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Forest Cover Change in Ethiopia: Extent, Driving Factors, Environmental Implication and Management Strategies, Systematic Review

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Abstract
Ethiopia has the largest forest land resource in the horn of Africa with a total of 12.5 million hectares (ha).The livelihoods of most the peoples in the country are highly interlinked directly or indirectly with forest resources. It plays enormous environmental, socio-economic significance and thereby contributes a great role in the sustainable development of the country as well. However, most of the forest resources of Ethiopia are highly exposed to degradation at an alarming rate. A century ago, forests covered about 40 % of the total landmass of the country. The spatial pattern of the forest has been shown a rapid decrement from 40% in 1900 to 16% in 1954, 8% in 1961, 4% in 1975, 3.2% in 1980 and now it is estimated to be less than 3%. The spatiotemporal forest cover change in Ethiopia has been attributed to natural and more importantly manmade factors. The major drivers of forest cover decline can be grouped as proximate driving factors and underlying driving factors in Ethiopia. Proximate driving factors of include; expansion of resettlement, expansion of agricultural practices and charcoal burning and cutting trees for fuel whereas, underlying driving factors include; economic, institutional, technological, cultural, demographic and biophysical factors. The alarming rates of forest degradation have been posing environmental, social and economic problems. The environmental implications of forest degradation are climate change, siltation of water bodies, and degradation of wetlands, soil erosion, and reduction in agricultural production. Therefore so as to reverse the current situation of forest degradation and maintain ecological balance, there has to be an inclusive responsibility by all levels of communities. The governmental and non-governmental organizations, farmers as well as the private sectors should play their own role in protecting the forest resources.
Keywords: forest cover decline, driving factors, management strategies
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1. Introduction

The livelihood, as well as the living of we human beings, are highly dependent on forest and forest derived resources. Forests are important sources of livelihood to millions of people and contribute to the national economic development of the many countries in the world (Othow *et al*. 2017). Forests are an important role in maintaining environmental productivity; they provide food for animals, serves as a standing cover to protect the land from wind and water erosion, stabilize the water cycle, ensure the functioning of the ecosystem, facilitates the process of evaporation and keeps the soil porous (Ghebrekristos 1984; Selassie 1998; Teketay 2001; Kelbessa and Girma 2011; Eshetu 2014). Forests are also used for construction as well as for tools, furniture, fuel, medicine, grass, and herbage, for forage and provide edible fruits (Langat et al. 2016). Forest store a greater amount of carbon dioxide to reduce global warming, give off oxygen and renewing the atmosphere (Balitta *et al*. 2017). Furthermore, forest serves as a source of income by attracting visitors, serving as recreational facilities; preventing the silting of lakes and dams; cleaning, regulating and distributing water resources (Othow *et al*. 2017).

However the large areas of the world's forests have degraded, and the problem continues unabated. Approximately 13 million hectares (ha) of forest were converted to other uses or lost through natural causes each year between 2000 and 2010 compared to 16 million ha per year in the 1990s (FAO 2010) though marked variations are observed across regions. The world forest has been decreasing from time to time as a result of the increasing human population and it has been occurring worldwide in many centuries.

In addition, deforestation and forest degradation are causing a significant reduction in the provisioning of valuable ecosystem goods and services from forests particularly in developing countries (Duguma *et al*. 2019; Lawson *et al*. 2014). The rate of deforestation has increased extremely in developing countries including Africa in the last 50 to 100 years (Othow *et al*. 2017). Furthermore, deforestation is to cause environmental degradation, which involves land degradation, water resources depletion and loss of biodiversity; still today there is a fast removal of those forests that are aged, non-replicable indigenous tree species which have different economic, cultural, ecological, medical and other purposes. Most importantly the loss of forest area is resulting in habitat disturbance, land degradation which declines soil productivity and water availability from time to time (Danano *et al*. 2018).

In Africa, forests cover about 21.4% of the land area which corresponds to 674 million hectares where Eastern

Africa alone covers approximately (13%) of the land area under the forests and woodlands based upon the FAO report (Frimpong 2011). Yet Africa accounted for a net loss of 4.0 million hectares per year, which equals about the size of Belgium and is equivalent to 0.3% of the entire African forest cover (Rademaekers *et al.* 2010).

Ethiopia has one of the largest forest resources in the horn of Africa. It owns a total of 53.1 million ha covered by woody vegetation which consists of 12.5 million ha of forest land and 40.6 million ha of another woodland (FAO 2015). However, most of the forest resources of Ethiopia are highly exposed to degradation (Demel 2001). The result of some studies demonstrates that approximately 40% of the country's land area was covered with dense forests (EFAP 1994). The forest cover of Ethiopia has been shown a rapid decrement from 40% in 1900 to 16% in 1954, 8% in 1961, 4% in 1975, 3.2% in 1980 and now it is estimated to be less than 3% (Amogne 2014). The FAO estimated a decline of forest cover from 15.11 million ha in between 1990-2000 with the annual decreasing rate (-140900 ha); 13 million ha in between 2005-2010 with the annual decreasing rate (-141000 ha) and 12.5 million ha in 2015 (FAO 2010; FAO 2015). In the same manner, most scholars agreed that rate of deforestation is extremely high due to several factor which estimated the annual rate of forestland decline is 104,600 ha per year that is 0.8% of forest cover of the country (Ferede 1984; Gebremarkos 1998; EPAE 2002; FAO 2010; Gebrehiwot *et al*. 2014; Zewdu & Beyene 2018).

