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Guidelines on sustainable forest management in drylands of Ethiopia

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Traditional beehives in the drylands of Ethiopia

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Foreword

The Government of Ethiopia has made sustainable forest management a priority. This document supports the government's priorities by contributing to the sustainable management of dry forests. Approximately 80% of forests in Ethiopia are currently considered as dry forests. These forests are an integral part of Ethiopia's forest ecosystems, which range from moist alpine forests of the Bale highlands in central Ethiopia to the hot and dry woodlands in the Borana rangelands in southern Ethiopia. Most of the endemic wildlife in Ethiopia is found in dry forests and is part of a delicate balance of unique ecosystems.

There is strong political will in sustainably managing forests, including dry forests. The government has integrated forests in key national documents that guide policies, regulations, and actions in Ethiopia. They include Ethiopia's Climate Resilient Green Economy (CRGE) strategy, Growth and Transformation Plan 2 (GTP2), and the Nationally Determined Contributions (NDC) in mitigating and adapting to climate change submitted to the United Nations Framework Convention on Climate Change (UNFCCC). In 2013, The Ministry of Environment, Forestry and Climate Change (MEFCC) was established. A system for measuring, reporting, and verification (MRV) of emission reductions from forests is being established at the national and regional levels. In 2016, Ethiopia was the first African country to submit a Forest Reference Level to the UNFCCC. In Africa, Ethiopia is one of the leading countries in implementing actions to reduce emissions from deforestation and degradation (REDD+). In 2018, a new forest proclamation was enacted, which has paved the way for shifting from forest conservation and protection to sustainable forest utilization and management to benefit a wider range of stakeholders.

Despite these efforts, in the last 2 decades, dry forests are rapidly being replaced by other land uses, such as small and large-scale agriculture, and settlements. Lack of arable lands in the more moisture-rich highlands, high population growth rates, and high demand for export-oriented agricultural products have led to large-scale conversion of dry forests into croplands and settlements. Dry forest biomes are experiencing the highest rate of forest loss in Ethiopia.

At the national level, dry forests contribute seemingly little in terms of direct income to households and income from exports. Nevertheless, there are strong economic, social and environmental reasons to sustainably manage and protect dry forests that are not well understood by the decision makers and the public. There is a prevailing perception that dry forests contribute little to Ethiopia's economy in general. Forests in drylands are less 'green', sparsely vegetated, and less densely populated. Dry forest products are poorly marketed, seen as inferior goods, and contribute little in formal employment generation and the formal economy. This has led to the rapid conversion of forests into other land uses that are perceived to be more beneficial. Nevertheless, the goods and services provided by dry forests, and investments by local stakeholders in managing them have been poorly documented, monetized and understood compared to other land uses, such as agriculture. Forest benefits are realized through long periods of time, and many do not have clear market values.

Land use decisions need to take into account the value of dry forests in sustaining other economic activities, the cost of transportation in providing similar goods and services to far-flung communities, and the investments that communities and individuals have made

in managing and protecting dry forests. Dry forests are habitat to a number of animals, trees, shrubs, grasses and herbaceous plant that are important for rural communities. Biodiversity in dry forests has made Ethiopia one of the world's most biodiverse hotspots. Dry forests bring a wide range of products and environmental services that provide inputs to other parts of the economy and ensure the sustainable livelihoods of local communities. Ecosystem services include protection of water supplies, reduction of soil erosion, and provision of products such as fuelwood, charcoal, fodder, medicinal plants, bush meats, construction materials, and famine foods. The cost-effectiveness of managing fodder from dry forests during droughts in isolated regions has never been valued and compared with alternatives such as transporting market-bought fodder from outside the drought area. The state legally owns almost all forests in drylands. In many cases, these forests have open access resources managed or used ¬de facto by communities or individuals, many of whom invest time, money and labor in monitoring, protecting and managing dry forests without legal clarity on their rights over these forests. These investments have never been monetized and considered in decisions affecting land use.

This document provides information on the national context of dry forests and practical management guidelines adapted to the Ethiopian context. The goal is to fill the information gap, which can allow decision-makers to better understand the true value of dry forests at the national level and take appropriate action. Much of the literature on dry forests in Ethiopia is based on case studies in different parts of Ethiopia or focuses on particular commodities with economic importance. In this document, the authors have taken a national perspective by stitching together information from the scientific and grey literature, new analyses focusing on dry forests based on existing secondary data, and comments and suggestions from key informants at the federal level and participants in two workshops held in Addis Ababa and Assosa.

Funding for this work is provided by the UN-REDD+ program through a technical assistance under the Food and Agriculture Organization of the United Nations (FAO) implemented by the Center for International Forestry Research (CIFOR), in collaboration with MEFCC. The structure of this document is based on FAO's "Guidelines on Sustainable Forest Management in Drylands of Sub-Saharan Africa" (FAO 2010).

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Acronyms

AC	*Acacia-Commiphora*
BG(RS)	Benishangul-Gumuz (Regional State)
CIFOR	Center for International Forestry Research
CRGE	Ethiopia's Climate Resilient Green Economy
CT	*Combretum-Terminalia*
DA	Dry Afromontane
ETB	Ethiopian Birr (USD 1 = ETB 28.4 as of 11 January 2019)
EWCA	Ethiopian Wildlife Conservation Authority
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
MAL	Ministry of Agriculture and Livestock
MEFCC	Ministry of Environment, Forest and Climate Change
mHa	million hectares
MOFEC	Ministry of Finance and Economic Cooperation
MRV	Measuring, Reporting and Verification
NTFP	Non-Timber Forest Product
OFWE	Oromia Forest and Wildlife Enterprise
PFM	Participatory Forest Management
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
SFM	Sustainable Forest Management
SNNP(RS)	Southern Nations, Nationalities and Peoples (Regional State)
SIDA	Swedish International Development Agency
SLMP	Sustainable Land Management Program
tC	tonnes of carbon
UNFCCC	United Nations Framework Convention on Climate Change
UNCCD	United Nations Convention to Combat Desertification
WED	Wild Edible Plants

1 Introduction

In Ethiopia and many other countries in sub-Saharan Africa, most of the vegetation resources are found in dry forests. They are an inseparable part of the landscape, culture, and livelihoods. The Climate Resilient Green Economic (CRGE) is Ethiopia's national strategy towards middle-income status by 2025. Within it, "Forestry: Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks" is one of the four pillars of Ethiopia's green economy. This is further reaffirmed as a national target in Ethiopia's 2nd Growth and Transformation Plan (GTP 2), which guides the nation's development path from 2015/16 to 2019/20. Goal 15 of GTP 2 is to: "Protect, restore and promote sustainable use of terrestrial ecosystems by managing forests, combating desertification, and halting and reversing land degradation and halt biodiversity loss" (National Planning Commission, 2016). Ethiopia's international commitment to rehabilitate millions of hectares of forest, strong engagement in REDD+, and the establishment of a dedicated Ministry of Environment, Forest and Climate Change (MEFCC) in 2013 are strong signals of political will to move towards a more forested future.

Despite this, the management of dry forests in Ethiopia has lagged behind compared to the management of the more carbon-rich and population-dense high forests, mostly found in the high lands. Much of Ethiopia's vision and approach to sustainable forest management (SFM) is based on experience in managing moist forests. Nevertheless, the environmental, economic, social and institutional constraints and opportunities shaping land uses in dry forests are very different, leading to different technical options, partnership possibilities, and capacity building needs.

This document supports national and regional decision-makers and actors responsible for planning and managing dry forests and related resources in Ethiopia, by tailoring an SFM guideline specifically for their needs. The document builds the economic case for investing in SFM (Chapter 2), summarizes the environmental, institutional and managerial context of these dry forests (Chapter 3) and provides guiding principles on SFM that are suited for the national context. It is an adaptation of the Sustainable Forest Management Guidelines in Drylands of Sub-Saharan Africa (FAO, 2010) that reflects the needs, constraints, and options unique to Ethiopia. It follows closely the policies, strategies international agreements, and laws of Ethiopia.

