites, Urochloa, Veronica, Hydrocotyle, Polygonium, and Kyllinga. Tree species include Ficus sycomorus, Tamarindus indica, Celtis africana, Mimusops kummel, Syzygium guineense, Terminalia brownii, Acacia polyacantha, Kigelia abyssinica, Phoenix reclinata, Trichilia spp., Diospyros spp. (Mengistu Wondafrash 2000).

3.5. Vegetation and some Environmental Variables

Studying plant species distribution in response to environmental Variables helps to generate information for a better understanding of ecological processes and in managing ecosystems. The environmental parameters such as altitude, aspect and slope have an important role in plant species distribution by their effects on the soil moisture and chemical characteristics (Enright *et al*. 2005).

Altitude, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas (Titshall et al. 2000). Among these three factors, altitude is most important (Day and Monk 1974; Busing et al. 1992). Altitude along with aspect and slope in many respects determines the microclimate and thus large-scale spatial distribution and patterns of vegetation (Geiger 1966; Day and Monk 1974).

The plant community of a region is a function of altitude, slope, aspect, rainfall and humidity also play an important role in the formation of plant communities and their composition (Kharkwal *et al.* 2005).

3.5.1 Altitude

Altitude is a major environmental variable that controls the distributions of plant communities in mountainous place. Plant species distribution in relation to altitude varies among ecosystems and plant life forms. According to Tabatabaei and Ghastriani (1992), altitude is one of the limiting and effective factors on plant species growth and dispersion. One of the common effects caused by altitude variation is the occurrence of different vegetative forms and forest types.

3.5.2 Aspect

Aspect can also be effective on the species composition, diversity and richness (Nuzzo 1996). It can mainly due to its effects on moisture contents of the slopes, variation in sunlight and wind below, effective on soil moisture, fertility and depth and thus on plants growth and dispersion. This is especially crucial in the areas associated with low moisture and rainfall levels (Chrstine and Mc Carthy 2005).

3.5.3 Slope

Slope is another environmental parameter which can be effective on the plants dispersal, diversity, richness and growth, mainly because of its effects on soil drainage and depth (Boll et al 2005).

3.5.4 Climate

On the continental scale, climate is the primary determinant for the overall geographic ranges of plant species (Woodward 1987; Woodward and Williams 1987). Geologic studies reveal that the geographic locations and extents of plant species have changed greatly as climate has varied in the past (Huntley and Webb 1988).

4. Status of Natural Forest

Forests and woodlands are estimated to occupy 650 million ha or about 22 % of the total land area of Africa, which corresponds to about 17 % of the global forest cover (FAO, 2001). Firewood is the most important forest product and the main source of energy for most African households, accounting for 91 % of all wood consumption. According to, FAO (2001) report the forests of East Africa region account for 21 % of the forest area of Africa.

However, the annual rate of deforestation in the region has increased from 0.7 % during the period 1981-1990 to 1 % at the event during 1990- 2000 (FAO 2001). Ethiopia is one of the countries in this region with annual deforestation rate of 0.8 % (FAO 2001). The annual loss of the high forests of Ethiopia is estimated between 150,000 and 200,000 ha, a rate at which in 15 years time the remnants of these high forests would be scattered patches in inaccessible areas (EFAP 1994). Even now, sixteen years after the EFAP assessment was carried out, forest destruction and degradation continues unabated despite the fact that the issue of the alarming deforestation rate in Ethiopia continues to be discussed in various floras.

It was believed that, in early 20th century about 42 million hectares or equivalent of 35% of Ethiopia's land area which is 110 million hectares was covered with natural forest. With the inclusion of savannah woodlands, about 66% of the country was covered with forest or/and woodland at that time (EFAP 1994). By the early 1950's, high forest was reduced to 19 million hectares or 16% of the total land area and It was reported that the high natural forest cover was 3.6% by the early 1980's, and about 2.7% by 1989's (WBISPP 2000).

In addition, best estimate made by FAO (2000) and Earth Trends (2003) indicate that in 1997 the total area of natural forest was 5.8 million hectares and later reduced to 4.4 million ha in 2000 with an annual loss of 375,000 ha.

