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Review on Plant Biodiversity and Ecosystem Services of Sacred and Church Forests in Ethiopia

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Abstract
Ethiopia is the richest country in biodiversity particularly by plant species. However, most forest resource aggressively damaged by anthropogenic pressure; it is very sever in highland parts of the country. As a result, numerous forest biodiversity and ecosystem service loss. Wonderful, there is patchy left forest around Ethiopian Orthodox Tewahido Church and sacred forest. Religious institution (EOTC) and traditional norms are the main central point for why these forests conserved. Mostly, the place and all available resources particularly plant biodiversity are highly respected by the community because they account as God's commandment and a convent for EOTC and memorabilia for culturati. Sacredness is playing an uncountable role in conserving biodiversity resource particular plant biodiversity and ecosystem service. Both forests might assists as in situ conservation for native plant species. Church with stonewall has high species number than without similar sacred forest has high species number than non-sacred forest. Their ecosystem services are multiple such as environment, social-culture, economic, and combat climate change besides spiritual and religiousness. Likely plays a central role in alleviating poverty by providing fruit and seeds for food and income. However, due to population growth, overgrazing, farmland expansion, settlement, climate change, land use change and modernization some scared and church forests have been worsening. Therefore, to ensure the ecosystem service of forest (Church and sacred) and to control from further damaged it should be safeguarded by the affiliate as well as by other stakeholders particularly the government put a target for such forest conservation.
Keywords: Biodiversity, church, ecosystem service, sacred, plant
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INTRODUCTION

Ethiopia is the blessed and the richest country in biodiversity resource (Biodiversity Indicators Development National Task Force, 2010) but also the center for the origin of biodiversity in the world (Asfaw and Tadesse, 2001). Predictable there are around 6500-7000 plant species available including 12 % endemic species (Negash, 2010; Tadesse, 2012) while the total number of woody plant species is around 1017, from these 29 endemics, which represented for 104 families and 387 general.

Global around eight million ha per year forest damaged within ten years (1990-2000) and 7.6 million ha per year within ten years (2000-2010) (Achard et al., 2014). Land covered by dense natural forest and woodland forests estimate 35-40% since the 19th century in Ethiopia (EFAP, 1994). However, it is become diminished from 12.4 million ha to 4.2 million ha, in which 2 million ha are lost with a mean of 140,000 ha per annual from 1990 to 2005 (FAO, 2001; Bekele, 2011, Teketay et al., 2010). Subsequently, the forest biodiversity and ecosystem service such as social, economic, environmental and cultural deteriorated as well (Sunderlin et al., 2005; Vedeld et al., 2007). This is due to biodiversity loss (Tadesse et al., 2014; Kindu et al., 2016).

Degradation of the natural forest resource is increasing due to the dynamic behavior of demographic and socio-economic conditions (Mascia et al., 2014). Many dry Afromontane forests have been changed to intensive agriculture land in Northern parts of the country (Alemayehu and Teketay, 2006; Bongers et al., 2006; Alemayehu et al., 2009; Getahun et al., 2016) because of population growth (Abiyou et al., 2015). This has primarily erupted from the unwise utilization of natural forest products for firewood, charcoal, construction, and expansion of agriculture.

Despite to these issues, many fragmented forests or small patches have remained around the Ethiopian Orthodox Tewahido Church (EOTC) and sacred area, church forest was preserved by Ethiopian Orthodox Tewahido Church (EOTC) followers mainly for spiritual while sacred forest conserved by the traditional custodian for the cultural purpose they had on tree species. Sacred forest common in South-west Ethiopia (Desalegn, 2007, 2012; John, 2014; Desalegn and John, 2015; Zerihun, 2017, 2019) whereas church forest predominance in Northern highland of Ethiopia (Alemayehu and Teketay, 2006; Bongers et al., 2006; Alemayehu et al., 2009; Alemayehu and Lowman, 2014; Carrie et al., 2016; Tilahun et al., 2015). This means that not saying that church and sacred forests are only availability in Northern and South but also in other areas, but varying in degree.

Historically, cultural norms and religious viewpoints are playing an invaluable role in protecting forest resources in the sense of sacredness all over the world including Ethiopia country. These types of fortification are administered by internal norms of law rather by legal and they have more effectiveness in protecting natural

resource especially forest species (UNESCO, 2003; Dudley et al., 2009). In Oromo cultural "Gada system", registered by UNESCO, is the best practice in conserving all resource (e.g. forest, water, grass, land) for a long period because they consider these resources specially tree species as sacred.

Sacred forest and church forests are a gold opportunity for conserving forest biodiversity and enhancing ecosystem services. In other word, they support as in situ conservation because many indigenous tree species and shrubs, completely lost from other places, but left in compound or outside of forest church (Alemayehu et al, 2002, Alemayehu and Teketay, 2006; Alemayehu et al., 2009) and as a sacred forest (Bhagwat and Rutte, 2006; Desalegn and John, 2015; Zerihun, 2017). As a result, sacred forest got acknowledgment by United Nationals Educational, scientific and cultural organization (UNESCO), Natural Sacred Site (NSs) and Convention on Biodiversity (CBD) as reported in the International Union for Conservation of Nature management guideline (Wild and McLeod, 2008).

Besides using as reservations for a different plants, wildlife, and micro-organisms, the church forest provides multiple benefits such as spiritual, social, economic and environmental (Bongers et al., 2006; Teferi and Demel, 2016).

Most native forests are protected because of their sacredness to communities whose they are conscious is connected with forest in all parts of the country (Carrie et al., 2016). In Sidama zone, large sacred forest like flagship Abo Wonsho Sacred Forest, a 90.2 hectare from beginning the availability not due to the intervention local people it is the divine work (Zerihun, 2019). Therefore, this is the best opportunity for having forest biodiversity and ecosystem service as well. However, current research shows that both sacred and church forests have been gradually declining from time to time (Bingelli et al., 2003; Alemayehu et al., 2005; Zerihun, 2019). This due to population growth, overgrazing, farmland expansion, settlement, climate change, land use change and modernization. So there is paradox ideas, one is about left forest around church and sacred area and the other is there is deterioration of left forest. It confirmation based, that means noticeably there is remnant forest inversely those forests are facing challenges. Even though most fragmented forest or patch forest and sacred forest unevenly distributed all over parts of the country, there is a conducted research in different parts for plant biodiversity and ecosystem services. Conversely, the result of all these findings not yet reviewed in a single form and surrendered to policy formulator, decision-maker and other concerned bodies for further sacred forest biodiversity management and enhance ecosystem service in Ethiopia. Besides, a good reviewed paper may give reliable information for an easy understanding of the plant biodiversity and ecosystem services of the church and sacred forests. Thus, this paper aim to overwhelm the above-mentioned gaps through reviewing plant biodiversity and ecosystem services of sacred and church forests in Ethiopia.

GENERAL BACKGROUND OF BIODIVERSITY IN ETHIOPIA

Biodiversity refers to the variety of life forms, which may include genes, species, animals, plants and microorganisms (Wilfred et al., 2007). The United Nations Convention on Biological Diversity provides a similar definition for biodiversity: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity does not easily defined because it is more than just the sum of its parts, as all of its elements, regardless of whether we understand their roles or know their status, are integral to maintaining functioning, evolving, resilient ecosystems. It the win and win relationship between humans and non- human things that include plants, animals, minerals; and the spiritual consciousness of the people regarding such relationship (Kimmerer, 2002).

Currently, around 7 to 20 million numbers of species exist in the world but yet about 1.75 million species only scientifically got recognitions. Currently, in Ethiopia vegetation physiognomic divided into nine major vegetation types such as desert and semi-desert scrubland, low land evergreen forest, Acacia Commiphora small laved deciduous woodland, Combretum-Terminalia broad-leaved deciduous woodland and savanna, Evergreen scrub, Afromontanerain forest, Dry evergreen montane forest and grassland, Afroalpin and sub-Afroalpin zone and final Riverine and swamp vegetation (Awas, 2007).