If the declining trend of forest in Ethiopia does not stop, the country will soon lose one of the most sophisticated forests with unique genetic diversity. However, the rate and extent of forest cover change and their drivers remain unclear. In addition, while the participatory management approach is said to be in place in this forest, the understanding of the local community regarding forest cover change, its drivers and possible solutions was scanty. Therefore, it is crucial to assess and monitor the status of forest cover change and the drivers of the change to inform coherent and sustainable forest conservation strategies. These strategies will require the inclusion of the local community's knowledge and perception for the design of effective and locally-relevant measures (Solomon *et al*. 2018).

2. Objectives of the Review

The objectives of this paper are to review; forest resources in Ethiopia, the extent of forest change in Ethiopia, driving factors of forest change, environmental implication of forest cover change and management strategies of forest in Ethiopia.

3. Methodology

In order to attain the objectives, data collection in the systematic review article is carried out document analysis through a depth review of related literature from different sources. Furthermore, in this article data were obtained from the review of related literature on the Web of Published articles, researches, books, reports from government and non-government organizations.

4. Literature Review

4.1 Forest Resource in Ethiopia

In Ethiopia, the forest is defined as land occupied with trees (natural and planted, including bamboo) attaining a height of more than 2 meters at maturity, a canopy cover of more than 20% and covering an area of more than 0.5 ha, with a minimum width of 20 meters (MEFCC 2018). This forest definition differs from the definition used for international reporting to the Global Forest Resources Assessment (FAO) and from the forest definition used in the National Forest Inventory which both applied the FAO (2015) forest definition with the thresholds of 10% canopy cover, a 0.5 ha area, and a 5 m height. The reason for Ethiopia to change its national forest definition is to better capture dry and lowland-moist vegetation resources. In specific, the reason for lowering the tree height from 5 to 2 m is to capture Termilania-Combretum dense woodlands found in Gambella and Benishangul Gumuz Regional States which in its primary state consists of trees reaching a height of around 2-3 m and above (MEFCC 2016).

Ethiopia's forest resources are diverse and comprises vegetation types that range from tropical rain and cloud forests in the southwest and south through dry forests of various complexity in the north, west, south, and central mountains and lowlands to the desert scrubs in the east and northeast and parkland agroforestry on the central plateau (Lemenih & Woldemariam 2010).

Forests have been classified by a number of authors. Prominent among these are Logan (1946), Chaffey (1979), Workie & Debella (2018). In this paper mainly we described the forest resource classification in Ethiopia based on their eco-regions by Workie and Debella (2018).

