

Lowland semi-evergreen forest of Ethiopia

Abstract

This paper gives an overview of the status of the forest structure, floristic composition, distribution, wild animals, ecological and economic values and threats of lowland semi-evergreen forest in Ethiopia, and of the conservation efforts. This vegetation type is restricted to the southwestern corner of the country and covers only a small portion of Gambella Regional State. It is the only lowland wet forest in Ethiopia. It is known for the unique collection of plants (it has more than 106 woody plant species including lianas) and various types of wild animals. However, due to resettlement expansion, fire, shifting cultivation, and commercial plantations it is under deforestation. Hence, considerable efforts should be made to disseminate appropriate and effective laws that would safeguard the protection and sustainable utilization of the remaining forest resources. Importantly, recognition of the forest values by the government and other stakeholders has a paramount importance. This should be by providing appropriate economic incentives, environmental marketing schemes such as water and carbon trading, sustainable uses of non-timber forest products such as honey, traditional medicine and promotion of ecotourism should be developed. As this forest has unique floral and faunal diversity there is a huge ecotourism potential for development. In particular, there are waterfalls, plant and animals resources and historical and cultural sites that can serve as tourist attractions.

Keywords: Conservation, forest structure, floristic composition, wild animals, ecological and economic values, threats

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Introduction

Ethiopia is an important regional center for biological diversity due to its wide ranges of altitude, its great geographical diversity with high and rugged mountains, flat-topped plateaus and deep gorges, incised river valleys and rolling plains.^{1,2} These helped the emergence of wide ranges of habitats that are suitable for the evolution and survival of various plant and animal species.

Vast area of Ethiopia is believed to have been covered by extensive forests in the past. A substantial proportion of the Ethiopian highlands were once believed to have been covered by forests having wide coverage than at present, but have gradually been cleared.³ Bekele⁴ remarked that the occurrence of isolated mature trees in farmlands and the patches of forests that are seen around church-yards and religious burial grounds indicate the presence of vast expanse of forests earlier. At the moment, most of the remaining forests of the country are confined to south and south-western parts of the country. However, nowadays the remnant forests in these areas are threatened by human activities.⁵ This is due to high population growth, poverty, low agricultural productivity and lack of alternative means of livelihood for most of the rural population, the forest resources of the country have been destroyed.⁶ The current rate of deforestation is estimated to be as high as 5% per year in the country.⁷

Among the vegetation types in Ethiopia, lowland semi-evergreen forest (LSEF) represents a rare and fragile forest ecosystem.^{3,8,9} Therefore, the main objective of this paper was to give an overview of the status of plants and wild animals' diversity, physical environments, opportunities, threats and conservation efforts of LSEF in Ethiopia.

Other names and distribution of Lowland semi-evergreen forest of Ethiopia

In Ethiopia, different authors have named this forest vegetation differently: lowland forest¹⁰ lowland evergreen forest,¹¹ dry peripheral semi-deciduous Guineo-Congolian forest³ *Baphia abyssinica*-*Tapura fischeri* community,¹² and lowland semi-evergreen forest.⁹

The lowland semi-evergreen forest was first described by Chaffey¹⁰ and he associated the Ethiopian lowland semi-evergreen forest with that of the moist semi-deciduous forest of Ghana and Uganda and the lowland seasonal rainforest of Malawi; and classified it as the Pan-Guineo-Congolian type. Further description was made by Friis³ and he named it as Dry Peripheral Semi-Deciduous Guineo-Congolian Forest type.

As described by many, the LSEF of Ethiopia is restricted to the southwestern corner of the country and covers only a small portion of Gambella Regional State. It include a narrow strip of humid forests, is restricted to the lowlands of the eastern Gambella Region in Abobo and Gog Weredas covering an area of about 200,000 ha.¹³ The forest is locally known as Abobo-Gog Forest.¹¹

Description

The topography of the LSEF of Ethiopia is located within altitudinal range between 450 and 600 m above sea level.¹³ Mostly, this forest is located on a nearly flat plain but the eastern part of the forest is located on a broken escarpment penetrated by the valley of the Baro, Gilo and other small rivers. It falls within the watersheds of the Baro and Gilo rivers-the tributaries of the Nile.