Biodiversity conservation is the procedure of maintaining the diversity of living all organisms, their habitats and the interrelationships between organisms and their environment. There are five major biospheres reservoir in Ethiopia such as Lake Tana, Yayu coffee forest, Majanga forest, Sheka forest, and Kafa forest, they playing a great role in conserving biodiversity and enhance ecosystem service. Ecosystem services defined as those components and processes of ecosystems that contribute directly or indirectly to human well-being (Luck et al., 2009). Therefore, it is the links between ecosystems and human societies. In the broadest sense, they are the benefits societies obtain from ecosystems (MEA, 2005). However, current rapid population growth, social, environmental and land-use alteration may highly affect biodiversity and ecosystem service. Besides, overexploitation of available resources (e.g. forest), overgrazing, fragmentation of ecosystem and introduction of alien species (e.g. *eucalyptus),* lack of management, and lack of properly understood the ecosystem service of the ecosystem by the community significantly influence the biodiversity and ecosystem service and in turn affect

human –being. Due to foregoing causes, many forest resources destroyed and biodiversity loss in most parts of the country particularly in Northern Ethiopia, however, some remnant forests were left around Ethiopia Orthodox Tewahido Church (EOTC) and sacred forest.

Brief information about sacred grove

Sacred grove is the site in which it extremely connected with religious and cultural ritual all over the world including Ethiopia, Japan, Morocco, India, and Ghana (Bhagwat and Rutte, 2006; Cardelús et al., 2012; Zerihun, 2019) and it is nexus between human being and biodiversity because of ecosystem service (Sponsel, 2008; Zerihun, 2019). The term "Sacred" invokes an aura of fear, individuality, admiration, and authority. It connected with religion but not with profane or secular (Schaffer, 2003). So, its site epitomized as a site of power and full faith (Sponsel, 2008). They are different types of sacred sites such as forests, trees, rocks, mountains, waterfalls, rivers, the sun, moon, stones and caves for seeks of mentioning a few (Zerihun, 2014, Dudley et al., 2009). All sacred sites are a subset of a sacred grove or sacred groves "collectively named'' and they are dynamic institutions and provide multifaceted functions in socio-cultural, political, ecological and symbolic areas (Siebert, 2008). Approximately, 80% of the world's high biodiversity included sacred ancestral lands and wisely managed by indigenous peoples and local communities (Toledo, 2013). Example, In Sidama zone, around 48 sacred natural sites identified which including 26 extant, 8 transformed and 14 extinct. Use as palaver, during kinfolk issues and community discussion or other settlement. Besides, the place helps as burial sites, grave markers, and demarcation and protection instruments (Zerihun, 2019). As a result, it known as sanctuary for biodiversity conservation and ecosystem service, in which church and sacred forests are playing a central role (Alemayehu, 2002; Zerihun, 2014, 2017, 2019; Carrie et al., 2016; Tulu and Zewdu, 2013).

Methodology

This review was done by collecting essential information systematically from secondary data such as articles, reports, and conferences, which might be published and unpublished. In the end, I put a discussed concept in the form of a tabular, a figure, and a narrative.

DISCUSSION

Sacred and church forest

As aforementioned both church and sacred forests are a subset of a sacred grove, and they playing a great role in plant biodiversity conservation and ecosystem service, which dispense all over the world including Ethiopia (Bhagwat and Rutte, 2006; Dudley et al., 2009). A sacred forest also recognized as a church forest because they also support for religious ceremonies, social gatherings, and burial grounds. Estimate 11% of the world forest is a sacred forest, which currently handled by the community (IUCN, 2009). Both forests may be planted forest, regenerated within an enclosed area, remnants forest for spiritual and cultural associate (Bhagwat et al., 2014) and highly conserved by the local community for a long century (Kibet, 2011).

Ethiopian Orthodox Tewahido Church (EOTC), surrounded by remnant Afromontane forests or sacred groves called church forest, is the oldest church in the world (Aymro and Motovu, 1970; Alemayehu, 2002). The church forest provides inexplicable services to the Ethiopian people through socio-cultural, supportive values and tree products, which explicitly or implicitly connected with forest biodiversity conservation besides religious purpose (Siebert, 2008). Due to this noticeable reason, most endangered and a few richness tree species hidden in sacred and church forests (Dudley et al., 2009). In Ethiopian highland, around 19,400 forest churches with total areas of 39,000–57,000 ha exist (Aerts et al., 2016), in which 8000 found specifically in Amhara regional state alone, which its coverage area is ranging between 1 ha to >100 ha (Reynolds et al., 2017) whereas most churches have less 1ha in Addis Ababa (Tulu and Zewdu, 2013) (Table 2). Nevertheless, around 35,000 EOTC exists in Ethiopia with more than 40 million followers and 500,000 clergies (Alemayehu, 2007).

In addition, sacred forest extremely connected with community culture in Southern Nations Nationalities and Peoples' Regional State (SNNPRS) and Oromia region state (particularly Guji and Borena) of Ethiopia. It is the oldest traditional indigenous knowledge and norms, in which the communities have more habituated with forest preservation for a mystical and commemoration of their family's death (e.g. Sidama Zone). There is various sacred nature site including a forest in Sidama Zone, which authorized as Sidama ethnicity identity in Southern Nations Nationalities and Peoples' Regional State of Ethiopia (Zerihun, 2017). Similarly, in Oromo culture if somebody not has child and died, a tree he planted during alive was assumed as his child, nominated by his name and the community memorial him by that tree (Desalegn, 2013).

Both church and sacred forests had been fortification and respected by the community than adjacent forests or natural forests. Consequently, the community does not have the moral to abuse forest biodiversity and ecosystem around church rather they strive to protect it. Because, from a religious and spiritual point of view they know that church forests must be "respectfully cover" and "shelter" the sacred Tabot, which is supposedly a copy of the Ark of the Covenant and kept within the church building. This derived from God's word, in the bible

standpoint the Ark of the covenant, which needs the wooden container for God's commandments to be covered with layers of luxurious fabric (Exodus 25:10–22, Exodus 26). The Ark is of fundamental importance for the religious practice of the EOTC and the identity of Christian Ethiopians, who consider themselves offspring of the earliest Israel. It may not astonish, from the beginning EOTC was surrounded by different tree species and the communities had a traditional experience of conserving forest for long-age without incorporating scientific conservation and government conservation strategic policy (Woldemedhin, 2008). Trees and shrubs are conserved within a church compound and around monastery or tsebel (Holy water) areas. For example, Woneba Mikael (A) and Wonjetta Mikael (B) churches were established in thirteen and fourteen centuries in West Gojjam Zone, Northern Ethiopia, which highly covered by forest (Figure 1ab). The total area of the church is 20 ha and 7ha, from these 15 ha and 5 ha of land size were occupied by different tree species in Woneba Mikael (A) and Wonjetta Mikael (B) churches respectively (Teferi and Demel, 2016) (Figure 1ab).