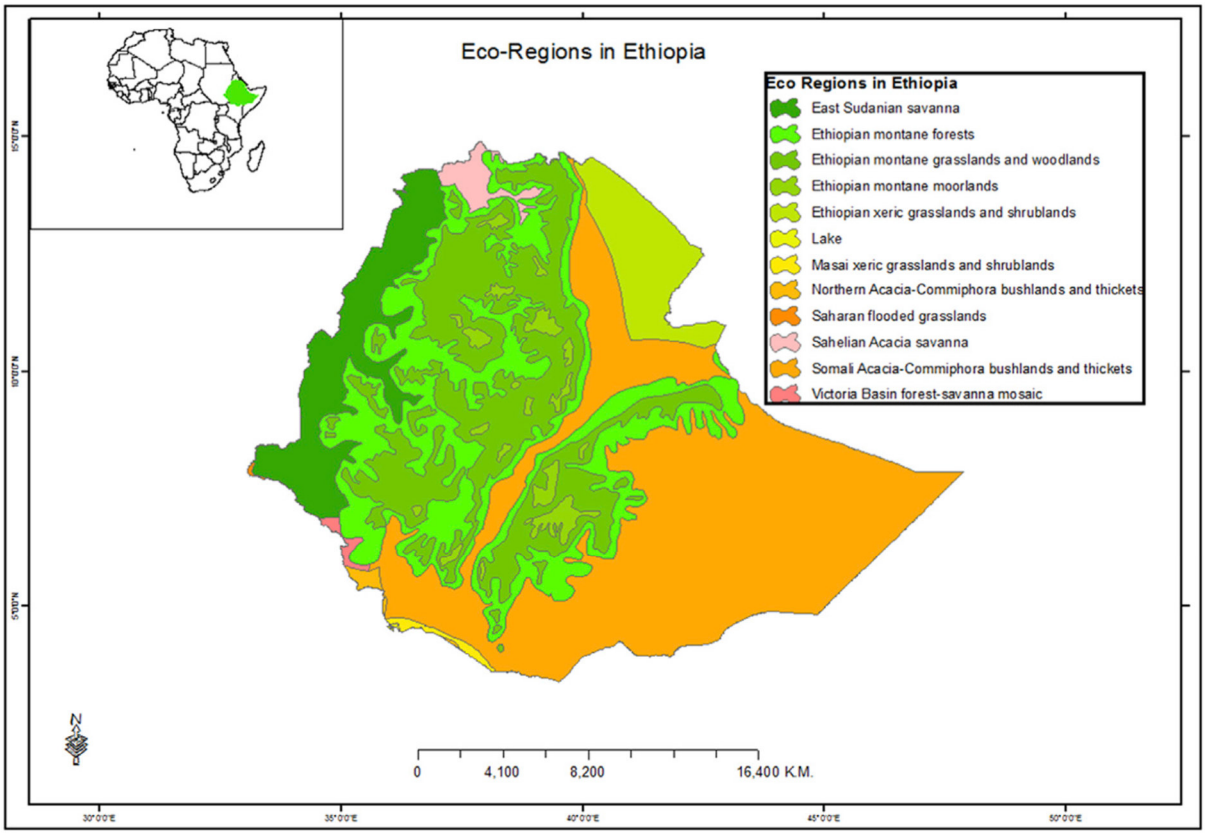

Figure:1 Map of Ethiopia showing the location of eco-regions and forest resources in Ethiopia
Source: Workie & Debella (2018)

Ethiopian Montane Grassland and woodland forest

This is a biologically rich and severely threatened ecoregion that covers the majority of two Ethiopian mountain massifs (Eastern and Western), separated by a part of the African Great Rift Valley. This ecoregion ranges from 1,800 m to 3,000 m in elevation, with the montane forest at lower altitudes and Afro-alpine habitat higher up (Word wildlife 2020)

Ethiopia Moist Montane Forest

Ethiopian moist montane forests occur within a wide range of annual and seasonal rainfall patterns, from 700-2,500 mm/year; with a mean annual temperature range of 15 to 20°C. They are found wherever the rainfall intensity and frequency are abundant within a mountain slope. They typically form a belt of vegetation over an altitudinal range between (1,000~1,200 and 2,600 m in the southwest of the NW and SE highlands of Ethiopia (Kelbessa & Girma 2011). The segment of this moist montane forest has long been recognized as the center of origin and diversity of wild Coffea arabica (Meyer 1965; Tesfaye 2006). Like other forests, these forest fragments are under continuous threat due to the expansion of agriculture and commercial plantations (e.g. tea, coffee) and also to modifications of the forest coffee due to the management of wild coffee (Senbeta *et al*. 2007).

East sudanian savanna (ESS)

The East Sudanian Savanna is a hot, dry, wooded savanna composed mainly of Combretum and Terminalia shrub and tree species and tall elephant grass (Pennisetum purpureum). The habitat has been adversely affected by agricultural activities, fire, clearance for wood, grazing by livestock and charcoal, but large blocks of relatively intact habitat remain even outside protected areas (World Wildlife. 2020) .

Topographically, the ecoregion is flat, mainly lying between 200 m and 1,000 m in altitude, although elevation rises slightly in western Ethiopia and around Lake Albert. The climate is tropical and strongly seasonal. Mean monthly maximum temperatures range from 30° to 33°C and mean minimum temperatures are between 18°C and 21°C. The annual rainfall is as high as 1,000 mm in the south, but declines to the north with only 600 mm found on the border with the Sahelian Acacia Savanna (World Wildlife. 2020)

Somali Acacia-Commiphora bushlands and thickets

The majority of east Africa is covered by this type of Ecoregion. Specifically, the Ecoregion occupies the rift valley region of Ethiopian and the Ogaden Desert. The topography is flat and low lying, most of the area below 500 m.a.sl. The mean monthly temperature ranges from 15℃ to 30 ℃, while the rainfall fluctuates between 100mm in the Ogaden Desert to 600mm in areas bordering the Ethiopian highlands. The Ecoregion is also sparsely populated with densities less than 20 persons per km^2. The common tree species are Acacia and Commiphora and

characterized by ancient and stable habitat. High numbers of arid-adapted endemic species are found in this Ecoregion (Workie and Debella 2018).

Ethiopian montane moorlands

The Ethiopian Montane Moorlands ecoregion covers the higher parts of the Ethiopian Highlands Massif, from around 3,000 m to higher than 4,500 m. Below 3,500 m the ecoregion would have formerly graded into montane forests and grasslands. However, most of these areas are now farmed or used for grazing. While the Ethiopian Montane Moorlands ecoregion makes up only 2% of the total land area in Ethiopia, it contains 80% of land above 3000 m in the Afrotropical realm. The vegetation, known as wurch to Ethiopians, consists of grassland and moorland with abundant herbs. Most plant species (many of which are endemic) show adaptations to the extreme conditions found at high altitudes (Word wildlife 2020).

Table 1: Areal coverage of Ecoregions in Ethiopia.

Sn	Eco-Regions	Area (Ha)	Area (%)
1	East Sudanian savanna (ESS)	9,848,320.00	8.71
2	Ethiopian montane forests(EMF)	22,734,100.00	20.11
3	Ethiopian montane grasslands and woodlands(EMGW)	23,653,000.00	20.93
4	Ethiopian montane moorlands(EMM)	2,503,410.00	2.21
5	Ethiopian xeric grasslands and shrublands(EXGS)	6,252,440.00	5.53
6	Lake	25,061.80	0.02
7	Masai xeric grasslands and shrublands(MXGS)	417,411.00	0.37
8	Northern Acacia-Commiphora bushlands and thickets(NACBT)	352,321.00	0.31
9	Saharan flooded grasslands(SFG)	44,352.10	0.04
10	Sahelian Acacia savanna(SAS)	1,317,400.00	1.17
11	Somali Acacia-Commiphora bushlands and thickets(SACBT)	45,543,400.00	40.29
12	Victoria Basin forest-savanna mosaic(VBFSM)	344,961.00	0.31
	Total	113,036,176.90	100.00