Geologically, the eastern part of the forest is located on the Precambrian basement (5000 Mya), the oldest rocks. In other places, the forest is on Pleistocene–Holocene deposits (recent deposit) (0.8–0.01 Mya). Studies by Mohr^{14,15} and Kasmin¹⁶ show the forest area as undifferentiated lying between the two rock deposits.

The soils in Abobo–Gog forest are reddish or brown Ferrisols derived from volcanic material.³ According to Awas et al.,¹² the soil texture is clay; the average pH is 6.73 in the topsoil and 6.73 in the subsoil. The organic carbon content is 2.39% in the topsoil and 0.53% in the sub soil. The total nitrogen is 0.51% in the topsoil and 0.14% in the subsoil. Available phosphorus is 4.17 ppm in the topsoil and 3.51 ppm in the subsoil. The exchangeable potassium is 16.93 ppm in the topsoil and 8.57 ppm in the subsoil. The exchangeable sodium is 1.07 ppm both in the topsoil and subsoil. The cation exchange capacity (CEC) is 51.55 meq/100 g soil in the topsoil and 18.02 meq/100 g soil in the subsoil.

According to Tadesse¹¹ this LSEF area is characterized by unimodal rainfall. The wet season is May to October and the rainfall is heavy during this time. November to April is the dry season and is characterized by very little rainfall. The annual rainfall in the forest area is 1300–1800 mm. The mean annual maximum temperature is 35–38 °C and mean annual minimum temperature is 18–20 °C.

Forest structure

Currently, it is not possible to describe properly the structure of LSEF because of lack of published information. However, some authors have articulated few notes for the sake of readers with incompleteness of the information given below about structure of the forest.⁹

Forest structure can be characterized using size class distribution, density, basal area and stratification.^{9,17} Most plant communities consist of a large number of species and hence it is not possible to include all species in a survey. Woody plants are only therefore used for the structural analysis description in most cases. Here, woody plant density, vertical stratification, and size class distribution are used only to describe the structural of the LSEF.¹⁸

The density of tree/shrub in Abobo–Gog forest is 1579 stems/ha. *Baphia abyssinica*, *Argomuellera macrophylla* and *Acalypha ornata* had the highest stem density. *Acacia seyal*, *Albizia malacophylla*, *Borassus aethiopicum*, *Clerodendrum capitatum*, *Ficus vasta*, *Lepisanthes senegalensis*, *Morus mesozygia*, *Polysphaeria parvifolia* and *Ziziphus abyssinica* had the lowest stem density.⁹ The density of individuals with diameter at breast height (DBH) greater than 10 cm was around 393 ind/ha.¹⁸

The maximum DBH ranged between 2.6 and 220 cm and the mean DBH between 2.6 and 133.2 cm. The maximum height ranged between 3 and 36 m and the mean height between 2 and 33 m.⁹ The height and diameter class distribution in Abobo–Gog LSEF also showed normal patterns of distribution.¹⁸ The height–class distribution shows more or less the same pattern with diameter–class distribution. Stem density decreases as height class increases. Density decreases uniformly as diameter class increases. In both cases, density decreased uniformly as diameter and height class increased.¹⁸

Basal area is computed for all tree and shrub species with DBH/DSH > 2.5 cm. The total basal area for Abobo–Gog forest is 29.3 m²/ha and the mean basal area is 6.02 m²/ha. The highest mean basal area

is recorded for *Ficus dicranostyla* (1.52 m²/ha) and the lowest (0.002 m²/ha) for *Abutilon* sp.^{9,18} The vertical structure of Abobo–Gog forest is distinguished according to IUFRO classification scheme.¹⁸ The following information is taken from¹⁹ and accordingly, the highest stem density is found in the lower storey and the lowest in the upper storey. Similarly, more species are found in the lower storey and less species are found in the upper storey. About 29% of the species are found in all the storeys. These are described as “species with regular vertical distribution”. About 23% of the species are found both in the lower and middle storeys and about 24% of the species are found only in the lower storey. Due to their structure, these species, which are mostly shrubs, can only reach the lower storey. Four species are represented only in the middle storey and one species in the middle and upper storeys. Their absence in the lower storey may be due to poor regeneration potential in the forest ground. Four species are found only the lower and upper storeys. Their absence in the middle storey may be due to selective removal. Three species are only found in the upper storey. The long term existence of these species is uncertain as there are no individuals to replace the old and dying species of the upper storey.