1.1 Dry forest definition adopted in these guidelines

In Ethiopia, forests are classified into high forests and dry forests. Dry forests are the largest vegetation resources in Ethiopia (WBISPP, 2004). Dry forests are defined as forests on drylands. We adopt the Government of Ethiopia's forest definition:

> "Land spanning at least 0.5 ha covered by trees and bamboo, attaining a height of at least 2m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course" (FDRE, 2017, pp. 5–6).

The Ethiopian definition is adopted to better capture *Combretum-Terminalia (CT)* dense woodlands, which are a very important part of dry forest vegetation, have high conservation value and are threatened by commercial agriculture

(FDRE, 2017). This is different from the definition used by the Food and Agriculture Organization of the United Nations (FAO), which is adopted by many countries:

> "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ" (FAO, 2012)

We also use a different definition of dry forests to suit the Ethiopian context. Popular definitions of drylands have their roots in crop production. They use the aridity index or length of growing period to distinguish between dryland and non-dryland. In contrast, the definition of dry forest areas adopted by Ethiopian foresters and scholars is based on potential natural vegetation classifications developed by Friis et al. (2010). Among the 12 vegetation classes found in Ethiopia, 5 classes are considered to define areas with "dry forests" (See Lemenih and Bongers, 2011, Sebsebe, pers.comm; Teketay, 1999). For simplicity, this report refers to them by their altitude (lowland/ highland) or biomes (*Acacia-Commiphora* (AC), *Combretum-Terminalia* (CT) and Dry Afromontane (DA)) as classified in Figure 1.

Adopting a vegetation-based definition for dry forests increases the likelihood that the natural environment shaping forest management practices and livelihood options are relatively uniform, and aligns with Ethiopia's national carbon accounting method based on the same vegetation classification system (FDRE, 2017).

Based on these definitions, the scope of dry forests in this guideline is limited to

> Forests located in areas with natural potential for the following vegetation types: (i) *Acacia-Commiphora* woodland and bushland proper, (ii) Desert and semi-desert scrubland, (iii) *Combretum-Terminalia* woodland and wooded grassland; (iv) Wooded grassland of the western Gambela region; and (v) Dry evergreen Afromontane forest and grassland complex.

1.2 The extent of dry forests in Ethiopia

The extent of dry forests is illustrated in Figure 1 and summarized in Table 1. The majority of the dry forest is found in Oromia (6.7 million hectares (Mha), followed by Somali (3.8 Mha) and Southern Nations, Nationalities and Peoples (SNNP) regional states. (2.8Mha) (Column 2). Dry forest occupies 80% of all forests in Ethiopia

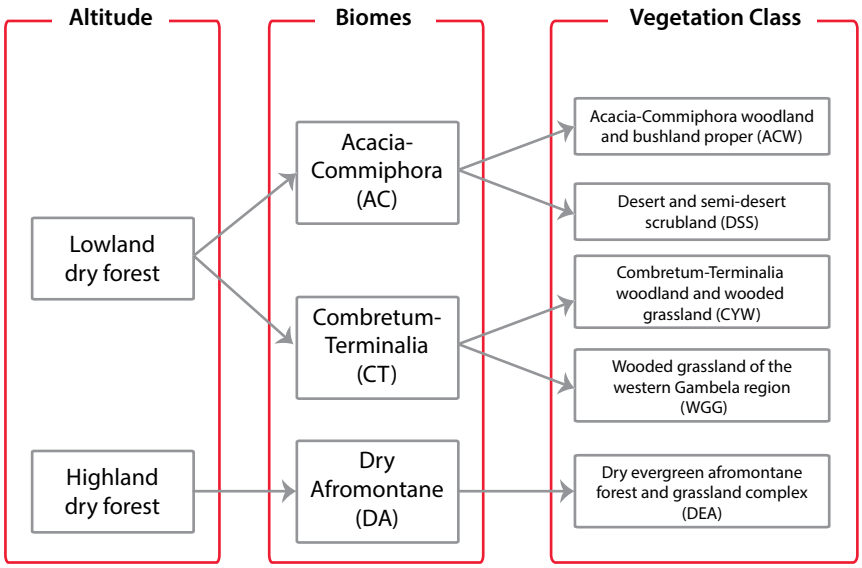

Figure 1 . Classification of dry forests used in this guideline.
Source: Authors' illustration, based on (Friis et al., 2010).

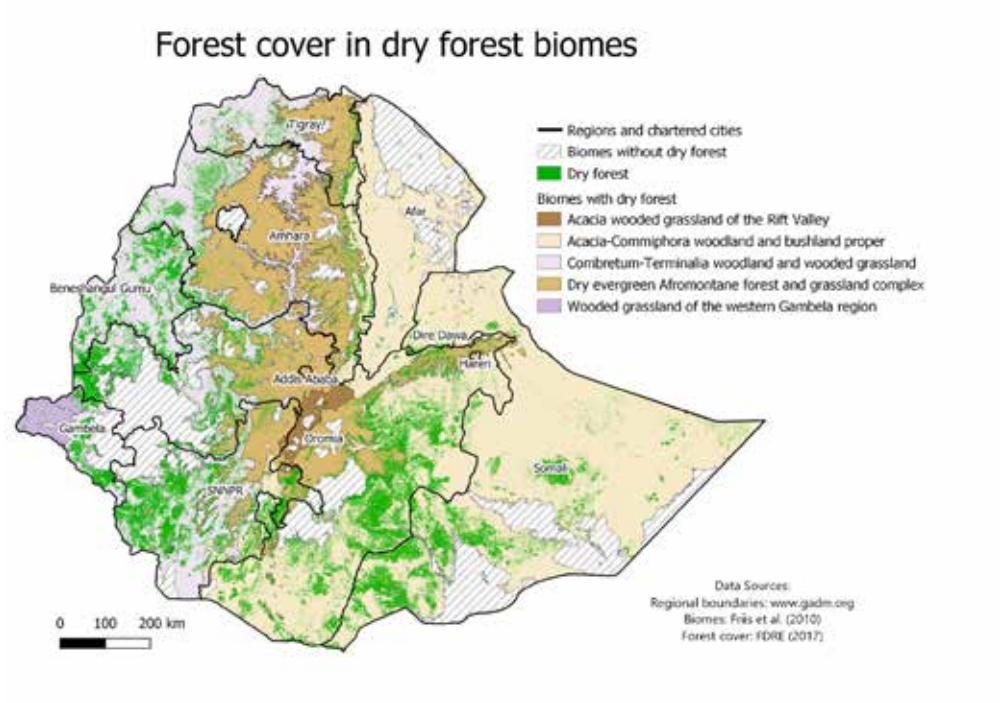

Figure 2. Dry forest biomes.

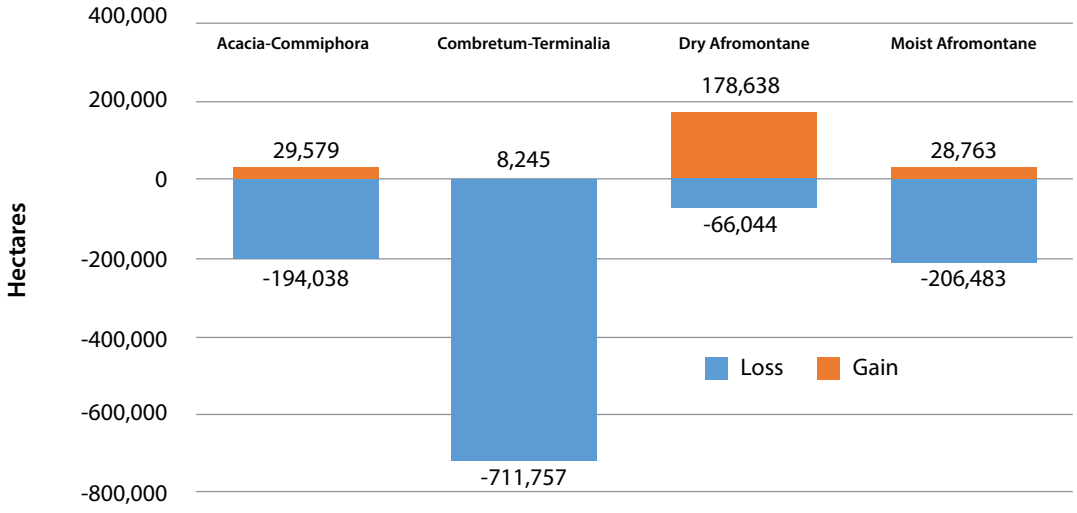

Figure 3. Total forest loss and gain by biomes (2000-2013) in Ethiopia.