Source: Workie & Debella (2018)

4.2 Extent of Forest Cover Change in Ethiopia

The extent of forest cover change in Ethiopia is closely linked to the ongoing population growth. More people generally lead to increasing demand for land for living and for agricultural production For instance, the south-western part of the Ethiopian Highlands had still been completely covered by montane rainforests. Shifting cultivation, which had been practiced for centuries within the area had not been really a threat for the forest resources. The situation changed with new settlers migrating from the central and northern parts of the country to SW Ethiopia. With the new settlers, a new farming system was introduced that was not adapted to the environmental conditions in the area (Reusing 2000).

In the mid-1960s, following the promulgation of a series of forest legislation, another round of extensive deforestation took place, this time despite the efforts of the government to put a stop to it. The legislation placed all large forests cover under state ownership, and put severe restrictions on the use and management of private forests. To most people, the new law was yet another example of the state extending its tentacles over all natural resources and denying individuals rights of access to them (Rahmato 2001). Another scenario during the imperial regime regarding forest resource was the expansion of large-scale, commercial agriculture, which was actively encouraged by the state, at the expense of the forests with an objective of increasing agricultural production (Eshetu 2014).

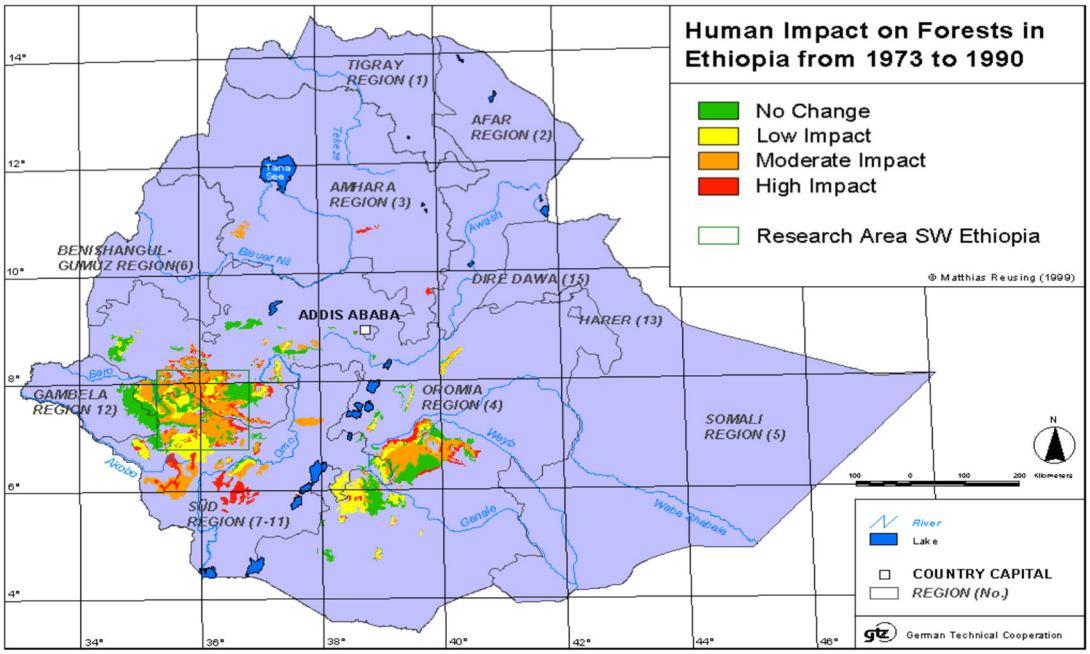

Figure: 2: Forest cover change of Ethiopia from 1973-1990
Source: (Reusing 2000)

The study made by Reusing (1998) reported that the satellite images of 1973 to 1976 indicate that during that time period around 4.75 % of the country was covered by forests. About 20 to 25 years ago. More than 50 % of the forests were still undisturbed, whereas the remaining part was already slightly to heavily disturbed. After applying the above-mentioned correction factors, the Adjusted forest area adds up to just around 3 % total forest cover in Ethiopia.

Furthermore, the satellite images of 1986 – 1990 indicated that, around 10 to 15 years later, less than 3.93 % of the countries area, respectively 45055 km2 of forest stands were remaining (adjusted Forest area: -1.4 %). More alarming than these figures are the relations within the density classes. The area of the degraded classes, slightly disturbed forest and heavily disturbed forest expanded significantly on the cost of the closed high forests, which diminished from 2.64 to 0.20 %. This means that at the end of the eighties, closed high forests did not even cover the area of Lake Tana, the biggest lake of Ethiopia, anymore (Reusing 1998).

Table 2: Forest Cover change of Ethiopia 1973-1990

	1973-1976		**1986 – 1990**	
Forest Class	Area (km^2)	Area (%)	Area (km^2)	Area (%)
Closed High Forest	30,243	2.64	2,346	0.20
Slightly Disturbed High Forest	14,158	1.24	7,466	0.65
Heavily Disturbed High Forest	10,009	0.87	35,243	3.08
Total	54,410	4.75	45,055	3.93

Source: (Reusing 1998).