Species “importance value” which incorporates the relative measures of basal area, frequency and density provides an assessment of the extent of structural dominance.¹⁷ The relative density, relative frequency, relative dominance and Importance Value Index (*IVI*) of the species in Abobo–Gog forest are varies from as high as 54.9 to as low as 0.14. *Baphia abyssinica*, *Malacantha alnifolia*, *Argomuellera macrophylla*, *Acalypha ornata*, *Tapura fischeri* and *Celtis africana*, respectively had the highest *IVI*.^{9,18} More than 50% of the total importance value is contributed by these six species.¹⁸

Floristic Composition of the of lowland semi-evergreen forests in Ethiopia

A floristic composition of lowland evergreen forest was made by some.^{3,10,12,18,19} Even some of these studies are a kind of exploration and it is very difficult at this point to correctly estimate the floristic composition of the forest.⁹

The LSEF is characterized by the presence of certain tree species, which are widely distributed in tropical Africa. In Ethiopia, the majority is confined to the lowland area.^{3,10} A study by Forest Genetic Resources Project¹⁸ reported that Abobo–Gog LSEF has more than 106 woody plant species including lianas. FGRP¹⁹ also identified a total of 83 woody species belonging to 33 families from Abobo–Gog forest. Fabaceae is the dominant family having 13.3% of the total species. The family Moraceae makes up for 9.6% of the total species; the families Euphorbiaceae, Rubiaceae and Combretaceae each makes up for 7.2% of the total species. A conservative estimate of the higher plants of LSEF could be around 500 species, but there is a need to make a complete floristic list of this forest for many future conservation interventions.⁹

Species composition usually changes with changes in altitude.⁹ In LSEF or Abobo–Gog forest higher species number was recorded in the middle altitudes and there is a tendency to decrease in species number as the altitude rise and decreases.¹⁹

Wild animals in lowland evergreen forest of Ethiopia

Several animal species are known to inhabit the LSEF ecosystem although intensive scientific investigations are lacking. Larger mammals living in this ecosystem include, among others, buffalo,

bush pig, bushbuck, civet, common jackal, defassa waterbuck, duiker, elephant, giant forest pig, hippopotamus, Lelwel hartebeest, leopard, lion, Nile lechwe, olive baboon, roan antelope, crocodile, tortoise, wart hog, giraffe, White-eared kob and wild dog.^{6,20} Although a complete inventory is lacking, the LSEF fragments are believed to support high bird species including ostriches, pelicans, herons, egrets, storks, ibis and geese.⁹

The importance of lowland semi-evergreen forest of Ethiopia

The LSEF of Ethiopia has significant role for biodiversity conservation.^{3,10,13} Most of the LSEF plant species are often restricted in their range of distribution.^{6,20} Hence, LSEF of Ethiopia can serve as a gene reserve for many of these useful forest species and it is being recognized as part of Ethiopian biodiversity hotspots.²⁰ It provides many ecological and socio-economic values and functions:^{6,9,20} (1) support energy flow and nutrient cycling; (2) reduce soil erosion, absorb and release water; (3) purify water and air; (4) regulate local and regional climate; (5) store atmospheric carbon; and (6) provide habitats for wildlife.

Economic services

Many people living in and around the LSEF are receiving various means of livelihood directly or indirectly from the forest.^{9,18} The major contributions of LSEF to rural livelihood are the following products and services:⁹ (1) fuel wood, (2) lumber, (3) food (wild food), (4) medicine, (5) livestock grazing, (6) recreation, and (7) honey production.