Deforestation poses a serious threat to the conservation of biodiversity in general and forest genetic resources in particular. In Ethiopia, rural people look for land to grow crops and graze animals, for construction and farm implements as a means of survival, the use of wood as a source of household energy which accounting for 78% of the total energy consumption, and demand for wood greatly exceeds that which the forest resources can sustainable supply (Girma 2005). In addition to the above reasons, fire, construction and the investment activities are also the major reasons for the reduction of forests in Ethiopia. Poor people in poor country knowingly or unknowingly damage the forests. The ultimate cause that has to be addressed for the forest destruction in Ethiopia is poverty. The rapidly growing population aggravates the cause, which by itself is triggered by poverty.

It has been projected that if the rate of deforestation continues unabated, the area cover by natural forests in 2015 will be reduced to scattered minor stands of heavily disturbed forests in remote parts of the country (Stiles *et al.* 1991).

5. Natural Forest Conservation

Forest conservation is currently the top agenda for a number of world conservation organizations, authorities and interest groups. Concern over forest conservation generally hinges on anthropogenic activities that lead to depletion forest resources. Conservation biologists have sought to protect forests using several different strategies from strict protection in National Parks, to sustainable forest management and other integrated conservation and development programs (Bruner et al., 2001).

The conservation of biodiversity has become a core concern for forest management in both the developing and developed world. This reflects a range of national and international initiatives established following the UN Convention on Biological Diversity, held in Rio de Janeiro 1992 (Grayson and Maynard 1997). These initiatives have committed governments to the maintenance of biodiversity through the sustainable management of forest ecosystems.

5.1. Natural forest conservation and utilizations

Forests play a crucial role in the lives of communities and nations. Apart from being reservoirs of other forms of biodiversity, forests are important as water catchments, soil erosion barriers, source of timber and non-timber materials. Forests also provide a very important service in the new and growing leisure industry, which involves the non consumptive use of biological diversity for example eco-tourism. Forests also provide very important ecosystem services that are generally considered to be free. Such essential services include nutrient cycling, soil formation, oxygen production, carbon sequestration and climate regulation. Forest biodiversity also has a 'hidden' value locked up in the genetic stock whose potential value is not yet known Mogaka *et al.* (2001).

Historically, conservation strategies have been dominated by attempts to fence off or reserve areas for nature and exclude people from the reserved areas (Adams and Hulme 2001). This model has been called the fortress conservation, coercive conservation or fence and fine and for a long time it dominated international thinking about conservation. Probably because of the perceived urgency of combating deforestation in tropical regions, approaches stemming from the natural sciences have played a predominant role in determining strategies for the conservation and utilization of forests. Until the early 1980s, this was dominated by conservationists, who recommended ecological management of forest environments. In this approach, ecological criteria are used to designate the natural areas to be protected, and these areas are then given full protection, with human communities being relegated to the surrounding areas and their rights of use restricted. Such approaches are now known to have failed (Weber 1996).

The aim of sustainable forest management is to coordinate these diverse activities in order to bring out their complementarities, while at the same time maintaining the quality of the ecosystem. To accomplish this, it is necessary to seek operating principles that can guide policy making (Weber 1996). The emergence and establishment of environmental economics in the 1970s helped to define a new approach to managing natural environments, in which economic criteria were taken into account along with ecological criteria. In fact, the former soon became a major factor in collective decision-making: thus, the model shifts from ecological management of nature to economic management. A brief description of this management mode points to three distinguishing features: nature is represented as a scarce resource for which a social demand exists; the issue for collective action is to develop forest resources and manage them efficiently and the policy instruments used are economic mechanisms, incentives and contracts.

This new economic argument is increasingly influential with regard to decision making on tropical forest management. This approach was quickly taken up by environmentalists and by the main international donors, who see it as providing objective justification for their resource conservation projects in tropical countries (Weber 1996).

5.2. Community based forest management

Protected areas were established at the expense of local people and often deprived them of their traditional economic livelihoods. As a result, local people considered protected or reserved areas as constraints to their livelihoods. Since it was not possible to create rigid separation between land used by local people to obtain natural resource products and those designated by governments as protected areas, encroachment, poaching, and degradation were inevitable (Primack 2002).