Source: Ethiopia's Forest Reference Level submission to the UNFCCC Table 10 (FDRE, 2017).

(Column 4). The AC, CT and DA biomes cover 91% of Ethiopia's land mass (Column 3). All rural regions of Ethiopia contain dry forests at differing extents. The vast majority (>90%) of forests in Benishangul-Gumuz (BG), Amhara, Tigray and Somali regional states are found in dry forest biomes (Column 4). Oromia holds the largest forest cover in all of Ethiopia (39%) with a majority of these forests (72%) falling within the dry forest class (Column 4). Although the DA biome covers a large proportion of the total land area, it is mostly (67%) covered by agriculture and contains a small proportion (13%) of dry forests.

Table 1. The extent of dry forests by region.

1.Regions and administrative states	2. Dry forest cover in region[a] (ha)	3. % of region in dry forest biome[b]	4. % of forest in region that is dry forest	5. % of region covered by dry forest	6. % of country covered by dry forest from each region
Addis Ababa	3,342	100%	100%	6%	0%
Afar	94,711	96%	66%	1%	1%
Amhara	1,605,614	94%	96%	11%	9%
Benishangul Gumuz	1,332,188	98%	98%	27%	8%
Dire Dawa	72	100%	100%	0%	0%
Gambela	531,261	70%	40%	17%	3%
Harari	36	100%	100%	0%	0%
Oromia	6,717,115	81%	72%	21%	39%
SNNPR	2,823,808	83%	77%	26%	16%
Somali	3,752,690	99%	99%	12%	22%
Tigray	483,479	99%	99%	9%	3%
Total Ethiopia	**17,344,315**	**91%**	**80%**	**15%**	**80%**

Based on author's calculations. Data sources: Regional boundaries (www.gadm.org, 2015), Potential natural vegetation (Friis et al., 2010), forest cover (FDRE, 2017).

[a] Dry forest cover is dense woodland, forest and bamboo found in biome listed in Figure 1.
[b] Percentage of region (forest or non-forest) classified as vegetation classes listed in Figure 1.

1.3 Challenges for sustainably managing dry forests in Ethiopia

The dry forest resources are being severely deforested and degraded. Between 2000 to 2013, dry forests experienced net forest loss faster than moist forests (See Figure 3). The highest loss in found in CT-type areas, which can be attributed to allocation of large (>5000 ha) tracts of land to investors for agricultural development and high population growth (natural and in-migration).

The expansion of subsistence and commercial farming, human-made fire, illegal harvest of wood for construction and biomass energy and overgrazing have caused rapid degradation and deforestation in dry forests (FDRE, 2017). In turn, these immediate causes have underlying factors including (i) lack of capacity in governance, management, and commodity development; (ii) lack of clear tenure over forest; (iii) lack of investment in the forestry sector; and (iv) strong demand for small and large-scale agricultural lands.

The next sections provide information on the context around these immediate and underlying causes of deforestation and degradation, and options to address them that is suited to the Ethiopian context.

2 The economic case for sustainably managing dry forests

2.1 Contributions of commodities and ecosystem services from dry forests to national and household income

Much of the underlying causes of rapid degradation and deforestation in dry forests is the perception that dry forests generate comparatively low economic value compared to alternative land uses, such as agriculture. This perception is mainly due to the poor accounting of non-market goods and services provided by dry forests, or poor added-value in marketed dry forest products and services. This section provides information on the relative economic value of dry forests for users at the national and household levels, including values that affect incomes and human wellbeing.

Forests provide a range of ecosystem services: provision (foods, fodder, materials, water and energy sources), regulating (climate, disease, floods, wastes, and water quality), cultural (recreational, aesthetic, and spiritual benefits), and supporting (soil formation, photosynthesis, and nutrient cycling) (Balvanera et al., 2014).

Non-timber forest products (NTFPs) from dry forests are widely traded in local, regional and international markets (Lemenih et al., 2003; Pearce and Turner, 1990; Worku et al., 2014). They are an important source of cash income for many rural people, and foreign exchange earnings from exports (Eshete et al., 2012; Lemenih et al., 2003; Worku, 2016).

The assumption that crops yield higher economic returns than forest products is not based on strong evidence (Dejene et al., 2013). Research on the economic value of dry forests is scarce, and generally excludes products and services whose market prices are difficult to determine, such as firewood, fruits, vegetables, bush meat, fodder, shade for livestock, and water supply protection.

In contrast, there is an immense body of literature and markets, which makes the economic returns on agricultural commodities evident. Given this, it is not surprising that Ethiopia's public investments to protect and develop commodity chains and ecosystem services from forests have been minuscule compared to investments in land uses driving deforestation and forest degradation. Compared to moist forests, these investment trends are more visible in drylands despite the significant environmental and economic values of dry forests. For example, Benishangul-Gumuz is almost entirely (98%) located in biomes where dry forests could potentially grow (See Table 1), but 14% of the region is allocated to land banks (See Figure 4).

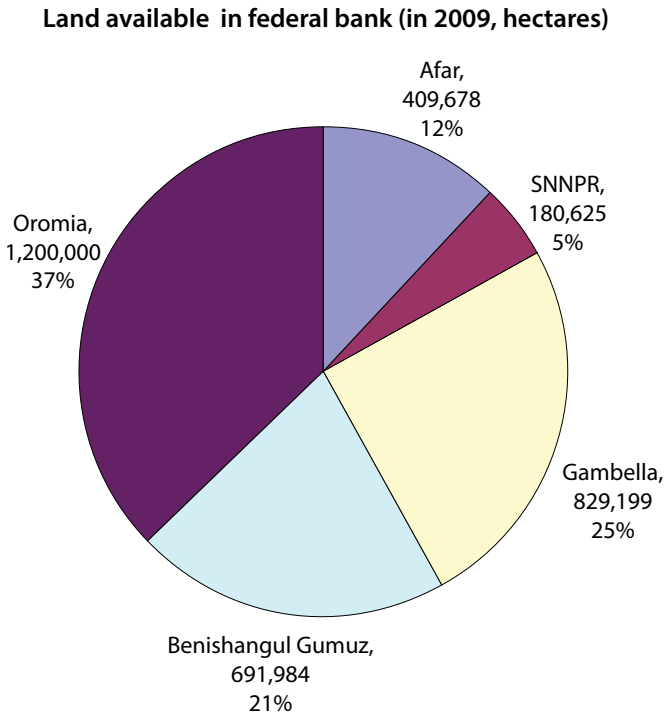

Figure 4. Land available in federal land banks in 2009 (hectares and proportion) for agricultural development purposes.

Source: Keeley et al. (2013) Chart 1.