For local community living in and around LSEF, honey production plays a significant role in their livelihoods. Honey collection is a traditional activity and collected, both from fixed beehives and hollow trees.⁹ The Mejenjer ethnic group in Abobo-Gog Woreda is the most skilled traditional beekeeper. People in the sample area produce honey for consumption and income generation. The occupation is a male domain and farmers fix beehives on trees selected for hanging up beehives.²¹ It is also reported that farmers fix beehives on tree that is not occupied by somebody, for hanging of beehives. Trees that are preferred for hanging of beehives include *Antiaris toxicaria*, *Celtis toka*, *Combretum adenogonium*, *Ficus dicranostyla*, *Tamarindus indica*, *Trichilia emetic*, and *Ziziphus pubescens*, among others. The most well-known honeybee flora in the LSEF include *Alstonia africana*, *Lepidotrichilia volkensii*, *Terminalia laxiflora*, *Anogeissus leiocarpa*, *Celtis toka*, *Combretum collinum* and many others.⁹ Mostly, the bark of *Mimusops kummel*, *Cordia africana* and *Antiaris toxicaria* are preferred for making beehives.¹⁸

Wild edible plants

According to FGRP²² the local community living in the Abobo-Gog forest area identified over 27 tree and shrub species as wild edible plants. Some of these include: *Ficus* spp., *Ziziphus* spp., *Capsicum frutescens*, *Carissa spinarum*, *Cordia africana*, *Dioscorea praehensilis*, *Erythroxylum fischeri*, *Manilkara butugi*, *Mimusops kummel*, *Tamarindus indica*, *Vangueria apiculata*, *Oncoba spinosa*, and *Syzygium guineense*, among others. Furthermore, the fruit of *Maytenus senegalensis* is used to produce edible oil. Some of the farmers also produce salt from burning some species. They usually burn the stem and branch of *Anogeissus leiocarpa*, *Cordia africana* and *Turraea nilotica* to produce ashes that can produce edible salt. After burning the wood, the ash is collected and dissolved in water to obtain salt filtrate followed by evaporation.

Medicine and other uses

The community living in the LSEF area also recognized over tree and shrub species as source of medicine,^{23,24} such as *Argemone macrophylla*, *Cassipourea malosana*, *Celtis africana*, *Landolphian buchananii* and *Trichilia prieuriana*.²⁴ The bark, branches, leaves or roots of these species are used as medication independently or mixed with other species. Out of these species, the bark of *Xylopia parviflora* and *Mimusops kummel* and the branches of *Baphia abyssinica* are used to cure tooth infections.²³

Additionally, the fruits of *Trichilia emetica* and the roots of *Gardenia ternifolia* are used for protecting humans from the attack of snakes and to cure liver infection, respectively;¹² whereas, barks of several plants are used to treat many diseases. Those of *Croton macrostachyus* and *Alstonia boonei* are used to treat diarrhea and gonorrhoea, respectively.¹² Those of *Terminalia laxiflora* and *Grewia bicolor* are recognized to treat wound infections, and those of *Mimusops kummel* and *Piliostigma thonningii* are recognized as colouring plants, while the bark of *Grewia bicolor* is used for soap production.⁹

As hydrological and ecological function

As this LSEF is located on the escarpment and plains, they have an important role in watershed management and as water catchment and erosion barriers, including a role in the capture and transport of water and protection of soils against erosion.⁹ The LSEF has an important role in stabilizing water quality and maintaining the natural flow pattern of the streams and rivers originating from them.²⁵ Additionally, the LSEF of Ethiopia is currently supporting different irrigation schemes indirectly. The water from the river systems (Baro, Gilo, etc) originating or passing through the LSEF is used in several lowland areas of western Ethiopia and the Sudan. For instance, a report by ENTRO²⁶ indicated that converting one hectare of forest to agriculture increases the sediment load in the Baro River (southwest Ethiopia) crossing into the Sudan by 25 Mg/year. The increased sediment load leads to annual cleaning costs of irrigation canals in the Sudan's irrigation schemes.