Massive destruction of forest resources during the transition period in Ethiopia (the early 1990s). Because, State forestry posed a threat to peasant livelihoods; it encroached on farmland, evicted house-holds living in and near it, and took away land that was customarily used for grazing. Many of the forests in question were enlarged by expropriating farmland and pasture (Eshetu 2014).

Also the primary results from the accuracy assessment are adjusted area estimates calculated by combining sample and map area estimates and their associated confidence intervals. The adjusted area estimate for forest loss is 1.1 million ha +/- 0.91 million ha and for the forest, the gain is 0.4 million ha +/- over the period 2000-2013 which corresponds to an annual forest loss of approximately 70,000 ha/yr and annual forest gain of approximately 30,000 ha/yr. This estimate is used as the activity data. The relatively high annual forest area gain in the Dry Afromontane biome gives some evidence that Ethiopia is already implementing several mitigating actions that aim to restore forest resources (MEFCC 2016).

5. Driving Factors of Forest Cover Change in Ethiopia

5.1 Direct/Proximate Driving Factors

expanding agricultural activities (burning and removing of the tree, and overgrazing), fuelwood and charcoal, and resettlement expansion program leads to deforestation and forest degradation (Walle *et al*. 2011; Oljirra 2019).

The main direct drivers of deforestation are generally agreed to be logging and the expansion of agriculture and infrastructure. Demand for wood fuels drives much of Ethiopia's forest degradation. Though the role of firewood in forest degradation is somewhat contested, charcoal dominates cooking energy choices in urban areas and uncontrolled fires, livestock grazing in forests are widely recognized to contribute to forest degradation (Zerga & Gebeyehu 2016).

Agricultural practices: Ethiopia's forests are increasingly under threat as the growing population requires more fuelwood and agricultural products, which leads to farmland expansion including commercial farms (MEFCC 2017). For instance, the large-scale investment agricultural schemes both private ones and state-owned ones - have been significant drivers in Gambella, Benishangul-Gumuz and Afar regional states (MEFCC 2016). The main drivers associated with agricultural expansion are: firewood consumption and pasture land expansion declines forest land (Danano *et al*. 2018).

Fuelwood and charcoal: The major drivers are rising demand for forest products like fuelwood, and charcoal. For example: in Ethiopian, Somali and Afar regional States charcoal is produced by almost all rural households as one of the core livelihood income sources (MEFCC 2016). According to FAO (2015), Ethiopia harvested more than 76 million m^3 of wood for fuel in 1993, and 101.1 million m3 in 2011, the most of any country. the country consumes over 100 million m^3 fuelwood each year, and in 2013 alone consumption was 124 million m^3 wood products (MEFCC 2017).

Resettlement expansion: Most of the resettlement programs recently have been undertaken in Bench-Maji, Kaffa, Dawuro, Sheka, South Omo zones and Basketo special district as well as in the western lowlands of Tigray and Amhara regional states throughout the year. In Southern Nations Nationalities and Peoples Regional State (SNNPRS) and Oromia National Regional State (ONRS), the resettlement sites were covered either with dense forests or wooded grassland prior to the implementation of the resettlement. In Amhara and Tigray regions, the woodland coverage reduced by 25.76% between 2000 and 2007 due to resettlement programs. Most of the woodland has been replaced by arable land for the cultivation of cash and food crops (Moti *et al*. 2011; Eshetu 2014).

5.2 Indirect/Underlying Driving Factors

Underlying driving factors of forest cover change in Ethiopia includes economic factors (challenges to forest management and investment), institutional factors (poor governance, and land tenure system), technological factor, cultural factors (ecoculture transformation) demographic factors (rapid population growth with high rate of natural increase), biophysical factors including slope of land, climate variability, and droughts (Moges *et al*. 2010; Kaimowitz 2012). In the same manner, more than 50 percent of the tree cover has disappeared due to indirect factors (Kaimowitz 2012).

Economic factors

Challenges of forest investment and management: Formally recognized private foreign investment in Ethiopia's forestry sector described here as activities involving forestation, reforestation, and market creations of non-timber forest products are currently limited. Of the handful of foreigners who made inquiries about investment opportunities to a government forestry official over the past few years, only one was moving forward with developing a business plan and securing appropriate permissions. Concerns about feasibility, human resources, the security of long-term lease arrangements and perceptions of political instability are commonly raised by foreign investors (Guillozet *et al*. 2011). The lack of investment is rooted in ecological and socio-economic challenges outlined below.

Table 3: Challenges of forest investment and management

Ecological	Socio-economic
Lack of knowledge & probable high expense of native tree propagation & establishment	Lack of economic diversification
Lack of clear guidelines for native vs. exotic replanting obligations	Lack of funding for forest management
Increased pressures on forest from land degradation, shrinking farm size & reduced grazing land	Human resettlement driving land conversion and new land use practices
Forest fragmentation	Ethnic tension and currency inflation

Source: (Guillozet *et al.* 2011)

Institutional factors:

It is underlying driving factors of forest cover change in Ethiopia which includes: competing for jurisdictional authority over activities affecting forests, weak enforcement capacity, political inferiority of forestry to agriculture, inexperience in enforcing reforestation regulations, unclear tenure arrangements and boundaries, and unclear reporting requirements (Guillozet *et al*. 2011). Accordingly, from the mid-1970s onwards, persisting community-initiated and newly established state-initiated forest property rights systems drifted apart and created a situation of legal pluralism. The former community-initiated continued to execute their forest resource-management activities

on the basis of "their" forest land property rights, rather than within the scope of the newly established institutional framework under the higher-level state bodies (Stellmacher 2013)