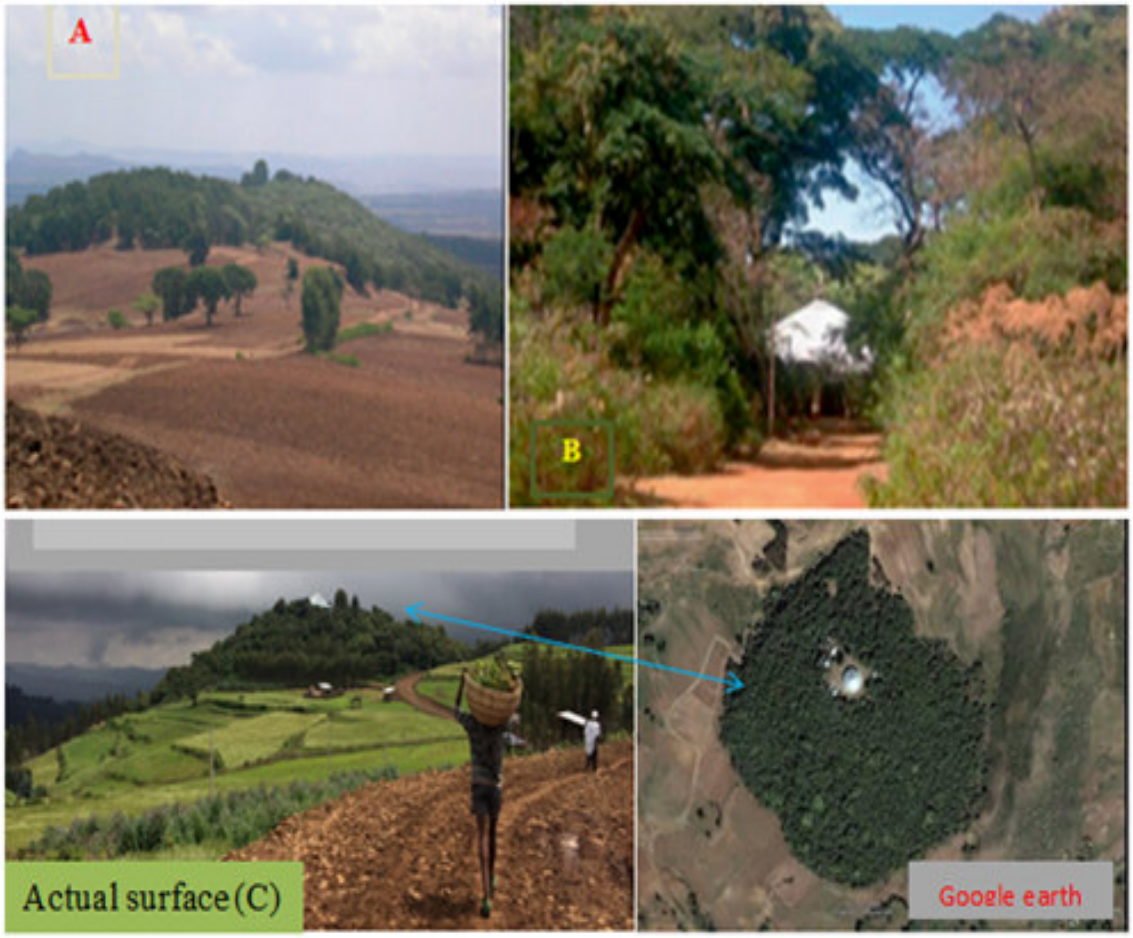

Figure 1: Church forest of Woneba Mikael (A), Wonjetta Mikael (B) and Debresena Mariam (C) Amhara region of Ethiopia
Source: Teferi and Demel (2016) (A and B) and Catherine et al. (2013) and Min (2016) (C)

Sacred and church forest VS plant diversity

Most plant biodiversity is extremely protected in a sacred grove, which includes sacred forest, and church forest, particularly stone walls is playing a valuable role in conserving different plant diversity. Church and sacred forests use as in situ conservation for native plant species in Ethiopia particularly endangered tree species (Teferi and Demel, 2016, Zerihun, 2014, 2019). A stone wall is not the traditional method of conserving biodiversity rather it is one strategic conservation part of community-based creativity, particularly it is not new to EOTC members. Most of the time, a wall is more advantageous where the forest is surrounded by agriculture and grazing activities (Chazdon, 2008; Amare et al. 2016; Carrie et al., 2016) and where forest status is highly degraded (Chazdon 2003). For instance, the study conducted by Carrie et al (2016) in Montane (1700–2100 masl) or upper Montane (2400–2800 masl) from South Gondar had relatively confirmed these points. Accordingly, from 13 church forests, they had recorded 64 wood tree species with mean of 9.0 ± 2.4 and 10.2 ± 1.6 with stone walls and 1.7 ± 0.7 and 5.3 ± 1.2 without walls of seedling and tree species respectively. Overall, 383 of a total

seedling from 27 different seedling and 113 numbers of a tree from 31 of tree species recorded in Montane. Besides 203 of a total seedling from 20 species and 183 numbers of a tree from 32 tree species recorded in upper Montane forests. Seedling density and species richness are significantly higher in all church forests with a wall than without walls both in Montane and in the upper Montane church. Not surprisingly, species composition within each church forest may differ from one to another because the regeneration capacity of some tree species, there is a tree species which is regenerated within a wall alone but not in without walls. For instance, tree species available in walls Montane (e.g. *Rhus vulgaris*), *Combretum molle and Canthium Oligocarpum* and in upper Montane (*Agave, O. europaea ssp. Cuspidate, P. africana and T. nobilis*). This shows that seedling species composition is more abundant in church forest with a wall than forest without a wall. This is the fact between sacred forest and none sacred forest of Wonsho (Zerihun, 2019) and Shawo forest (Samuel and Alemayehu, 2019) in SNNPRS of Ethiopia. Furthermore, tree density and richness are governed by stonewall or fence in both sacred forests (Desalegn and Jonh, 2015) and a church forest (Carrie et al., 2016). Because it reduces, the disturbance came from humans and livestock. This is a good opportunity for regenerations of various tree species and safeguarding of endangered and endemic taxa continuously for a long time (Bongers et al., 2006). For example, *Olea europaea ssp. cuspidate* species are not has a good regeneration ability in the South Gondar zone (Alemayehu et al., 2009a; Haileab et al., 2011), but now have a chance to regenerate because of a wall (Carrie et al., 2016). In general, the regenerative ability of tree species is very swift in church forest of with a wall than without a wall particularly for regenerating fragmented forest. Similarly, according to Mohammed and Teshome (2014), around 41 different woody plant species, with 7156 individual wood plant species were identified from Tara Gedam forest, South Gondar Ethiopia. From recorded species *Olea europaea (598)*, *Allophylus abyssinicus (556)* and *Albizias chimperiana* (474) ranked as the first, second and third dominance tree plant species whereas *Acanthus sennii* the least dominant. Besides, Teferi and Demel (2016) reported total 56 numbers wood species recorded from nine churches in which their density ranging from 10 to 46 and similarity composition estimated by Jaccard's coefficient, shows that a wood species which may exist in Mercha Giorgis also available in Zeguda Giorgis and Zambi sellasie by more than 50%.

According to Tulu and Zewdu (2013) conducted a study on seven EOTC's forest in Addis Ababa, detailed see Table 2. As a result, from seven churches around 22 different tree species with a density of 1488 were recorded, which ranging from 3 to 18 with a minimum species density 75 trees ha-1 (Risa Adibarate Entoto Kidist Mariam) to maximum species density 413 trees ha-1 (Menbera Tsebaot Kidist Silase Cathedral). Among the registered tree species, *Juniperus procera* has the highest density with 884 individuals while *Pinus radiata, Spathodea nilotica* and *Araucaria jussieu* accounts for the lowest density with two (2) individuals. Amazing, this amount of tree species presence around or within the city (Capital city of Ethiopia) may show how tree species biodiversity protected particularly native tree species (39) in Ethiopia (Table 2).