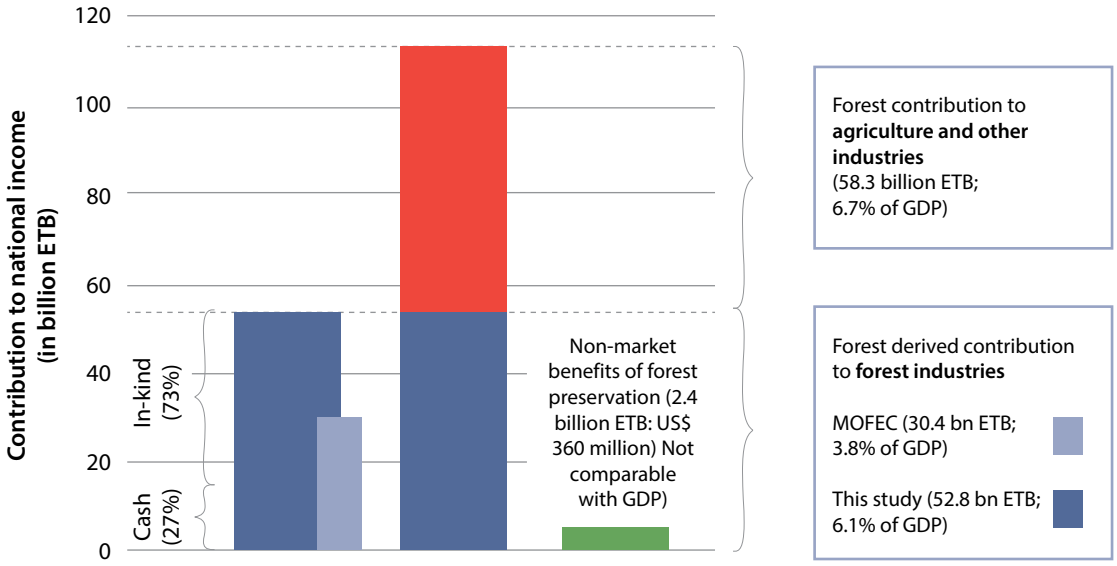

Figure 5. Contributions of forests to the national economy, 2012-13.
Source: Figure 2, UN-REDD Programme (2016).

The UN-REDD Programme conducted a more thorough accounting of forests' contributions to the Ethiopian economy (UN-REDD Programme, 2016). They take into account cash and in-kind contributions of forests in the national gross domestic product (GDP), and contributions to other sectors of the economy, mainly agriculture. Although this study does not separate between dry and moist forests, it finds considerable underestimation of forests' economic contribution in Ethiopia's national accounts. According to these estimates, forests contribute 12.9% to the 2012-2013 GDP, consisting of 6.1% in cash and in-kind contributions to forest industries, and 6.8% in contributions to other sectors (See Figure 5). In comparison, values by the Ministry of Finance and Economic Cooperation (MOFEC) show that forests contribute to 3.8% of the GDP.

2.2 Contributions to the national economy

2.2.1 Exports and foreign currency

Ethiopia has been facing a severe foreign currency deficit and trade imbalance, which drives land use decisions to favor export-oriented commodities. In 2016, Ethiopia imported USD 19.1 billion worth of goods, while exporting USD 1.25 billion. Of the more than 1,478 types of export commodities, 209 have a positive trade balance, i.e., their export value is more than their import value. Table 2 below highlights the role of forests in producing Ethiopia's top 11 export commodities with the highest trade balance (i.e., exports minus imports), and therefore are the most important in generating foreign currency. They account for USD 1.25 billion in exports, or 83% of the USD 1.5 billion/year total exports in 2016[1]. Forest goods and services such as fodder, fuelwood, construction materials, and water supply are essential in producing all of these commodities.

Forest products from dry forests, such as unprocessed bamboo, gums, resins, and honey, are contributing more than their fair share in easing Ethiopia's foreign currency deficit (See Figure 6). In general, imports are used to meet the severe supply gap in wood and wood products. Ethiopia imported USD 397 million wood and wood products, or 1.3% of total imports while exporting USD 1.1 million (UN Comtrade, 2018).

For gums and resins, honey and bee wax, and unprocessed bamboo, the picture is reversed. The total export value of these dry forest products is 25 times more than their imported value, totaling USD 14.5 million in 2016, or more than twelve times the total export value of all other wood products and processed bamboo products

1 Excluding re-imports and re-exports

Table 2. Trade balance of Ethiopia's top 10 export commodities, 2016.

Rank & Sector[a]	Commodity (commodity code)[b]	Trade balance, USD million[c]	% of total exports	Role of forest[d]
1	Coffee, not roasted, not decaffeinated (90111)	714.84	47.4%	Goods and services
2	Gold (incl. gold plated with platinum) (710813)	128.81	8.5%	Services
3	Kidney beans, incl. white pea beans (71333)	107.54	7.1%	Services
4	Meat of goats, fresh/chilled/frozen (20450)	93.47	6.2%	Goods & services
5	Chickpeas (garbanzos), dried, shelled (71320)	67.22	4.5%	Services
6	Dried leguminous vegetables (71390)	46.24	3.1%	Services
7	Cow leather further prepared after tanning/ crusting (411200)	37.77	2.6%	Goods & Services
8	Beans of Vigna mungo (L.)/Hepper/*Vigna radiata* (L.) Wilczek (71331)	14.98	1%	Services
9	Goat leather further prepared after tanning/ crusting (411310)	12.97	1%	Goods & Services
10	Dried vegetables (71290)	12.91	0.9%	Services
11*	Lac; Natural gums, resins, gum-resins & oleoresins (e.g., balsams) (130190)	9.73	0.7%	Goods & Services

Source: UN Comtrade, 2018, based on data reported by Ethiopia's Central Statistics Agency.

[a] Color coded according to HS6 classification = Blue: Animal products; Orange: Vegetable/Plant products; Grey: Minerals, others.
[b] Abbreviated commodity descriptions based on the 6-digit H3 commodity classification system.
[c] Values are equal to export values minus re-exported values (i.e., imported into Ethiopia then exported to a third country, without value addition).
[d] Goods = forest goods are used to produce this commodity, e.g., timber, fodder; Services = forest services are used to produce this commodity, e.g. shade, pollination, or water regulation.
* Produced from dry forests.

combined. Unlike wood and wood products, these non-timber forest commodities from dry forests are ahead in exports.

2.2.2 Forest Ecosystem Services

Forest carbon sequestration and storage

Dry forests have lower forest carbon densities compared to moist forests. Based on the carbon density figures for dry forests in Ethiopia Forest Reference Level submission to the the United Nations Framework Convention on Climate Change (UNFCCC), dry forest biomes contain 59% of the nation's forest carbon stocks (See Table 3). Nevertheless, dry forests have low carbon densities, which makes it uneconomical to manage for carbon sequestration. The vast majority (>90%) of forest carbon in Afar, Amhara, Benishangul-Gumuz, Somali and Tigray regions are in the dry forest, accounting for 24% of the national forest carbon stock. Note that due to difficulty in detecting and classifying bamboo land cover, the amount of forest carbon in regions with large bamboo land cover (e.g., Beneshangul-Gumuz) may be underestimated.

Water regulation and buffer against desertification

Dry forests are essential for regulating water flow and availability. The rapid degradation and loss of forests in dry regions such as Afar and Somali are the main contributing factor in frequent, and devastating flash floods in these regions (See Billi et al., 2015). Ethiopia is home to some of the most massive dams in the world. The dry forests of Benishangul-Gumuz Regional State (BGRS), for example, are essential for safeguarding water supply and reducing siltation for the Great Ethiopian

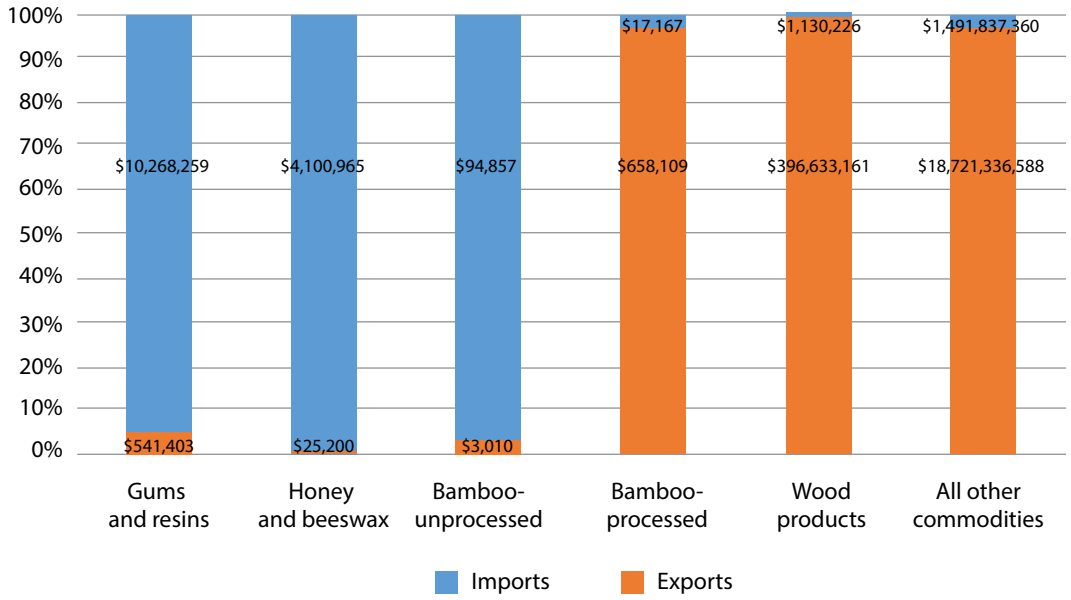

Figure 6. 2016 Import and export values of forest products found in dry forests compared to other products.