Unfortunately, after political independence most governments in Africa embraced and continued colonial biodiversity protection policies. Due to poor outcomes associated with government-centered policies, many conservation policies in Africa failed because traditional local authorities that once controlled these resources have been disenfranchised (Agrawal and Clark 2001). Local people's cultural and socio-economic values regarding the natural resources around them were ignored in most state-centered management activities. According to (Agrawal and Clark 2001), if local communities were effectively involved in conservation, the benefits they would receive would create incentive for them to become good stewards of natural resources. On the other hand, if communities are not involved in active management of natural resources it is likely that they will harvest resources at an unsustainable rate, In this regard, effective decentralization and devolution of power and control over resources from the centralized state to local communities has become a pressing policy issue throughout the world today(Brown 1999).

5.3. Natural Forest protection

Forest protection can be defined as predominantly natural areas safeguarded by law or custom where species and ecosystems are conserved for current and future generations. Since the best way to maintain species is to maintain their habitats, protected areas are an essential means for sustaining diversity. Protected areas also help in stabilizing the local climate, protecting watersheds, and preventing erosion. Protected areas constitute the most widespread mechanism used to conserve the remaining natural forests of Ethiopia. However, the present coverage of natural forest is generally inadequate. Conservation must be a part of a broader process of managing the whole landscape. Thus, protected areas will contribute to the conservation of the remaining natural forests in Ethiopia, if they are able to meet the legitimate developmental aspirations of the people that live in and around them (Sayer *et al.* 1992). Protection and conservation of the remaining natural forests is critical to protect species and biodiversity in Ethiopia. The identification, demarcation, and gazetting of the remaining natural forests and wildlife and leaving them as a heritage to the next generation will be beneficial to present as well as the future generations.

6. Conclusion

Ethiopia is one of the centers of plant genetic diversity. The flora is very heterogeneous and has a rich endemic element owing to the diversity in climate, vegetation and terrain.

However, continued destruction or exploitation of vegetation without giving due consideration to their propagation domestication and cultivation has resulted in vicious cycle where increased vegetation destruction has led to increased scarcity or rarity of resources which in turn have resulted in increased demand and subsequent of further destruction.

Therefore, to improve the natural vegetation diversity and structure of the forest, to minimize the influence of the surrounding communities and utilize the forest resources sustainably for present and future generation, the basic needs and traditional rights of the communities over the uses of forest resources should be recognized. Besides, for better conservation of plant biodiversity, several different strategies from strict protection in National Parks, to sustainable forest management and other integrated conservation and development programs should be realized.

References

1. Adams, W. and Hulme, D. (2001). Conservation and Community **In**: Hulme D. and Murphree M. (Eds) African Wildlife and Livelihoods. James Currey Limited Oxford.
2. Anonymous (1992). Ethiopia National Report on Environment and Development. A report prepared for the UN Conference on Environment and Development, Rio de Janeiro, Brazil. Addis Ababa, Ethiopia.
3. Anonymous (2001). PRA Report on Abobo-Gog Natural Forest. Unpublished Report of Forest Genetic Resources Conservation Project, Institute of Biodiversity Conservation and Research, Addis Ababa, Ethiopia.
4. Anonymous (2004). Forest Resources of Ethiopia. Woody Biomass Inventory and Strategic Planning Project. Addis Ababa.
5. Agrawal, A., and Clark, CG. 2001. *Communities and Environment*. New Brunswick, NJ: Rutgers University Press.
6. Boll, T., Svenning, J., Vormisto, J., Normand, S., Grandez, C. and Balslev (2005). Spatial distribution and environmental preferences of the Piassaba palm *Aphandra natalia* (Arecaceae) along the Pastaza and Urituyacu rivers in Peru. *For. Ecol.Manage,* **213**: 175-183.
7. BSP (1993). Biodiversity Support Program African Biodiversity: Foundation for the Future Framework for Integrating Biodiversity Conservation and Sustainable Development.
8. Bray J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27:325-349.
9. Braun, E.L. 1950. Deciduous forests of eastern North America. Blakiston Co., Philadelphia, PA.
10. Brown, D. 1999. *Principles and practice of forest co-management: Evidence from westcentral Africa*. London: Overseas Development Institute/ Brussels: European Commission.
11. Bruner, A.G., Gullison, R.E., Rice, R.E., da Fonseca, G.A.B. (2001). Effectiveness of parks in protecting tropical biodiversity. *Science,* **291**:125–128.
12. Busing, R. T., White, P. S., and MacKende, M. D., 1992, Gradient analysis of old spruce-fir forest of the Great Smokey Mountains circa 1935. *Canadian Journal of Botany*, **71**: 951-958.
13. Chaffey, D. (1979). South-west Ethiopia forest inventory project: a reconnaissance inventory of forest in south-west Ethiopia. Land Resources Development Centre, England.
14. Christine, J. and McCarthy, B. (2005). Relationship of understory diversity to soil nitrogen, topography variation and stand age in an eastern Oak forest USA. *For.Ecol.Manage.* **217:229**-243.
15. CBD (2009). Ethiopia's 4th Country Report. Institute of Biodiversity Conservation, Addis Ababa, Ethiopia.
16. Day, F. and Monk, C. (1974). Vegetation patterns on a Southern Appalachian watershed. *Ecology*, **55**:1064-1074.
17. Demel Teketay (1999). Past and present activities, achievements and constraints in forest genetic resources conservation in Ethiopia. **In**: S. Edwards, Abebe Demissie, Taye Bekele and G. Haase (eds.), Forest Genetic Resource Conservation*:* Principles, Strategies and Actions: Proceedings of the National Forest Genetic Resources Conservation Strategy Development Workshop, *21-22 June 1999*. Institute of Biodiversity