Relatively, in Gamo Highland sacred forest (2.24Ha), 152 total species (species richness), 19 endemic to Ethiopia, 5 species endemic to Afromontane forests, 4 species national priority (e.g. *Juniperus procera*, *Hagenia abyssinica, Prunus africana,* and *Cordia africana)*, one (1) internationally identified as vulnerable (e.g. *Prunus africana)* and 4 species near threatened was identified. Even though small, relatively it contained high species density and plays an unplayable role in biodiversity conservation and ecosystem services (John, 2014). Similarly, Samuel and Alemayehu (2019) conducted a study on Shawo sacred forest reported 16 plant species with a mean plant density of 499 individuals per hectare. Amongst 16 species, *Rubus species* and *Ocotea kenyensis* are the highest (2039) and lowest (29) density individuals per hectare respectively. Besides, *Eucalyptus globules* and *Juniperus procera* are the most exotic plant species with a density of 226 and 128 individuals per hectare, respectively.When compared, mean plant density species (499) individual per hectare more than each church's species density of Addis Ababa (Tulu and Zewdu, 2013) **(**Table 2). Inversely, numbers of indigenous species and density species more dominance than exotic species in seven churches of Addis Ababa city (Tulu and Zawdu, 2013) (Table 2). In context to area size, church forest has higher species density than sacred forest.

Catherine et al (2013) ratified that fragment forest church (Zahara and Debresena) has small size, isolated, small canopy closure and a high degree of edge effect, which activates the vulnerability loss of tree species. When edge effect increases microclimate is changing (increase temperature, reduce humidity, increase wind pressure) as a result all biodiversity deterioration increase (Chapin et al., 2002; Alemayehu et al., 2009). In further, open forest or less canopy forest and delimited boundary forest is suitable for cattle grazing which interrupt soil physical property (Bulk density Vs compaction), chemical soil properties (PH, essential soil nutrient) and biological soil property (damage microorganism), which conjointly, in turn, limit the regeneration and establishment of tree species (Catherine et al., 2013; Skinner et al., 2009). Similarly, four sacred forests are highly suffered due to the surrounding of agriculture and grazing land and lack of a fence, which in turn weaken the forest biodiversity in Gamo Highland (Desalegn and Jonh, 2015). This means relatively higher plant density in sacred and church forest than none sacred and church forest even if there is some influencing factor emerges for them. As a result, sacred forests kept the security of some endangered native tree species particularly in Wonsho sacred sites (Zerihun, 2019**) (**Table 3) and church forest (Carrie et al., 2016). This indicates that sacred

natural site "forest" highly supports conserving plant species particularly endangered medicinal plants (Table 4). As a result, the community utilizing medicinal plants either primary or temporary for remedies of both animal and human ailments (Zerihun, 2017).

Table 2: Species number and species density of seven EOTC in Addis Ababa

Name of Church	Area (Ha)	Species				Total species (no)	Total density in area
		Indigenous		**Exogenous**			
		Species (no)	**Density**	**Species o)**	**Density**		
Birhanate Alem Petros Wo Pawulos	0.13	4	136	-	-	4	136
Genete Tsige Kidus Giyorgis	0.77	6	305	5	35	11	340
Debre Keraniyo Madihanalem	0.21	5	130	3	6	8	136
Re'ese Adbarat Entoto Kidist Mariam	0.08	2	67	1	8	3	75
Kechene Debre Selam Medhanalem	0.63	6	208	4	27	10	237*
Menbere Tsebaot Kidist Silasse	1.82	9	355	7	58	16	442*
Yeka Debre Sahil Kidus Michael	0.09	7	115	3	38	10	153
Total	**3.73**	**39**		**23**		**62**	**1519***

Source: Update from Tulu and Zewdu (2013)
* Indicate replaced with the correct 1488, 413, 235

Table 3: Endangered native woody tree species protected at Wonsho-Sidama, Ethiopia

Local name	**Scientific name**
Dagucho	*Afrocarpus falcatus*
Seetame	*Olea capensis spp.*
Duwancho	*Syzygium guineense*
Garbicho	*Ocotea kenyensis*
Oloncho	*Psydrax schimperiana*
Dugucho	*Pouteria altissima*
Sidancho honcho	*Juniperas procera*
Ţonţoloma	*Lepidotrichilia volkensii*
Woraricho	*Syzygium guineense (Wild.) DC.*
Koqqo	*Drynaria volkensii*
Falako	*Macaraga kilimandsharica Pax*
Çuço	*Maytenus arbutifolia*
Bulancho	*Withania somnifera*
Shohicho	*Ocotea kenyensis*
Godicho	*Fagaropsis angolensis*

Source: Zerihun (2019)

Table 4: Some selected medicinal plants species of Shawo sacred forest

Plant species	**Treatment**
Embelia schimperi	Tap worm
Syzygium guineense	Tonsil
Maesa lanceolata	Mosquito disease
Croton macrostachyus	Scars
Eucalyptus globulus	Kintarote/hermorrhoids

Source: Samuel and Alemayehu (2019)

Ecological and Socio-culture of sacred and church forest

Historically, there is nexus between community culture, indigenous knowledge, and religious with biodiversity and ecosystem services of the forest resource. The contribution of natural sacred forest innumerable, amongst them ecological and socio-culture are the central outcome and discussed in this paper. Before sixty years ago, most available scared forests are natural and contrast with current, which planted tree species dominant. Because of indigenous knowledge and its sacredness most forests are sustainable conserved and in turn support as captivation, attraction, connectedness, hazard, ritual, and remedial (Jamir and Pandey, 2002) and climate

regulation (Cardelús et al., 2012; Amare et al., 2016). The study conducted in Shawo sacred forest ratified these issues (Samuel and Alemayehu, 2016).

Sacred forests can be private or household and communal resources based on the perspective of the users or the farmers (Zerihun, 2019). However, church forest is too complex because it is common resource (religious place and land) (Travis et al., 2017). For instance, in Sidama zone, there is a forest, which is managing at the household level. If the sacred forests assist for a reminder and for symbol connecting father-son generation if even one died then the sacred tree on the place is highly protected because of their ceremonial/ritual and ancestor's symbolism purpose. Such kinds of sacred forests categorized under household sacred grove (mine'e ha'ara), which was planted by scan group in the past, particularly *Afrocarpus falcatus* tree species. Because of the household's standing point or mentality, such tree species are continuously managed until they fall due to old age (Zerihun, 2019).

Similarly, church forest is playing a valuable role in strengthening the community intimacy through including both communities those who may be far away from the church (secular) and those who often actively involved in church (affiliate). Church forest serves as dwell for clergy (e.g. priests, nuns, monks, priests, and deacons), they are living in the forest with respectfully and sometimes they were invited to feasts when it is taking place within church forest and the societies very glad about their participation in feasts. The other advantages of church forest is that it a place in which it helps to celebrate or meeting (Mehaber) by the members, especially Orthodox followers community, it is a kind of eating and drinking Tella and memorialize one another by partaking together (Izabela and Peter, 2018, Peter et al., 2016).

Furthermore, church forest has multiple services such as social (increase intimacy, indicate the presence of church from a far distance (Figure 1 and 3), serve as platforms to discuss about religious and social issues), economic (all timber, no-timber and income), ecological and cultural benefits besides to spiritual service (Alemayehu et al., 2005; Wassie, 2007; Reynolds et al., 2015). Besides, environmental service (protection from strong wind, storms, and soil erosion, provide shade and conditioned atmosphere for religious festivals and meditations outside of the church buildings, provide sweet and pleasant smell around churches, and create beautiful scenery, impression, and contemplation for prayers) (Bongers et al., 2006, Teferi and Demel, 2016). Sacred forest also provides all the foregoing benefits (Zehirun, 2017). Besides, most natural sites including sacred forests are using as an instrumentality in conflict resolution, particularly in Sidama (Worsho forest) (Zerihun, 2018). Addition to cultural and spiritual services, both forests provide ecosystem services (ecological) such as water filtration, reducing soil erosion (Figure 2). Because, sacred forest use for either as burial grounds or as places for indigenous rituals belongs to Gamo people (Desalegn and John, 2015). As a result, people willingly protecting it to sustain their contribution in terms of culture, religious beliefs, and taboos (Figure 2).