Source: UN Comtrade (2018).

Table 3. Carbon stock in dry forests, by region and administrative state, 2013[a].

1. Regions and administrative states	2. Total forest carbon stock (tC)[b]	3. % of forest carbon in each region that is from dry forest[c]	4. % of forest carbon in Ethiopia that is from dry forest[c]
Addis Ababa	223,493	100%	0%
Afar	3,109,897	100%	0%
Amhara	80,069,963	96%	7%
Benishangul Gumuz	54,637,754	94%	4%
Dire Dawa	3,145	100%	0%
Gambela	112,066,616	18%	2%
Hareri	2,358	100%	0%
Oromia	562,549,386	49%	23%
SNNPR	212,543,403	57%	10%
Somali	123,035,553	100%	10%
Tigray	23,320,307	99%	2%
Total Ethiopia	**1,171,561,877**	**59%**	**59%**

[a] Figures include above and below ground carbon, and dead wood.

[b] Total forest carbon stock is carbon stock in bamboo, dense woodland and forest areas of all biome types included in Ethiopia's Forest Reference Level calculations, including AC (32.96 tonnes of carbon (tC)/hectare (ha), CT (38.88 tC/ha), DA (66.56 tC/ha), Moist Afromontaine (117.83 tC/ha) and Others (0 tC/ha) (FDRE, 2017).

[c] Dry forest carbon stock includes only the carbon stock in bamboo, dense woodland and forest areas in vegetation classes listed in Figure 1.

Renaissance Dam. Built since 2011, this would become the largest hydroelectric dam in Africa, supplying 6,450 MW of electricity for Ethiopia and possibly neighboring countries like Sudan, Egypt, and Djibouti. Managing sedimentation from upstream erosion is an essential element in ensuring the longevity of this and other dams in Ethiopia (Borji, 2013; See International Hydropower Association, n.d.).

AC and CT woodlands in Somali, Afar, Tigray, Amhara, and Benishangul-Gumuz regions are in areas with high and very high desertification risks[2]. Maintaining these woodlands are crucial for averting future desertification. A hypothesis that forests attract rain (Sheil and Murdiyarso, 2009) has led to increasing evidence that inland rainfall patterns and water availability are much higher in areas with forests compared to those without forests (Ellison et al., 2017). Small losses in forestland can dramatically increase inland aridity by cutting off the movement of moist winds from oceans or other water bodies.

Wildlife habitat

Ethiopia has diverse geographic, environmental and climatic diversity that has led to immense ecological diversity and wealth of diversified biological resources (Ethiopian Institute of Biodiversity Conservation and Research, 2001). Forest ecosystems are home to most of Ethiopia's 6,500-7,000 species of higher plants, 240 mammal species, and 845 bird species. Many of them (12% of plants, 22% of mammals and 24% of birds) are considered endemic to the country. Ethiopia is the center of origin for many cultivated plants and forage species where relatives of most of these exist in the wild. Much of this biodiversity is in protected areas such as national parks. They are mostly located in dry forests and hold untapped economic potential as wildlife tourism destinations. Other countries that share similar ecosystems and biodiversity in the region (e.g., Kenya, Uganda, Tanzania) have been more successful at seizing this opportunity compared to Ethiopia.

2 See the global desertification vulnerability map, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_054003

2.3 Contributions to household income and wellbeing

Dry forests are substantial sources of income for households living in drylands, but their contributions are not well characterized. An estimated 57 million rural Ethiopians were engaged in at least part-time in extracting forest products (Yimer, 2017). The collection and sale of gums and resins, firewood and charcoal, wood for construction and farm tools, and medicinal plants and forest food generates direct income from dry forests. The proportion of household income from these dry forest products is estimated to be around 30% to 40% in Somali region (Lemenih et al., 2003; Worku et al., 2014) and 17% in Amhara, Tigray and Oromia regions (Teshome et al., 2015). These studies find that the poor benefit more from dry forests. These estimates did not include the value of dry forests for livestock fodder. If included, the estimated contribution of dry forests to household income would be significantly increased since livestock production contributes an additional 28% of income (Teshome et al., 2015).

A large number of rural people in dryland areas depend on traditional medicines based on wild plants to treat human and livestock diseases (Awas, 2007). About 80 percent of the rural community and a significant proportion of the urban dwellers in Ethiopia depend on herbal medicines for their primary health care. The economic value of these medicines can be immense once we take into consideration the costs of providing similar goods and services, including the provision of health workers and medicines.

In some dry forest areas, women-headed households have higher proportions of their income from dry forests compared to male-headed households (Teshome et al., 2015). For women, income from dry forests is relatively more stable, accessible and fast compared to other income sources, such as livestock and crop production. Livestock production, especially in traditional pastoral systems prevalent in dryland areas, requires frequent and distant migration for fodder and water. Crop production requires high capital and labor. Their involvement in forest management discourse is minimal, yet they are increasingly participating in forest product collection and marketing (Worku et al., 2014). There are structural challenges for women to access income from dry forest products. In Amhara region, access

Two women and a boy entering a dry forest.
Photo: Manuel Boissière, 2018.

Table 4. Comparison land use options on drylands in Metema District, Amhara region.

Land use option	Revenue		Cost		Profit (Revenue - cost)	
	Farm gate	Market	Farm gate	Market	Farm gate	Market
Sesame	4,256	4,522	1,140	1,215	3,116	3,307
Cotton	3,337	3,814	1,380	1,500	1,957	2,314
Gums & resin	2,561	3,283	514	529	2,047	2,754

Note: USD 1 = ETB 17.2.
Source: Dejene et al., 2013.

to gums and resins are only available to members of cooperatives.

Very few studies compared household income from forests and other sectors. A study comparing sesame, cotton and forest gum and resin production in Metema District, Amhara region, finds that net income from sesame is highest, followed by gums and resins, then cotton (Dejene et al., 2013, see Table 4). Additionally, the cost of producing gums is much lower and less sensitive to price changes, making it more reliable and accessible to the poor.

2.3.1 Livestock production

Ethiopia is one of the leading producers of livestock in Africa. Almost all pastoral and agropastoral areas of Ethiopia are in the CT biome, which is where dry forests are also found. Almost half of Ethiopia's dry forests are within the same landscapes as pastoral areas, namely in Afar, Somali and southern Oromia regions.

Pastoral areas are managed by pastoralists who traditionally move around large areas of rangelands in search of fodder and water for their livestock.

Agro-pastoralists produce livestock in combination with farming. Traditional pastoralists produce the majority of Ethiopia's livestock. In either case, the dry forest provides essential goods and services that can support livestock production. Nevertheless, tradeoffs between forest conservation and livestock production need to be managed.