Conservation and Research (IBCR) and the German Technical Co-operation (GTZ); Addis Ababa, Ethiopia.
18. Earth Trends (2003). Forests, grasslands, and dry lands of Ethiopia. Retrived on 04/03/ 2011 from http://www.earthtrends.wri.org.
19. EPA (1998). National action Programme to combat desertification .Addis Ababa, Ethiopia.
20. Enright, N., Miller, B. and Akhter, R. (2005). Desert vegetation and vegetation environment relationships in Kirthar National Park, Sindh, Pakistan. *J.Arid Environ*., **61**:397-418.
21. Ethiopian Forestry Action Program (1994). The challenge for development, Volume II. Ministry of Natural Resources Development and Environment Protection. Addis Ababa, Ethiopia.
22. Ethiopia Ministry of agriculture, natural resources management and regulatory department.1998. In: proceeding of sub- regional workshop on forestry statistics IGAD region, Nakuru, Kenya, 12-16.
23. FAO (2000. Global Forest Resources Assessment. *FAO Forestry Paper 140*, Rome, Italy.
24. Ferris, R. & Humphrey, J.W. 1999, 'A review of potential biodiversity indicators for application in British forests', *Forestry*, vol. 72, no. 4, pp. 313-328.
25. Franklin, J.F., Cromack, K.J., Denison, W., McKee, A., Maser, C., Sedell, J., Swanson, F. and Juday, G. 1981, *Ecological characteristics of old-growth Douglas-fir forests*, General Technical Report, USDA Forest Service, Portland, 118pp.
26. Franklin, J.F. 1988, 'Structural and functional diversity in temperate forests', **in**: *Biodiversity*, eds. E. O. Wilson & F. M. Peters, National Academy Press,Washington D.C., pp. 166-175.
27. Franklin, J.F., Spies, T.A., Van Pelt, R., Carey, A.B., Chen, J. (2002). Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas- Fir forests as an example', *Forest Ecology and Management*, **155**: 399-423.
28. Friis, I. (1992). Forests and Forest Trees of Northeast Tropical Africa: Their Natural Habitats and Distribution Patterns in Ethiopia, Djibouti and Somalia. *Kew Bull. Add. Ser.* **15:** 1-396.
29. Friis, I. and 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. Kongelige Danske Videnskabelige Selskabs Biologiske Skrifter 54: 399-439.
30. Gauch, H. and Stone, E. (1979). Vegetation and soil pattern in a mesophytic forest at Ithaca, New York. *Amer. Midi. Nat.* **102**:332-345.
31. Geiger, R. (1966). The climate near the ground. Harvard University Press, Cambridge, Mass.
32. Geis, J.W. and W.R. Boggess. 1970. Soil-vegetation relationships in a prairie grove remnant. Bull. Torrey Bot. Club 97:196-203.
33. Girma, A. 2005. Rehabilitation and sustainable use of degraded community forests in the Bale Mountains of Ethiopia. Inaugural Dissertation Faculty of Forest and Environmental Sciences, Albert-Ludwigs-University, Freiburgim Breisgau, Germany
34. Hedberg, O. (1957). Afroalpine vascular plants. A taxonomic revision. Systematic botany, Upsala. 15:1. 1-411.
35. Hedberg, O. (1964). Features of afroalpine plant ecology. Acta Phytogeographica Suec. (Upsala). 49: 1-144.
36. Heywood, V. (1995). The Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridg.
37. Hunter, M.L. 1999, 'Biological diversity', **In**: Maintaining Biodiversity in Forest Ecosystems, ed. M. L. Hunter, Cambridge University Press, Cambridge, pp.3-21.
38. Huntley, B., and Webb, T., III, eds., 1988, Vegetation history, handbook of vegetation science, volume 7: Dordrecht, Kluwer Academic Publishers, 803 p.
39. Hurni, H. and Ludi, E. (1998). Reconciling conservation with sustainable development. A participatory study inside and around the Simien Mountains National Park, Ethiopia. Produced with the assistance of an interdisciplinary group of contributors. CDE, Bern.
40. Kavanagh, R.P. 1987, Forest phenology and its effect on the foraging behaviour and selection of habitat by the yellow bellied glider, Petaurus Australia Shaw. *Aust. Wildl. Res*., **14:** 371-384.
41. Kharkwal, G., Mehrotra, P., Rawat, Y.S. and Pangtey, Y.P.S. (2005). Phyto-diversity and growth form in relation to altitudinal gradient in the Central Himalayan (Kumaun) region of India, Current Science, **89**(5): 873-878.
42. Kumlachew Yeshitila (1997). An ecological study of the Afromontane vegetation of Southwestern Ethiopia. M.Sc. Thesis. Addis Ababa University.
43. Lisanework Nigatu and Mesfin Tadesse (1989). An ecological study of the vegetation of the Harenna Forest, Bale. *SINET: Ethiop. J. Sci.* **12**:63-93.
44. Menassie Gashaw (2000). Survival strategies and ecological performances of plants in regularly burning savanna woodlands and grasslands of western Ethiopia, Gambella. Ph.D thesis, Addis Ababa University, Ethiopia.
45. Mengistu Wondafrash (2000). Wetlands, Birds and Important Bird Areas in Ethiopia. Proceedings for