In Shawo sacred the forest strongly conserved by traditional rules and regulations (e.g. no cutting tree without permission if did there is punishment) for about 100 decades (10 generations) through transferring from descendants into next-generation (Samuel and Alemayehu, 2019). Amazing and heart touch traditional of forest conservation, "If the tree failed by different natural causes Gamo people undertake special ceremony to respect nature and express their sadness. They gathered and cried during the ceremony like what we did for human being funeral ceremonies. They express their sorrow by beating their stomach with their right hand and prey for the dead tree". Finally, the traditional leader will plant seedling for the concept of replacement (Samuel and Alemayehu, 2019).

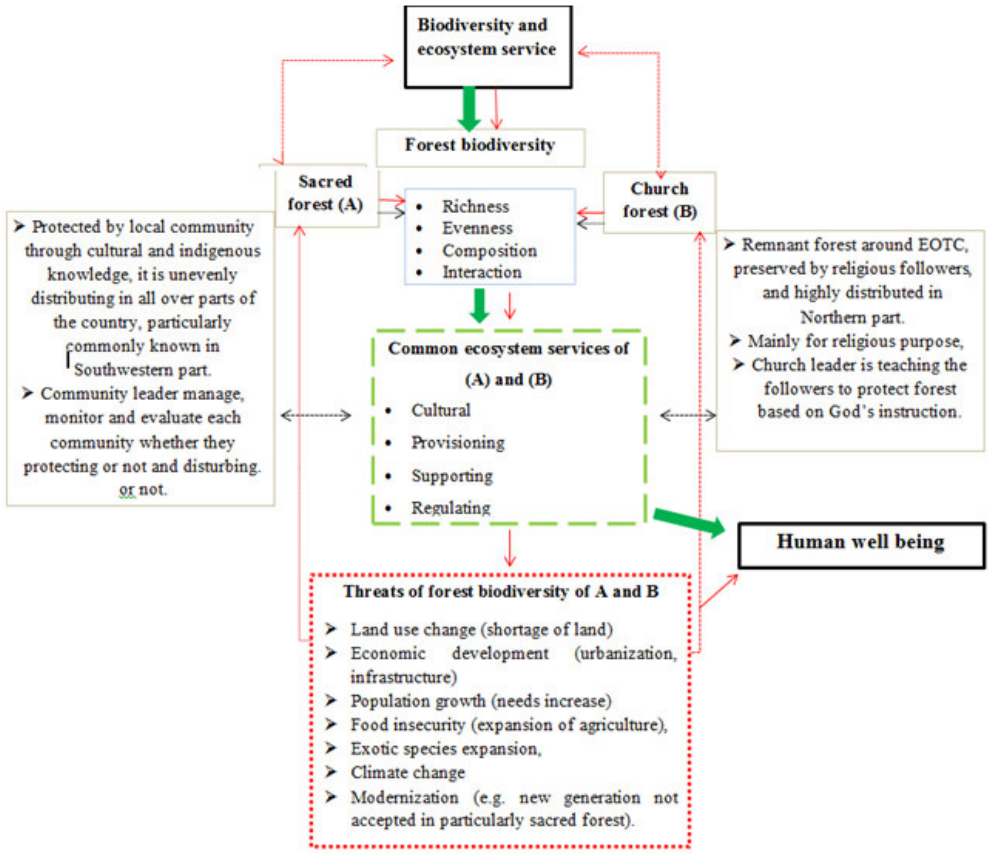

Figure 2: Flow chart of sacred and church forest biodiversity and ecosystem services

Figure 3: Church forest with most characteristics
Source: Peter et al. (2016)

Role of Sacred and church forest for farmer's livelihood

In general, sacred and church forests are scattered in parts of the country. This because there are different agro-ecological conditions, climate conditions, landscapes, different ethnic groups with various culture, different perceptions of people on forest and political instability. Not questionable, normally, natural forest contributes incredible multiple benefits to livelihoods of farmers in the form of economic (timber and non-timber forest products), and environment (nutrient cycling, water storage, carbon storage, climate regulation) (Bhagwat, 2009). Sacred forest and church forests can provide all these benefits besides spiritual and religious values (Teferi and Demel, 2016) (Figure 2). From church forest, most religious followers can use tree products for firewood, honey, freshwater, and cattle grazing (Alemayehu et al., 2010). In contrast, using church forests for firewood, honey, freshwater and cattle grazing, construction wood, fodder is entirely restricted in few churches in the highland of Ethiopia (Bongers et al., 2006, Peter et al., 2016).

According to Abiyou et al (2015), the church forest has four major services such as provisioning, protection, cultural and supporting services (Provision of habitat, nutrient cycling, soil formation and retention, production of atmospheric oxygen, water cycling and climate balance, soil erosion control) (Figure 2). In addition, the main role of sacred forest (all plants can use for medicine but varied in amount) is using for medicinal purposes to Sidama community of Southwestern Ethiopia (Zerihun, 2017). Gamo community, traditional uses medicine from wood species of Shawo forest (Table 4**).** It is a traditional aspect of indigenous with indirectly comfort livelihood of the people. This ratifies that in most parts of Ethiopia more than 80 percent of people using plant medicine as primary health care (Kassaye et al., 2006).

Economical the local community can use it for income generation through sold dead trees or branch, besides; social value for shade purpose during dry and raining season particularly elder farmers had assembled under a shade of trees and make a discussion about the community issue and spiritual. In rare cases, church forests may use for improving food security particularly during drought (Bongers et al., 2006). Besides, the benefit obtained from four church forests (Hiruy, Debresena, Dengolit and Gelawdios) articulated as renewable (cultural medicines, fruit, seed collection, shade and prayer, honey) and non-renewable (e.g. Timber, construction materials, firewood) (Figure 4).This is because under renewable perspective the degree of forest destruction not visible while non-renewable is highly devastating forest resource (Travis et al., 2017). Most Afromontane forests have disappeared or transformed in some parts of the country in which indigenous species is extremely removed and few patches left due to the presence of EOTC followers which predominated by exotic species particularly eucalyptus (Reynolds et al., 2015; Bongers et al., 2006; Aerts et al., 2016). This may directly connect with the socio-economic values, in which EOTC follower using it for firewood, timber and as a source of income (Dessie and Erkossa, 2011; Amare, 2019). But due to the degradation rate and coverage size of forest a some church limited the use of forest products (E.g. for firewood and construction timber, firewood, fodder) but they allow to use medicine, honey, tree seeds collection, medicine and contemplation purposes (Bongers et al., 2006; Travis et al., 2017). Inversely there a church forest allows utilizing non-renewable and renewable tree products but there is rules and regulation, norms and religions standard based God's instruction (Travis et al., 2017) (Figure 4a).