Land tenure system and weak policy: Land privatization is a topic of considerable dispute in Ethiopia The government owns all forest and agricultural land, granting usufruct rights to citizens in the case of farmland and maintaining all management authority in the case of forestlands (Guillozet *et al*. 2011). Uncertain land tenure system leading to low people investment, including lack of ownership, triggers illegal logging and the so-called tragedy of commons (Assefa & Bork 2014) Likewise, weak policy implementation on land use, low capacity of forest institutions, land use conflict and policy discrepancy are aggravating forest cover loss in Ethiopia (Moges *et al*. 2010). Furthermore, most of the policies and proclamations relevant to the dry land forest resources lack accountable and stable institutions to see their implementation on the ground. Most do not have detailed implementation guidelines either. Thus, their implementation and subsequent revision aspects leave much to be desired. Inter-sectoral policy integrations are also very weak, in some cases, with contradicting or conflicting contents, e.g. conservation and investment (Kelbessa & Girma, 2011).

In addition, the incentives that are stipulated by the forest policy are not implemented in Ethiopia to the required level and thus, most forest users are unaware of them. The revision of the forest proclamation is almost finalized, and the draft forest proclamation takes into account the current changes in the institutional set up at the federal level and capitalizes emerging opportunities such as climate benefits of forests (MEFCC 2018).

Technological factors:

Wood product demand is growing fast in Ethiopia due to population growth. The construction sector boom, growth in urbanization and urban population, and growing middle class is driving rapid growth in demand for wood and other forest products (FSR 2015; MEFCC 2017). Likewise, the cutting down of trees for lumber that is used for building materials, furniture, and paper products have a major impact on forest cover in Ethiopia. Forest logging legal or illegal leads to deforestation. Ethiopia loses about 141,000 hectares of natural forests each year due to firewood collection, conservation of farmland, overgrazing and use of wood for building material (Oljirra 2019).

Cultural factors:

Ecoculture transformation: Empirical research made by Regassa *et al*. (2017) in the Gedeo zone, Southern part of Ethiopia described that the Gedeo experienced extensive ecocultural transformations after they became part of greater Ethiopia in the early twentieth century. Also, their study argued, the Gedeo youth, engaged in cutting trees for firewood, charcoal, and construction materials, and the truck drivers, loading the resulting lumber to sell in nearby towns. On the other hand, a bit further into the hinterlands from the main road, are the elders who continue their sacred beliefs and practices of agroforestry, which protect trees from being cut down, harbor diverse aspects of the ecosystem, and sustain a long-standing coexistence. Whereas Gedeo elders are worried about the decline of indigenous knowledge and the rise of environmental degradation, the youth and government authorities interpret human-environment relations differently.

Demographic factors:

One of the most frequently cited underlying causes of forest decline is population pressure. That more population should translate into more deforestation and thus higher pressures to degrade forests makes intuitive sense. With an increased population, there would be more families in search of land for agriculture or looking for fuelwood or timber (Contreras-Hermosilla 2000). In addition, demographic characteristics mainly population density and rate of natural increase are indirect factors for forest cover conversion through the growing needs for additional lands for farming and grazing as well as demands for tree products (Gessesse & Bewket 2014). Furthermore, expanding population resulting in actual human and animal populations exceeding the carrying capacity of the land also has a great impact on forest resources (Danano *et al*. 2018).

Biophysical factors

Climatic factors such as insufficient and variable rainfall, unpredictable variation in rainfall patterns within and between seasons, the occurrence of intermittent but serious drought periods that affect forest cover, and biological factors including diseases and pests (Kelbessa & Girma 2011). The temporal climatic changes and variability have also affected the phenology of vegetation cover in all Eco-regions of Ethiopia. For example, greenness onset shifted to earlier periods and the growing period lengthened in most eco-regions. The shift is triggered by the shift in the rainfall and temperature pattern but temperature relates inversely to vegetation greenness and cover (Workie & Debella 2018). In addition, deforestation is negatively related to slope, elevation, and distance to roads, forest edge and aspects (Danano *et al.* 2018).