Awareness Raising on Wetlands of Ethiopia, Addis Ababa, pp.13–15.
46. Mesfin Tadesse (1986). Botanical review in Bale mountains national park, Harenna forest expedition, preliminary report. Addis Ababa, pp. 9-11.
47. Mogaka H., Simons G., Turpie J., Emerton L. and Karanja F., (2001). Economic Aspects of Community Involvement in Sustainable Forest Management in Eastern and Southern Afica. IUCN Policy Brief.
48. Mowbray, T.B. and H.J. Costing (1968). Vegetation gradients in relation to environment and phenology in a southern Blue Ridge gorge. Ecol. Monogr. 38:309-344.
49. Mueller-Dombois, D. and H. Ellenberg (1974). Aims and methods of vegetation ecology. John Wiley and Sons, N.Y.
50. Mutke, J. & W. Barthlott. 2005. Patterns of vascular plant diversity at continental to global scales. Biologiske Skrifter **55**: 521-537.
51. Noss, R.F. (1990), Indicators for monitoring biodiversity: a hierarchical approach, Conservation Biology, vol. 4, no. 4, pp. 355-364.
52. Noss, R. F. and Cooperider, A. Y (1994): Saving Nature's legacy: Protecting and restoring biodiversity. Washington, D. C.
53. Nuzzo, V. (1996). Structure of cliff vegetation on exposed cliffs and the effect of rock climbing. Can. J. Bot., **74**: 607-617.
54. Pichi-Sermolli, R. C. E. (1957). Una Carta Geobotanica, dell'Africa Orientale Ethiopia and Somalia- Webbia 13: 15-132.
55. Primack, RB. 2002. Essentials of conservation biology, 3rd ed. Cambridge MA: Associates Inco.
56. Sayer, A.J., Harcourt, S.C. and Collins, M.N., (eds) 1992. The conservation Atlas of tropical forests Africa. IUCN. Cambridge, UK, 282pp.
57. Stiles, D., Pohjonen, V.M. and Weber, F. (1991). Reforestation: The Ethiopian exprience, 1984-1989. Technical Support Division of *UNSO (United Nations Sudano-Sahelian Office)*, New York.
58. Tabatabaei, M. and Ghasriani, F. (1992). Natural Resources of Kurdistan. First Edn, Jehad-e- Daneshgahi Cultural Press, Tehran, 570pp.
59. Tadesse Woldemariam (1998). Diversity of woody plants and avifauna in a dry afromontane forest: on the central plateau of Ethiopia. Swedish university of agricultural sciences.
60. Tamrat Bekele (1994). Studies on remnant Afromontane forests on the Central Plateau of Shewa, Ethiopia. Ph.D. thesis. Acta Unifersitatis Upsaliensis, UPPSALA.
61. Tappeiner, U. and Cernusca, A. (1996). Microclimate and fluxes of water vapor, sensible heat and carbon dioxide in structurally differing sub-alpine plant communities in the central Caucasus, Plant Cell Environment, 19:403-417.
62. Tesfaye Awas, Sebsebe Demissew and Tamrat Bekele (1997). New plant records for Ethiopia. *SINET: Ethiop. J. Sci.* **20**(1): 133–138.