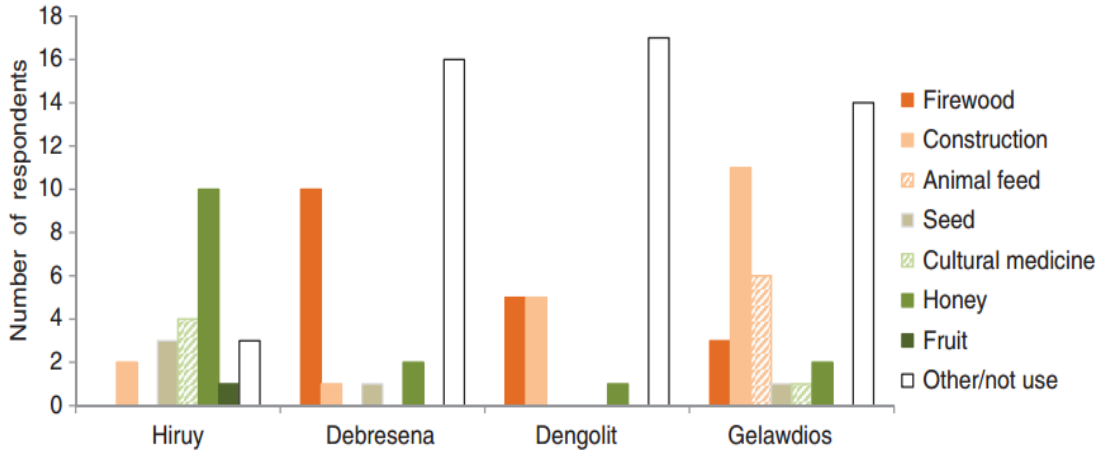

Figure 4: Extractive benefits (red shades) versus renewable benefits (green shades) sought from four church forests

Source: Travis et al. (2017)

Implication in mitigation climate changes

Scientifically authorized forest plays a central role in combating climate change through absorbing or sequestering and accumulating more carbon from the atmosphere. Both church forest and the sacred forests are playing incomparable contribution against climate change. Research might ratified their contribution sacred forest (Alemayehu, 2002) and church forest (Tulu and Zewdu, 2013; Beyene et al., 2018). Most sacred grove forests; left the forest or planted or regenerated tree species around the sacred area (e.g. EOTC and culture assets) and had small size in hectare and known by less canopy closure (Catherine et al., 2013; Cardelu's et al., 2019). These patches' forests contribute to climate mitigation away from sanctuary and ecosystem services (Gould, 2012). According to religious and spiritual perspective, Global warming was considered as God's anger or curse; because of the natural gifted resource (Forest) disturbed by anthropogenic pressures instead of protected and managed; which is outside of God's commandment. Climate change has dynamic behaviors and needs continuous awareness (Gifford et al., 2011). Due to this issue, the leaders of EOTC constantly admonishment their followers turn back to through confess and act according to God's willing and then manage and planting different plants species surrounding church but also on their private land, which is the best option for combating climate change. Besides, they also teaching and preaching about the goods, awful and situation may emerge worldwide anxieties including causes and consequences of climate change, appropriate mitigation and adaptation measures. Tulu and Zewdu (2013) conducted a study on seven EOTC forests in Addis Ababa, already mentioned above indicated that the church forest plays a great role in regulating microclimate and mitigate climate change. Consequently, from seven churches around 2077.88 and 7625.82 tons with a mean of 296.84 and 1088.40 carbon and carbon dioxide were sequestered respectively. Besides, carbon stock of 129.85 + 154.11 and 25.97 + 30.82 tons per hectare estimated from above ground and belowground biomass, respectively. Furthermore, they also elaborated that carbon stock calculated from above ground biomass (41.9%), below ground biomass (8.4%), dead litter (5.8%) and in soil (43.9%) (Figure 5). This clearly shows that high amount of carbon stored in soil because there is high decomposition and high soil nutrients particularly organic matter. Unforgettable about EOTC and sacred forest, the presence of the Afromountain forest ecosystem is its diversity and richness in indigenous species, which helps for combating climate mitigation like other forests. This is due to the fact reason that around one-third of land size is covering by church forests (Bekele, 1992; Taye, 1998). Therefore, when forest coverage increases the carbon stock directly increase then it reduces climate change. Besides, when land covered by forest soil carbon increase, which is also, minimizes the emission of carbon into the atmosphere.

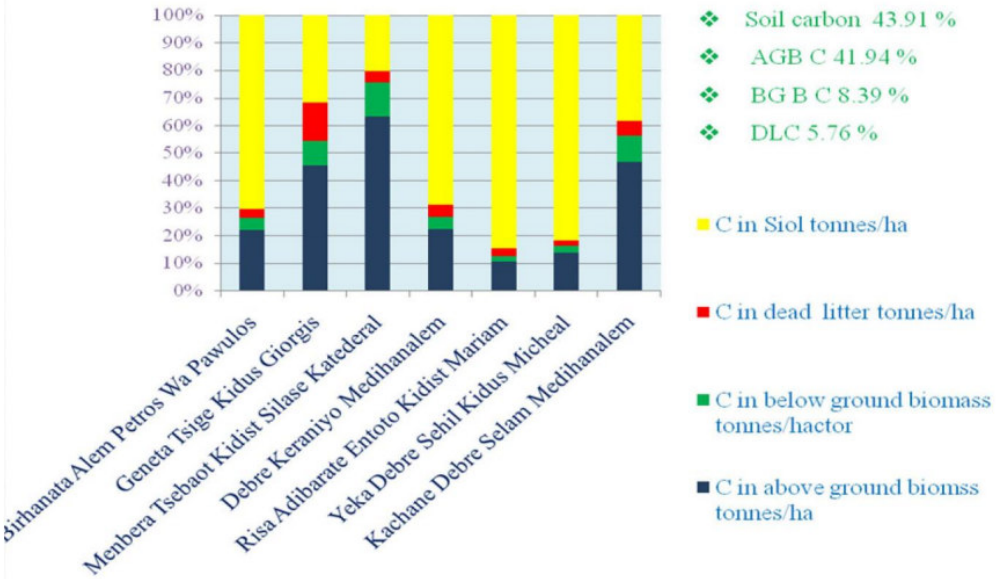

Figure 5: Estimated carbon stock from seven churches forest in Addis Ababa
Source: Tulu and Zewdu (2013)

Threats of sacred and church forest

Present-day most sacred and church forests are threatening by many causes. For instance, in Sidama, commonly known tree species gradually deteriorated due to infrastructure development (e.g. urbanization, road, market places, and schools), religion influence (religion intrusiveness and modernization) because a few sites of SNS are protected only by Sidama Ancestral Religion (SAR) practitioners, overpopulation leading to changing forestland into agriculture through cutting of tree, particularly *A.falcatus* tree species (Zerihun, 2014). Climate change is also influencing the species richness, diversity, and distribution. Because its changes in tree species may become reduced or extinct then reduce biodiversity. For instance, due to the increment of an average global warm or

surface temperature by 2°C, it extremely affect about 15-40% of species to extinction (Stern, 2006). Not amazing, climate change (e.g. drought) exacerbate the degradation of sacred forest (Alemayehu et al., 2005). Mainly, anthropogenic activity prioritized as a major influence factor for worsening church (Figure 1 and 6) and sacred forests (Figure 7a-f). For instance, Wonjetta Mikael, Woneba Mikael, and Debresena are highly surrounded by agriculture and grazing land and there is a lack of demarcation boundary, this simple representation of the forest for any user (Figure 1). A crucial point, as fragmentation of forest increases there is a high degradation rate due to a high degree of edges effects (Laurance et al., 2011). Edge Density (ED) is a measure of the total length of the edge of all of the patches in each land-cover class divided by the total landscape area. A large value of edge density indicates a high level of human disturbance and fragmentation of the class (Desalegn and John, 2015). Consequently, it enhances the death of the rate of tree species and seedlings species than intact forest (Zambrano et al., 2014) and declines the species richness and species density (Laurance et al., 2012). In contrast, Carrie et al (2016) reported two points, deforestation of church forest intensification (because it is surrounding by pasture and agriculture) inversely stone walls (for demarcation boundary) considered as a solution, which helps for reducing the disturbance of human's from church forests in South Gondar of Ethiopia. As a result, species richness and species density highly significant in the forest with the stone wall than non-stone walls.