Threats

Lowland semi-evergreen forest of Ethiopia is being recognized as part of Ethiopian biodiversity hotspots. However, the Ethiopian LSEF is among the most threatened habitats in the country due to rapid expansion of farmland following resettlers, investors and state farms, excessive cutting of trees for firewood and construction and forest fire.^{9,21} This means that virtually all these unique habitats and associated biodiversity are facing significant threats due to both natural and anthropogenic factors.

A study by WBISPP¹³ indicated that over 30% of the lowland or other vegetation types have been lost over the last two to three decades in Gambella region alone. Although the country has forest policy and strategies, implementation is mostly weak due to lack of strong political will for forest conservation. In most cases, policies give emphasis to the production of crops at the expense of forestland. In this regard, there is a big interest by the government to expand agricultural investment (rubber plantation, palm oil plantation and biodiesel) into southwest forestlands of Ethiopia including the LSEF in recent years.²¹ If most of these investment projects are going to be implemented as they were planned, they are going to eat and destroy hundreds and thousands of forestlands in the area.²⁷ The problem of forest destruction of the land semi-evergreen forest needs to be

addressed as urgently as possible if this natural vegetation is to be saved from loss.

Conservation status

For many years, Ethiopian forest was owned and controlled by the state. Nevertheless, the state control had weakened from 1991 to 1996 during transitional government and this forest was highly destructed.²⁸ This resulted in increasing conversion of forest land into agriculture land and reckless cutting of trees for timber, construction wood and fuel wood. Thus, to maintain the continuity of the remaining forest, the government designated 58 National Forestry Priority Areas covering approximately 4 million ha, or 3.3% of the total area of Ethiopia.²⁹ The aims of designating these forests were for their production, protection and conservation of the biological services.²⁹ Among these designated forest areas, the lowland forests of Abobo, Godere and Gog were the major ones.

The existing knowledge on the extent of the LSEF, its distribution, diversity of its constituent species as well as ecological requirements is very limited. As reported by Reusing³⁰ in some of the designated forest areas, significant proportions of the forests were lost because of deforestation and degradation—where threats on LSEF were mentioned as serious problems.

The National policy on the forest resources of Ethiopia clearly indicated that the LSEF be kept primarily for protection and conservation purposes. Commercial utilization, according to the policy, is a secondary objective. However, the present management of the LSEF fails to achieve its major primary objective. Actually, the forest has been declining both in quality and quantity at a faster rate in the last decade than ever before, and the existing forest policies do not seem to have worked at all.⁹ Therefore, considerable efforts should be made to promulgate appropriate and effective laws that would safeguard the protection and sustainable utilization of the remaining LSEF resources.

Abobo–Gog forest is the only lowland semi-evergreen forest in Ethiopia. It is known for the unique collection of plants and various types of wild animals. A transformation of the potential values into real benefits for the local population living in and around the forest is crucial. It is only when values of the forest are recognized that the people are willing to conserve the resources. Importantly, recognition of the forest values by the government and other stakeholders has a paramount importance. Therefore, considerable efforts should be made to disseminate appropriate and effective laws that would safeguard the protection and sustainable utilization of the remaining forest resources. Otherwise, the few remaining natural forest patches of the country will be lost sooner or later.

In light of these facts, the following points are recommended to improve and prolong the conservation and use of LSEFs of Ethiopia:

1. Since conservation is impossible without appropriate economic incentives, transformation of the potential value of the forest resources into real benefits for the rural population is mandatory. For this to be realised, environmental marketing schemes e.g., water and carbon trading should be enhanced.
2. Sustainable uses of non-timber forest products such as honey, traditional medicine and others should be promoted.

Promotion of ecotourism should be developed. As this forest has

unique floral and faunal diversity there is a huge ecotourism potential for development. In particular, there are waterfalls, plant and animal resources, as well as historical and cultural sites that can serve as tourist attractions.

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Conflict of interest

None.

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