Trees provide a wide range of goods and services for pastoralists and their livestock, which would be extremely expensive or labor-intensive to provide through other sources. In rangelands, the primary sources of fodder are grasses and shrubs. The tender twigs, leaves, and seed pods of many palatable tree species are consumed by browsing livestock such as cattle, goats, and sheep (Shenkute et al., 2012). They provide nutrients lacking in grassland pastures, especially during the dry/cold season. Because trees have deeper roots than grasses, they remain green in the dry season and become critical feed reserves during drought when grasses and shrubs perish (Gina et al., 2014; Mengistu et al., 2017; Tengnäs, 1994). Ethiopia is experiencing more frequent droughts and unpredictable seasons due to climate change (Carty, 2017). Since most livestock is managed traditionally, trees in rangelands would be increasingly important for ensuring the survival of livestock in Ethiopia.

In the Borana rangelands (southern Oromia/ Somali regions), pastoralists use most (76%) of the 324 plant species identified in their rangelands. Trees and shrubs comprise at least 40% of the plant species identified by pastoralists and produce forage, medicines, food, construction, hygiene, rituals and shade (Figure 7). Trees have medicinal value for livestock, which are crucial since veterinary services are difficult to access in many remote pastoral areas. Women use the smoke from aromatic trees and shrubs to cleanse themselves and their clothing (Gemedo-Dalle et al., 2005). Older people are more familiar with the uses of plants than the young. Women have more knowledge about plant uses, especially regarding grasses and herbaceous species (Gemedo-Dalle et al., 2005).

In some areas, grazing pressure from livestock has reduced the extent of dry forests and hinders forest restoration efforts. Seedlings of economically important *Boswellia* species, for example, are preferred by goats and sheep. In other areas, such as the Borana pasturelands in southern Ethiopia, and areas around Dire Dawa, the spread of several indigenous and non-indigenous tree species into grasslands are threatening fodder availability for livestock. These tradeoffs highlight the national importance of integrating livestock production within forest management objectives, and vice versa.

2.3.2 Fuelwood and charcoal

Extraction of fuelwood and charcoal has devastated the dry forest, driven by high population growth in rural and urban areas, and the influx of refugees. Households, especially women and children, walk further each year in search of fuelwood

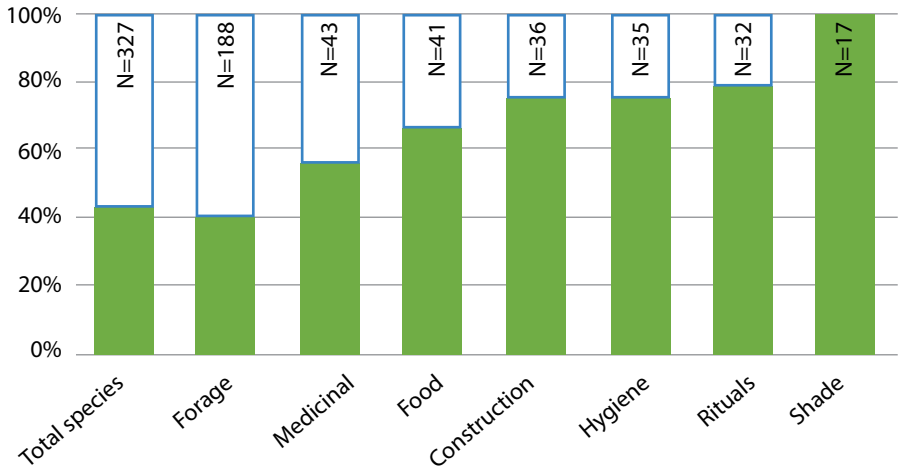

Figure 7. Proportion of useful plant species identified by Borana pastoralists that are trees and shrubs.

Source: Gemedo-Dalle et al. (2005), Table 2, p.48. "N" denotes total species number, including grasses, sedges, climbers, and succulents.

and charcoal. In refugee camps, this has led to increased security concerns for women and children, higher prices for host communities, and destruction of forest resources. With proper management, however, the high demand for fuelwood and charcoal can be used to provide sustainable sources of income and jobs.

In the Afar region, there could be an opportunity for supplying this growing demand while controlling the spread of *Prosopis juliflora* ("Prosopis" or "mesquite"). This invasive species, also known as mesquite in North America, is threatening the livelihoods of pastoral communities by reducing the availability of grasses for livestock. There are chemical and mechanical methods to eradicate or remove *Prosopis*, but these methods require continued intervention and high labor inputs. One-off *Prosopis* harvests lead to vigorous coppicing, which stimulates further growth and spread. Hence, follow up interventions are necessary to eradicate this plant permanently, but are difficult for areas where local populations are low and mobile such as Afar and Somali regions. In countries such as the United States and Australia, lump charcoal and briquettes from mesquite are the most widely available charcoal for household consumers and restaurants, and consumers prefer it because it is inexpensive, burns hot and has a pleasantly smoky aroma. In Sudan, charcoal production from *Prosopis* is being supported by NGOs as a way of controlling its spread while gaining economic benefits (Ahmed, n.d.; ATTS, n.d.). Collaboration between nomadic pastoralists, who traditionally control and manage rangelands for grass and fodder, and small-scale enterprises that are trained at sustainably managing *Prosopis* for charcoal could be beneficial.

Dry forests are also the natural habitat of lowland and highland bamboos, which are suitable for fuelwood and charcoal. Using bamboo for fuelwood is an alternative to using wood from slow-growing trees in the same region. Stems that are 4 to 6 years old are harvested at 1 to 3-year intervals. 25% of each clump can be thinned every year. Due to this high rate of growth, bamboos can be a dependable and sustainable source of fuelwood and charcoal. In the Benishangul-Gumuz region, for example, there are markets dedicated to selling bamboo for fuelwood.

Nevertheless, the current bamboo resources are not managed sustainably, leading to low incomes for households and the degradation of the growing stock. Bamboos are often not harvested at the correct interval and amount, leading to low bamboo quality and poor health of the bamboo clump. The poor management of bamboo for fuelwood and charcoal may be due to a lack of awareness of optimal harvest methods, which are entirely different from that of timber trees. Compared to other sources of fuelwood, bamboo is fast growing and benefits – rather than suffers- from regular harvests. Lowland bamboo is solid or semi-solid, which makes it ideal for fuelwood or charcoal use.

2.3.3 Non-timber forest products

Gums & resins

In Ethiopia, there are several types of gums and resins produced from over 60 tree species, mainly of the genus *Acacia*, *Boswellia* and *Commiphora*. The main gum resin producing species is *Boswellia papyrifera*. There are an estimated 2.9 Mha to 4.3 Mha of woodlands with gum and resin trees, and *B. papyrifera* can be found in about 1.5 Mha of that area (Lemenih and Kassa, 2011a; Tadesse et al., 2007).

Dry forests are the source of gums and resins, which are the most important export commodity in the forest sector in Ethiopia. Gums are formed when internal plant tissues decompose through a process called gummosis, while resins are formed through oxidation of essential oils produced by the plants. Gums can dissolve in water, but not in alcohol or ether. In contrast, resins can dissolve in ether or alcohol, but not in water. The most essential gums and resins in Ethiopia are frankincense, myrrh, and gum arabic. Frankincense and myrrh are technically gum resins because they are a mix of both gums and resins; Gum arabic is a true gum. Many industries use them, including the pharmaceutical, food, beverage, textile, cosmetics, and printing industries. Domestic consumers use frankincense and myrrh for religious reasons, fumigation, and medicine.