Similarly, according to Desalegn and John (2015) sacred forest and ecosystem service extremely threats by newly appearing of economic, social and cultural aspects and deactivate management, extensive grazing, tree cutting and conversion of land into cultivate land, lack of any restoration intervention. The well-organized traditional values, cultural taboos, belief systems, and bylaws by the church's leader and community elders for the safeguarding of sacred forest did not show remarkable results now today. So, to overwhelm these problems since 2007 around the three-community nursery site was established to multiple seedlings for the purpose of enrichment planting and but it was discontinued due to financial problems in Gamo Highlands of Ethiopia (John, 2014).

According to Abiyou et al (2015), there are a numerous constraints for church forest conservation such as poverty (stimulate deforestation), problem of sharing knowledge, lack of cooperation, modernization (Youth generation rejected the original cultures and spiritual heritages), lack of demarcation and sharing experience in six EOTC of North Shoa Zone, Amhara Region (Figure 6).

To keep the ecosystem service, quality and quantity of forest biodiversity species and sustainably managing it requires further encouragement and awareness primarily for the religious community and cultural society by the affiliated leader of each forest resource. Besides the government, NGOs and other community should participate in preserving and managing it by full commitment. Because the benefits forest is boundary-less service particularly relate to environment perspectives and it contributes paramount. Due to its multidimensional services, many authors recommended the important options should take place for safeguarding the forest biodiversity of church and sacred forests. For instance, its management should be integrated with environmental education (Keane et al., 2011), community participation especially during monitoring (Dickinson et al., 2012), conservation planning need multidisciplinary approach (stakeholders) (Denier et al., 2015) and to highly strength it should be assisted by some payment for ecosystem service (Amare et al., 2016).

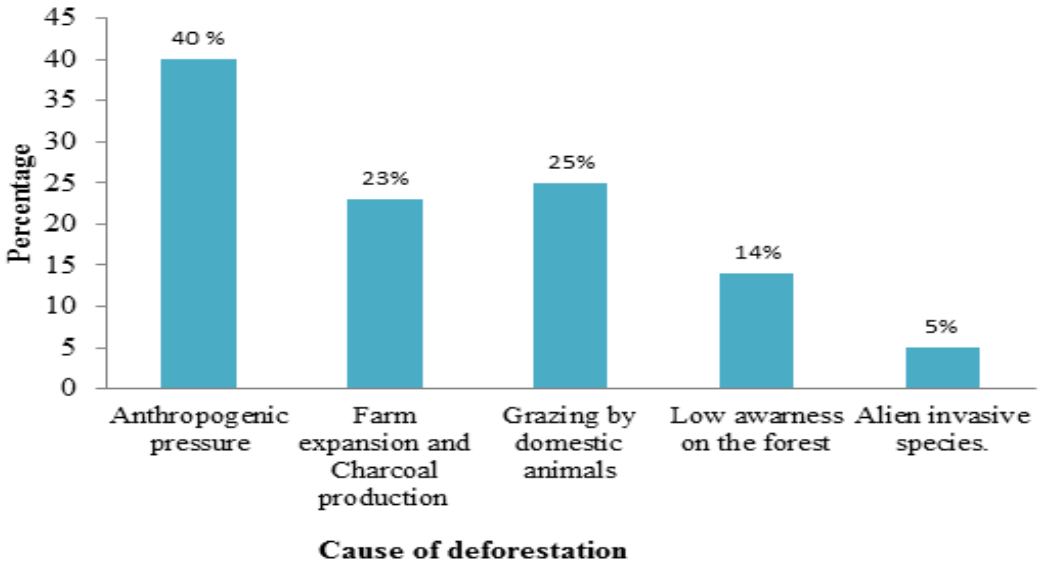

Figure 6 Major causes of deforestation and losses of biodiversity
Source: Update from Abiyou et al (2015)

The deterioration church forest and the sacred forest is observing all over the place today, it is due to the availability of overpopulation inversely associated with a shortage of land. As a result it strongly discouragement forest biodiversity protection and ecosystem service and inversely increased tree species threatening. In the past time, church and sacred forests served as sanctuaries for endangered tree species, wild animals and microorganisms in all parts of the country, particularly during exacerbate deforestation (Table 5). Conversely, in current, the secureness characteristics of these forests have been gradually undermined; this may break out from complex problems like lack of limited land, population need increases and infrastructure development including the above-mentioned cause of church forest (Figure 6). In this manner, the most important tree species are threatened (Table 6).

Most Homegrown tree species are colonized by invasive exotics (e.g. Eucalyptus). A small EOTC priest called them the "Evil tree". Because of its negative, they had called it an evil tree. They are not only intensively deteriorate native tree species, but also they need more water for growth or extract more water from ground which limit water supply, create toxic to soil and water, wildlife and destroy medicinal plant in which most people depend on, and distort cultural heritages (Alemayehu et al., 2009, Aerts et al., 2016; Amare, 2019). The expansion or intensification of exotic tree species in specific land use or forest (scared and church forest), they a major cause for extinction of indigenous species, biodiversity reduction, diversity species reduction, limit evenness of native species, inversely increase abroad, as a result, affect ecosystem service and prompt climate change but in little, it may improve socio-economic of the people. In general exotic species threats biodiversity and ecosystem services (Alemayehu et al., 2009; Amare, 2019). According to Zerihun (2014), about 10 sacred forests are either extinct or transformed into cultivation or arable land, others like school, open market places, roads, urban development and individual ambition of gaining quick cash from in Wonsho - Sidama Ethiopia (Table 5).

Table 5: Some ‘extinct’ or ‘transformed’ Wonsho sacred forest Sidama of Ethiopia

Name of sacred forest	**Major tree species**	**Conservation state**	**Reason for endangerment**
Komole	*Commiphora schimperi, Syzygium guineense, Cordia africana, Hagenia abyssinica*	Disappeared	Agriculture expansion
Haraka	*Rhus glutinosa, Cordia africana, Syzygium guineense, Croton macrostachyus*	Disappeared	Agriculture expansion
Arache	*Podocarpus falcatus*	Disappeared	Agriculture expansion
Bollo	*Yeshania alpine*	Decline and degraded	Agriculture expansion
Madale	*Syzygium guineense*	Disappeared	Agriculture expansion
Kotte	*Podocarpus falcatus*	Now there are no trees	Agriculture expansion
Hambasa	*Podocarpus falcatus, Croton macrostachyus, Celtis africana*	Disappearing; “now few exist”	Land for school building
Gulla Gowwa	*Cordia africana*	“Now almost all cut down; only remnants exist”	Agriculture expansion
Mamuna	*Podocarpus falcatus*	“Full of podo trees where people worshipped in the past; now it is obsolete.”	Land use for market and farm place.”
Golola	*Podocarpus falcatus*	“Half of the space is farmed; about 50 sacred trees stand.”	Agriculture expansion

Source: Zerihun (2014)

Therefore, there is no guarantee for the unrepeatability of the past decade forest degradation action in Ethiopia because the effort made for conserving left forests could not bring remarkable results. Contrariwise, there is the stretch of economic growth, urbanization, population size double, and inflation. It needs immediate action and deep attention to limit from further degradation of forest biodiversity and keep its ecosystem service as a wall. Making boundaries for utilization of forest product experience must be adopted because a few church and sacred forests had shown relative advantages in combating degradation (Bongers et al., 2006; Travis et al., 2017).