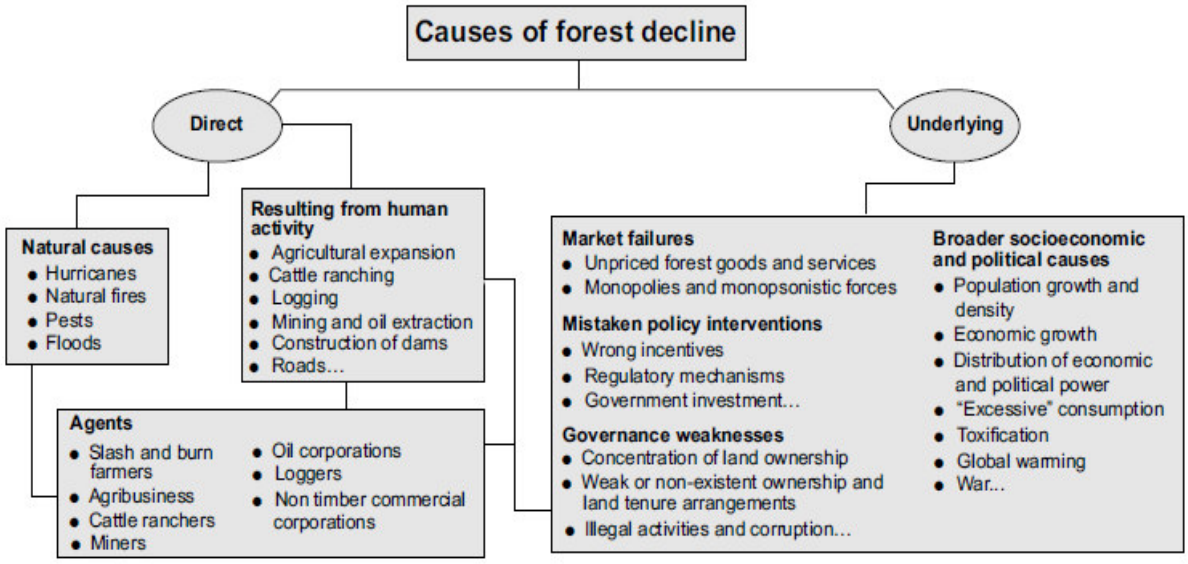

Figure 2: Forest cover change drivers: Source: (Contreras-Hermosilla 2000)

Environmental implications of forest cover change in Ethiopia

Forest cover decline is a major challenge in developing countries where agriculture plays a leading role in the survival of the wider community. Due to the heavy reliance on agriculture, the effect of forest decline has been a chronic challenge in Ethiopia where most of the landscape remains barren as a result of past deforestation (Belayneh *et al.* 2018). The depletion of forest resources and the subsequent negative environmental effects are difficult to quantify in monetary value although resource depletion illustrates numerous observable environmental impacts in the study area. The depletion of forests also exposed the land to severe soil erosion and degradation, which in turn, increases the sediment load in water resources, reduces land productivity, decreases forest products, negatively affects biodiversity and changes the microclimate. These will have tremendous socio-economic impacts on the communities. For example out-migration, disguised unemployment, prolonged hunger, increased restoration costs of the degraded environment, and food insecurity (Belayneh *et al.* 2018).

According to Gebre Egziabher (1986); Nigatu (1987); EFAP (1994); Bishaw (2001); Teketay (2004); Yemshaw *et al*. (2009); Tadesse *et al*. (2011), widespread forest resource depletion in Ethiopia has led to soil erosion and decline in soil fertility, loss of or decline in biodiversity, shortage of timber and non-timber forest products, reduction in agricultural production and productivity, recurrent drought and famine, flooding, scarcity of water, loss or degradation of wetlands, siltation of water bodies, desertification, climate change, and poverty. Forest depletion is among the root cause of human-driven climate change with the emission of increased concentrations of greenhouse gases (GHGs) particularly Carbon dioxide (CO_2). The world's climates (e.g., microclimate) and forests are intimately interlinked (Roland 2011). One of the consequences of forest cover decline is that the carbon originally held in forests is released to the atmosphere, either immediately if the trees are burned, or more slowly as un-burned organic matter decays (Archana 2013).

Deforestation and overgrazing in the watersheds, compounded with poor agricultural practices, have led to reduced infiltration of rainwater and increased runoff and sedimentation of water bodies (especially lakes and dams), thereby reducing the quantity and quality of water for domestic and industrial uses to enhances siltation and sedimentation. For instance, hydroelectric power dams such as Tekeze Dam and Gilgel Ghibe I Dam are also facing the problem of siltation due to deforestation and soil erosion in the catchment areas (Zegeye 2017). In addition, many wetlands are facing serious environmental problems due to deleterious anthropogenic activities in the catchment areas. Clearing of forests, construction of irrigation and drainage systems, the building of factories and the use of fertilizers and pesticides, all contribute towards the damage of these indispensable but fragile systems (Woldu 2003). Furthermore, continuous cultivation is causing more and more soil erosion and nutrient loss. Indeed, soil loss is greatest on cultivated lands compared to that on pastures and forests (Lemenih 2004).

6. Forest Resource Management Strategies in Ethiopia

In order to increase the forest cover of Ethiopia, the policy was introduced in April 2007 by Council of Ministers with the aim of increasing forest cover and its significance to the national economy, food security and sustainable development of the nation. The overall objective of the policy is to conserve and develop forest resources properly so that there could be a sustainable supply of forest products to society and contribute to the development of the national economy (Sisay 2008).

To achieve the intended aim of the strategy the government has undertaken the following specific objectives;

policy statements about encouraging public and private sectors to participate in forest development; improving the productivity of forests; replicating and distributing suitable tree species. The overall objective of the policy is "to conserve and develop forest resources properly so that there could be a sustainable supply of forest products to the society (hence satisfying the demand) and contribute to the development of the national economy." As stated in forest development, conservation and utilization Proclamation No. 542/2007 (FDRE 2007), in order to properly conserve, develop and utilize the forest resources of the country, major forestlands should be designated as state forests, their boundaries should be demarcated with the participation of the local community and they should be registered as protected and productive forests (article 8:1); forests shall be protected from forest fire, unauthorized settlement, deforestation, undertaking of mining activities and other similar dangers (article 9:7) (Eshetu 2014).
According to Solomon *et al*. (2018), various efforts have been made at several levels to maintain and increase the forest cover. Among the main activities that have been implemented were the establishment of enclosures, formulation of bylaws, enrichment plantation and soil and water conservation structures. enclosures' are areas closed from human and animal interference to promote natural regeneration of plants on formerly degraded communal grazing lands.