Between 2012 and 2016, they generated an average of USD 11.3 million per year in exports revenue, as compared to USD 4.3 million from exports of forest timber products (Chatham House, 2018, see Figure 8). These trade figures are likely to be much larger in practice, due widespread informal wholesale trade of gums and resins in the border

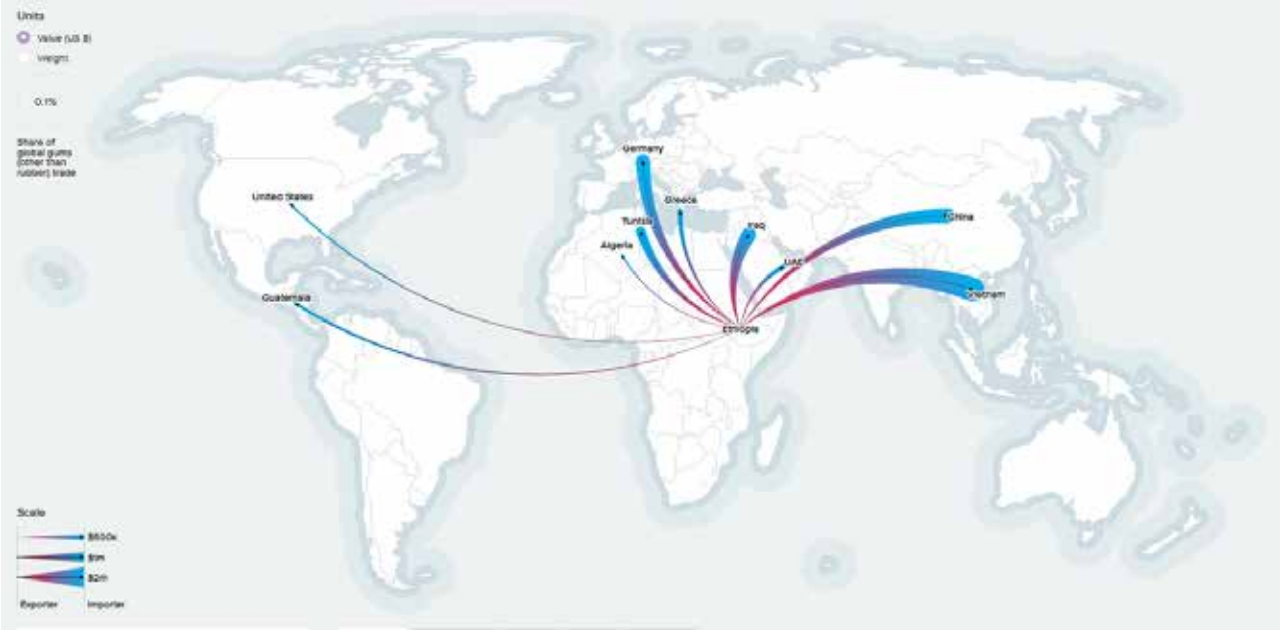

Figure 8. Volume of gums and resins exported from Ethiopia in 2016.

Insert: The export value of gums and resins from Ethiopia 2012-2016.
Source: Chatham House, 2018.

regions of Kenya, Somalia and Sudan (Gebru et al., 2014; Kassa et al., 2011).

Frankincense, myrrh, and gum arabic have been traded since antiquity, leading to a complex yet well-established value chains for gums and resins in Ethiopia. In these chains, the role of the government, private sector, and smallholders differ according to the commodity and location. There are two major value chains for gums and resins in Ethiopia: the northwestern (Tigray, Amhara) and south (Oromia) (Gebru et al., 2014). In the northwest, companies and cooperatives are involved from aggregation to marketing domestically or internationally, while individuals (e.g., farmers, community members) are mainly collectors/tappers. In the south, individuals play a more significant role than in the northwest, as they are involved in the collection, aggregation, transportation, and marketing. Frankincense dominates northern markets, while gum arabic, myrrh, and opopanax are popular in the south and southeastern part of the country (Mekonnen et al., 2013).

There are also different roles for women and men in the value chain. In the north, only men collect gums because of the harsh and remote conditions of the forest. In southern and eastern Ethiopia, women and children collect gums and resins as part of them taking care of their livestock. The task of cleaning, sorting, and grading are exclusively for women, often the poorest of the poor (See Figure 9). Women are also heavily involved in frankincense retailing in urban centers (Kassa et al., 2011).

Despite its economic contributions at the national and household levels, the resource base is degrading rapidly. Between 1970 to 2000, the area in Tigray covered by *B. papyrifera,* which produces frankincense, shrank 35% (Kassa et al., 2011). Several studies in Ethiopia (Tigray and Amhara) and Eritrea find poor natural regeneration of *B. papyrifera*, and there have been very few successful efforts to replant these trees. Trees that are currently productive cannot be replaced fast enough to maintain production, threatening the future production of gums and resins in Ethiopia. Also, these trees are being over-tapped or tapped incorrectly, which reduces their productivity in the long term. In Amhara region, where cooperatives play a significant role in the value chain, only households who are members of cooperatives with concession rights can tap Boswellia trees, diminishing the economic incentives for other households to protect *Boswellia* trees.

Figure 9. Employment in the gums and resins value chain.

The gums and resins value chain employ rural men and women in dryland areas for tapping (left), sorting and grading (center), to be ready for final packaging (right). Photo taken from Lemenih and Kassa (2011a).

Traditional beehives, Benishangul-Gumuz region.

Photo: Manuel Boissière, 2018.

Honey

The honey subsector in Ethiopia produces only 10% of its potential, with untapped possibilities to create jobs, spur economic growth and reduce poverty (Dong et al., 2016). Ethiopia is the biggest honey producer in Africa and is in EU's third-party country listing of honey producers since February 2008. Nevertheless, only 1.5% is exported due to high domestic prices, low or irregular supply of honey that meets quality standards of major honey-consuming countries (e.g., Germany, France, Norway, China, Japan, US, UK), and lack of marketing experience. Across Africa, there is a need for a business-oriented and well-focused approach to a viable beekeeping industry (Moinde, 2016).

Nearly 2 million rural households practice beekeeping in Ethiopia (Daba and Wolde, 2016). Beekeeping is often done using traditional practices and integrated into existing livelihood practices, including agriculture, agro-pastoralism,

Figure 10. Comparison of highland and lowland bamboos.

Left: highland bamboo (*Yushania alpine*); Right: lowland bamboo (*Oxytenanthera abyssinica*). Photo taken from Fayera et al. (2017).

and pastoralism. Beekeepers produce an estimated 400,000 tonnes of honey in 2009, from Oromia (39%), Amhara (27.3%), SNNP (14.7%), and Tigray (9.8%) regional states. Ethiopian honey is consumed by the producer (10%), used to make honey wine (or *tej*) for domestic consumers (70%), or sold to urban consumers (20%). Urban consumers are the primary consumers of high value-added table honey. 60% of honey in Ethiopia comes from natural forests, which are depleting.

Bamboo

Nationally, bamboo contributes ETB 56 million to the GDP; an estimated 750,000 people depend on bamboo for their livelihoods (MEFCC 2017a). Ethiopia's dry forests are rich in bamboo, notably the lowland bamboo (*Oxytenanthera abyssinica*). *O. abissynica* is found widely throughout sub-Saharan Africa outside humid tropical areas. The distinguishing feature is that lowland bamboo is often solid, grows in 1000 to 1800 m above sea level (masl) and produces viable seeds for propagation; highland bamboo is hollow (see Figure 10), is found in 2,200 to 3,200 masl and does not have viable seeds.

Most bamboo stands in Ethiopia are natural stands. Several regions have areas with high potential for lowland bamboo production, including all of Benishangul-Gumuz and adjacent zones in Amhara and Oromia, and some parts in Gambella and Tigray (Mulatu et al., 2016). These areas coincide with the *Combretum – Terminalia* dry forest biome in western Ethiopia (See Figure 2).

Bamboo forests are particularly exposed to permanent conversion after mass flowerings when large swathes of bamboo stand produce flowers and die. A mass flowering was recorded in Benishangul-Gumuz in 2011, resulting in the death of 85% of the 400,000ha of bamboo forests in the region within 7 years (Sertse et al., 2011). Lowland bamboo stands regrow after a few years when left alone because they produce large amounts of viable seeds after flowering. These seeds are easy to handle and transport, which helps the process of regenerating bamboos lost during the mass flowering. In Benishangul-Gumuz, some community members collect the bamboo seeds for sale. Many communities are not aware that this is a natural regeneration process and attribute it to disease because they occur so rarely: only once every 30 to 35 years.