63. Tesfaye Awas, Tamrat Bekele and Sebsebe Demissew (2001). An ecological study of thevegetation of Gambella Region, southwestern Ethiopia. *SINET: Ethiop. J. Sci.* 24(2): 213–228.
64. Tesfaye Awas, Menassie Gashaw, Getachew Tesfaye and Asfaw Tilahun (2003).Ecosystems of Ethiopia. National Biodiversity Strategy and Action plan (NBSAO) Project, IBCR, Addis Ababa, Ethiopia.
65. Tewolde Brhane Gebere Egziabher, 1991. Diversity of Ethiopian flora. In: Engles, J.M.M Hawkes, J.G and Melaku Worede (eds), plant genetic resources of Ethiopia, Cambridge University press. Cambridge, pp. 75-81.
66. Titshall, L.W., O'Connor, T.G., and Morris, C.D., 2000, Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. *African Journal of Range and Forage Science*, **17**: 70–80.
67. Wikum, D.A. and Wali, M.K. 1974. Analysis of a North Dakota gallery forest: vegetation in relation to topographic and soil gradients. Ecol. Monogr, **44**:441-464.
68. Willig, M. R., D. M. Kaufmann, and R. D. Stevens. 2003. Latitudinal gradients of biodiversity: pattern, process, scale and synthesis. Annu. Rev. Ecol. Syst. **34**:273-309.
69. Woodward, F.I., 1987, Climate and plant distribution: Cambridge, Cambridge University Press, 174 p.
70. Woodward, F.I., and Williams, B.G., 1987, Climate and plant distribution at global and local scales: Vegetation, v. 69, pp. 189-197.
71. Woody Biomass Inventory and Sstrategic Planing Project (1995). Phase II, Project Document. Government of the Federal Democratic Republic of Ethiopia, Addis Ababa.
72. Yalden, D. W. (1983). The extent of high ground in Ethiopia compared to the rest of Africa. , *SINET: Ethiop. J. Sci.* **6:** 35-39.
73. Zenebe Gebere Egziabher, Werede Sisay and Tirungo W/Michael (1988). Socio –economic survey of Hugum Burda-gratkhassu state forest. Tigray National Regional state, Bureau of Agriculture and natural resource, Ethiopia.
74. Zerihun Woldu (1988). Variation in grassland vegetation on the central plateau of Shewa, Ethiopia. Ph.D.

Thesis, Uppsala, Sweden.
75. Zerihum Woldu, Feoli, E., & Lisanework Nigatu (1989). Partitioning on elevation gradient of vegetation from southeastern Ethiopia by probablistic methods. *Vegetatio*. **91**:189-198.
76. Zerihun Woldu (1999). Forests in the vegetation types of Ethiopia and their status in the geographical context. **In**: S. Edwards, Abebe Demissie, Taye Bekele and G. Haase (eds.), Forest Genetic Resource Conservation: Principles, Strategies and Actions. Proceedings of the National Forest Genetic Resources Conservation Strategy Development.