Table 4: Possible solutions to maintain forest cover as perceived by respondents.

S/n	Possible Solutions	Number of Respondents	Percentage
1	Strengthening of forest protection	78	52
2	Improving soil & water conservation activities	58	38.6
3	Awareness creation	55	36.6
4	Enrichment planting	53	35.3
5	Compensation	46	30.6
6	Zero grazing	22	14.6

Source: (Solomon *et al.,* 2018)

In fact, the current government has been initiated by different approaches and strategies on forest resource management and utilization. Even though there is no specific provision concerning to increase forest covers in the constitution, some of the existing policies and laws (rural land, environmental, energy, investment, wildlife and etc.) indirectly contribute forest cover increase in Ethiopia (Chimdesa 2017). According to Kelbessa & Girma (2011), the sustainability of forest resource management depends on the balance between private and public interests and the use and benefits these resources provide for both present and future generations.

In addition to this, Bekele & Leykun (2001) have been identified in situ forest conservation system in the country. These are participatory forest management (PFM), area exclosures, church, and sacred forests, traditional community-based forest management, and home garden agroforestry system.

Participatory forest management (PFM): PFM in Ethiopia has been started 10 years ago. At present, over 640,857 ha of forest land in the country is being managed under PFM. These pilot PFM projects have attempted to promote among others: sustainable utilization of the forest resources for livelihood diversification such as non-timber forest products like forest coffee, honey, spices, and others, employment opportunity and income generation through the establishment and promotion of Bamboo product based micro-enterprises.

Area exclosures: In several degraded lands across the country, area exclosure has been launched. In the Tigray (one million hectares), Oromia (916,766 ha), Amhara and SNNP Regions have been closed so far and effective results have been achieved through the restoration and rehabilitation of the vegetation.

Church and sacred forests: Accordingly, significant forest patches are conserved and managed in and around churches, monasteries, graveyards, mosque compounds and other sacred sites in several parts of Ethiopia. For instance, it was reported that 28 Orthodox churches in northern Ethiopia cover a total of 500.8 hectares of remnant forests. There are 35,000 similar churches throughout Ethiopia that are likely to contribute to the conservation of considerable remnant dry forests. Similarly, sacred forests are found mainly in south west Ethiopia in Kefa, Masha and Sheka forests.

Traditional Community Based Forest Management (TCBFM): This system also involve communal efforts such as forests and woodlands managed by the Borana people with the Geda institution and the management of Afromontane forests in the southwest for non-timber forest product extraction by the Kobo system. Other forest areas that are smaller in extent are privately managed through various forms of traditional forest management such as the Gedeo and Sidama agroforestry system.

Home garden agroforestry system: Home gardens are among the traditional agroforestry systems practiced in Ethiopia. They are habitats for different indigenous and exotic tree/shrub species, where the upper story is dominated by multipurpose tree/shrub species and the understory is dominated by enset, coffee, fruit trees, medicinal plants, and other food and cash crops. To date, there is no comprehensive information on the extent of home gardens in Ethiopia. However, reports indicate that about 576,000 ha of land in the dry areas of South and Southwest Ethiopia are managed as home gardens and other forms of traditional agroforestry systems. A considerable number of species are managed in most of the home gardens.

According to Bishaw (2001), to overcome driving factors of forest cover change in Ethiopia including

deforestation and forest degradation to manage forest on a sustainable basis and to ensure healthy ecosystems, forest resource management are proposed. These are implementation of agroforestry and social forestry in the rural areas where subsistence farming is practiced; expansion of plantation forestry both industrial and non-industrial on currently uncultivated and sloping lands; conservation of the remaining natural forests to conserve species and biodiversity; to revise social, economic and investment policies of the country and training and research capacity building and reinforcement.

7. Conclusion

Forest cover decline is the major form of land degradation in Ethiopia which poses severe socio-economic and environmental consequences. The problem is triggered by anthropogenic factors which can be classified as proximate driving factors and underlying driving factors. Proximate driving factors of deforestation include; expansion of resettlement, expansion of agricultural practices and charcoal burning and cutting trees for fuel whereas underlying driving factors of deforestation include; economic, institutional, technological, cultural, demographic and biophysical factors. Lose of forest affects climate as they are important absorbers of greenhouse gases like carbon dioxide (CO_2) thereby preventing the rise in global average surface temperatures. Indiscriminate cutting of forest in Ethiopia also causes sedimentation of water bodies, exposure of soil to water and wind erosion and degradation of the important function of wetland ecosystems. Unless the declining trend of forest cover in Ethiopia brings to an end, the country will lose immense environmental and socio-economic values and the sustainable development of the country will be influenced at large. Thus, in order to maintain the natural potential of the forest ecosystems and derive benefits for present and future generations greater efforts are highly required from all stakeholders through applying the very important biodiversity conservation approaches (protection, sustainable forest management & rehabilitation).

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