Impact of land use change on biodiversity and ecosystem services

The land is the mainstay resource for all other resources. Today land uses land cover changes (LULCC) is an epicenter problem in Ethiopia, because of an enormous expansion of cultivating and grazing land into forest and shrubs land (Haileab et al., 2011; Bekele et al., 2018; Dinka and Chaka, 2019). This is directly swift the degradation of plant biodiversity species and ecosystem services (Bradshaw et al., 2008; Foley et al., 2005). Besides, the size of both natural and sacred forests lessened, particularly in Northern parts. LULCC is trigger by complexity issues in which population growth governed it (Degife, 2018). There are uncountable reasons why people have deforesting forest resources. It is obvious that there a shortage of cultivable land, to fulfill their daily life. This very worsens for the community who their life is being dependent on forest and forest products. When the size of the forest is small, its edge more increases because of species density and richness become decline due to high disturbance. Detrimental rate is relatively more in developing regions because of socio-economic change and demography influences (Mascia et al., 2014; Bhagwat and Rutte, 2006). Habitat fragmentation commonly defined as a process when "a large expanse of habitat is transformed into several smaller patches of small total area, isolated from each other by a matrix of habitats unlike the original'. When it has happened it directly, affected habitat patterns in four ways such (a) reduction in habitat amount, (b) increase in a number of habitat patches, (c) decrease in sizes of habitat patches, and d) increase in isolation of patches. Most churches forests in Northern part are surrounded by various human activities and encroachments of people increasing from daily (Figure 1ac and 3). For instance, Desalegn and John (2015) deep-rooted land cover changes and patch fragmentation as a serious problem threaten forest in Gamo Highland of Ethiopia. They found that for over 15 years (1995- 2010), farmland and settlement area highly increased to109% while forest area decreased (Sacred and none sacred forest) by 36.6%, which encompasses the decline of forest patches, mean size, edge density and mean shape index by 16.1%, 26.8%, 29.1%, and 13.3% respectively. This means forest size 7216 ha (10.8%) in 1995 became declined to 4573 ha (6.8%) in 2010 (Table 6). They added that when a forest patch decreases the edges density inversely increases this will trigger the vulnerability of forest due to the expansion of settlement and farm (Table 6). Due to the expansion of farmland and settlement more sacred forest (four from six) and all none-sacred forest (six) shows a trend of loss area, which manifested through either increase or decrease of patch size, shape index, and edge density of each forest (Figure 7a-f), which accelerated threats forest biodiversity. Furthermore, forests patch size decrease while edge effect increases highly enhance the deterioration of biodiversity (Desalegn and John, 2015). Therefore, forest biodiversity extremely deteriorated due to anthropogenic pressure, as a result, reduce ecosystem service. Ecosystems services of forest biodiversity are also occurring when the species density and richness permanently preserved as sacred forests (Cardelu's et al., 2012; Amare, 2019). It is the worldwide sacred site (e.g. church and sacred forest) commonly degraded by overpopulation, social unfairness, governance problem, political instability and lack of improperly formulated and implemented land-use policy (Dudley et al., 2009). Biodiversity has extremely deteriorated due to land-use change (Bradshaw et al., 2008), particularly forest biodiversity entirely or partial change to agriculture land (Haileab et al., 2011; Gashaw et al., 2014).

Table 6: Impacts of Land-cover change sacred forest in the Gamo Highlands (1995–2010)

Years of land cover classes	**1995**		**2010**		**1995 – 2010 change**	
	Area (Ha)	**%**	**Area (Ha)**	**%**	**Area (ha)**	**%**
Farm and settlement	19,255	28.84	40,329	60.4	21,074.0	+109.4
Forest	7,216	10.81	4,573	6.8	-2,643.0	-36.6
grazing land	16,878	25.28	10,390	15.6	-6,488.0	-38.4
wooden grassland	23,415	35.07	11,472	17.2	-11,943.0	-51.0
Total	**66,764**	**100.0**	**66,764**	**100.0**	**0**	**0**

Source: Desalegn and John (2015)

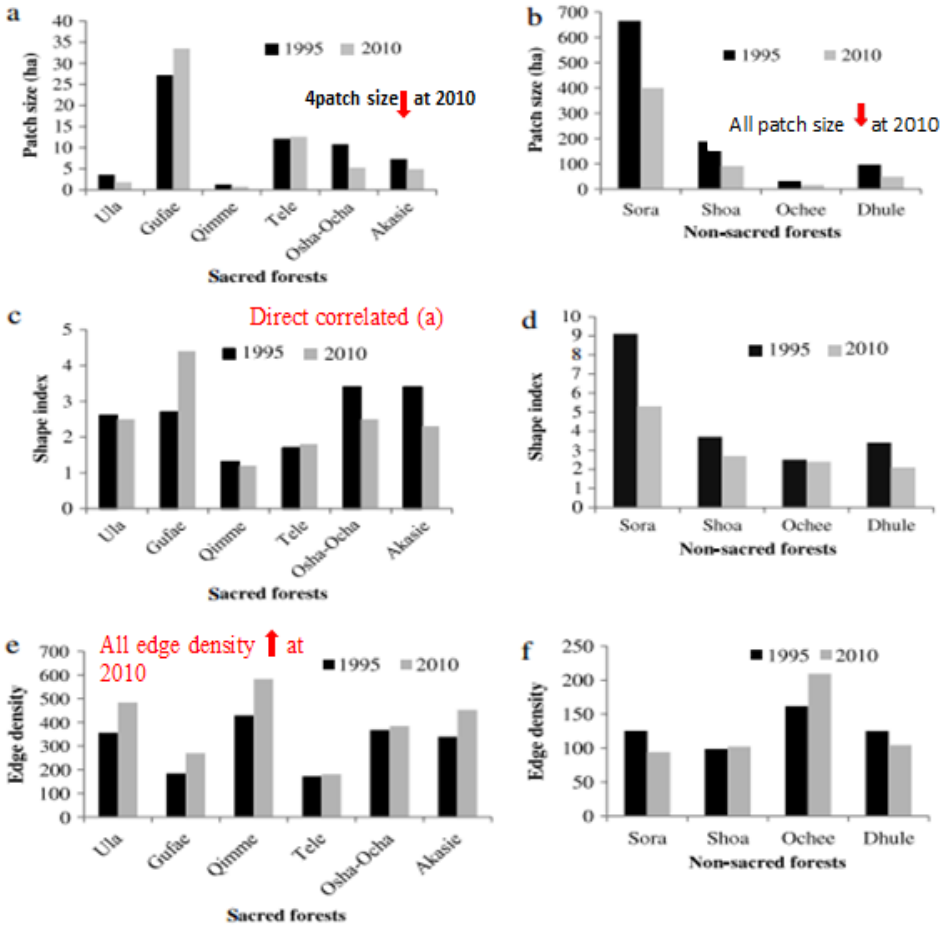

Figure 7: Patch size (ha) (a and b), shape index (c and d) and edge density (e and f) of six sacred forests and four non-sacred forest patches in the Gamo Highlands of Ethiopia in 1995 and 2010.(Desalegn and John, 2015)

CONCLUSIONS AND RECOMMENDATION

Sacredness is playing an uncountable role in conserving biodiversity resource particular plant biodiversity and ecosystem service.

Sacred and church forests are the remained patchy forest. Religious institution (EOTC) and traditional norms are the main central point for why these forests conservation. Generally, both are unevenly distributed all over parts of the country. For instance, EOTC is highly dominant in the Highland (North) part of the country while sacred forest relatively in Southwestern part. This may have a direct relationship with the religious beginning and communities' outlook. Mostly, the place and all available resources particularly plant biodiversity are highly respected by the community because they account as God's commandment and a convent for EOTC and memorabilia for culturati. They are not only using for sanctuaries specially for native tree species due to this in future the most indigenous not completely loss. Besides, it has multiple benefits such as ecosystem, social-cultural, economic, and combating climate change besides spiritual and religiousness. As a result, the livelihoods of the some farmers are not vulnerable to risks. Furthermore, it support in alleviating poverty through providing fruit and seeds for food and income. However, today, due to complex factors relatively some forests (Scared and church) have been deteriorating in a different area. Therefore, sacred groove (church and sacred) forest should be highly conserved by the affiliate as well as by other stakeholders particularly the government put a target for such forest conservation.

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