The loss of hundreds of thousands of hectares of bamboo forest in the span of a few years has negatively impacted livelihood and biodiversity and highlights the importance of these bamboo forests to local people and ecosystems. Bamboo mass flowering is associated with increased soil erosion, landslides, rodent population, and migration of large animals due to the loss of forest cover; some communities in Benishangul-Gumuz observed higher incidences of *Trypanosoma* disease and subsequent livestock deaths (Sertse et al., 2011).

The majority of lowland bamboo forests suffer from the "tragedy of the commons" problem

(Sertse et al., 2011). The government has no formal management, protection, or utilization plans for natural bamboo stands. There are small patches of bamboo managed by Oromia Forest and Wildlife Enterprise and NGOs (e.g., Farm Africa and Assosa Environmental Protection Association (AEPA) in Benishangul-Gumuz region through Participatory Forest Management [PFM]) and small-scale community enterprises. Bamboo forests are the subject of intense competition between large-scale investors, government organizations, bamboo traders and local communities (Desta, 2016). Despite the lack of formal management plans, some local communities in Benishangul-Gumuz perform de-facto management of shared bamboo resources through collective actions such as PFM. In these areas, the existence of large-scale investors has triggered ownership disputes, frequent bushfires, and bamboo forest degradation. Such events highlight the need to strengthen tenure rights over forest resources and support community collective actions as a way to manage bamboo resources more sustainably (Desta, 2016).

Local consumers use lowland bamboo for construction (e.g., fencing, livestock enclosures, house construction), basketry, and fuelwood. Many other uses are currently underdeveloped in Ethiopia, including for restoration of degraded lands, furniture, and other finished bamboo products (e.g., toothpicks, chopsticks, and bamboo flooring). Despite its multiple uses and availability, bamboo resources are still poorly managed, and market linkages are not well developed (Embaye, 2003; Mekonnen et al., 2014). Most bamboo is sold as unprocessed bamboos culms (i.e., poles) mainly in roadside markets. Imports of bamboo products are mainly value-added bamboo seats, whereas bamboo exports are mostly in the form of raw material for plaiting/basketry.

In lowland dry forests, bamboo culms are found in natural forests located far from residential areas, preventing female-headed households from engaging in potential bamboo businesses. With better forestry extension, households can be encouraged to plant bamboos in their homesteads, as is the case for highland bamboo. In areas where bamboo is closer to residential areas, more women and youth are engaged in their marketing and production. Rural residents see bamboo as an inferior good used mostly by the poor (e.g., using bamboo shoots for food). This perspective has influenced the way people market, use and manage bamboo (Mekonnen et al., 2014).

Edibles plants and bushmeat

Numerous ethnobotanical studies are documenting wild edible plants (WEP) and associated indigenous knowledge in Ethiopia (Bahru et al., 2013; see review in Lulekal et al., 2011). In drylands, WEPs supplement staple food, fill the gap during seasonal food shortages and as emergency food during famines (Bahru et al., 2013). Nevertheless, there have been very few assessments of the nutritive value of consuming these plants at the household and national level, contributing to the underestimation of the value of these plants, their ecosystem and related indigenous knowledge (Rowland et al., 2015). The result is that WEP's value for households is underestimated, leading to the neglect of their ecosystems and the indigenous knowledge about them. Our knowledge of WEPs is also geographically limited. There are few research studies on WEP in dry lowlands, and the existing studies only cover 5% of Ethiopia's 494 districts (Lulekal et al., 2011).

In comparison to other countries, there have been limited efforts in Ethiopia to protect WEP resources and increase their role in improving household food security. These efforts include integrating WEPs into agricultural systems, increasing commercial and non-commercial utilization, conducting nutritional analyses of WEPs, and analyzing the economic and nutritional contribution of WEPs to the households (Lulekal et al., 2011).

In comparison to WEPs, bushmeat is an even more contentious and poorly understood issue. In Benishangul-Gumuz and SNNP regions, for example, consumption of bushmeat is widely practiced among some ethnic groups but is rarely discussed publicly due to strong religious and formal rules against their harvest and consumption. In the lower Omo, SNNP region, hunting practices are steeped in tradition, have clear gender roles, and sustained by the interplay between male and female roles despite strong disincentives to continue (Lowassa et al., 2012).

3 The context of forests and the forest sector in Ethiopian drylands

3.1 Environmental and social contexts

The main challenges facing dry forests and the forest sector are the rapid decline of the forest resource. This is mainly driven by the lack of forest ownership among local communities, competing land uses, demographic pressure, climatic changes, and various threats to forest health (e.g., pests, diseases, and fires) (Eshete et al., 2005; Gebrehiwot et al., 2003; Lemenih et al., 2007). These drivers are operating within an ecological and social context, involving government and non-government actors. This section reviews the ecology of dry forests, the actors influencing them, and the underlying forces affecting dry forest loss: tenure, demography, climate change, and natural threats to forest health.

3.1.1 Ecology

Compared to moist forests, dry forests are found in areas that have longer dry seasons and lower water availability, with annual rainfall ranging from 900 to 2000 mm. Three to eight months of drought per year is common. Due to this water-constrained environment, dry forests are home to a unique and diverse range of plants and animals. A fourth of Ethiopia's plant species are only found in dry forests (Lemenih and Bongers, 2011).

Growth and productivity in drylands are generally low. For example, *Acacia-Commiphora* woodlands grow approximately 0.0015m^3 per hectare per year, and each hectare has about 6.5m^3 of standing volume (Lemenih and Bongers, 2011). Due to the low productivity, regeneration and restoration are more challenging than in high forests. Avoiding deforestation and degradation would be the most effective way of ensuring these goods and services continue to be available in Ethiopia.

Deformed, shrubby, brown, over-aged trees generally grow in dry forests (See Figure 11). Not only can dry forests appear very different from the lush green forests people usually envision, but they also differ in structure, diversity, species

Figure 11. The different looks of dry forests.

Dry forests can be the classic 'green' forest (left) or 'brown' (right) depending on the species composition and season. Pictures by Abeje Eshete.

Table 5. Geography, species composition and threats in dry forest vegetation types.

Biome	Vegetation type[a]	Geography	Major species	Threats
Acacia-Commiphora	*Acacia–Commiphora* (AC) (small-leaved) deciduous woodlands	900–1,900 m asl, Southern, central (Rift Valley) and eastern and southeastern lowlands	*Acacia seyal, A. albida, A. senegal, A. etbaica, A. mellifera, A. drepanolobium, Balanites aegyptiaca, Commiphora africana, C. myrrha, C. fluviflor, C. paolii, C. crenulata, C. guidotti, C. erythraea, C. schimperi, C. ogadensis, C. rostrata, C. serrulata, C. gileadensis, C. hildebrandtii, C. cyclophylla, C. corrugata, Boswellia microphylla, B. ogadensis, B. neglecta, B. rivae*	Traditionally occupied by nomadic and agro-pastoralists. However, those in the Rift Valley are being affected by cropland expansion, grazing, drought, and unsustainable fuelwood harvest
	Desert and semi-desert scrubland (DSS)	Below 900 m asl, North-eastern and eastern (Ogaden) lowlands	The vegetation consists of deciduous shrubs, mostly *Acacia* spp., together with sparse evergreen shrubs and succulents. *Commiphora* and *Boswellia* species also exist	Grazing and refugee camps are affecting the vegetation considerably
Combretum-Terminalia	*Combretum–Terminalia* (CT) (broad-leaved) deciduous woodlands	500–1,800 m asl, Western, north-western and parts of south-western lowlands	*Boswellia papyrifera, Terminalia glaucescens, Grewia spp. Terospermum kunthianum, Stericulia setigera, Oxytenanthera abyssinica, Balanites aegyptiaca, Annona senegalensis, Acacia polyacantha, A. senegal, A. seyal, Combretum adenogonium, C. collinum,* and *C. molle*	Human influence is growing in recent years; Fire, crop cultivation (particularly sesame) and overgrazing are becoming threats to the vegetation
	Wooded grassland of the western Gambela region	450–600 m asl. This is a special type of forest in Ethiopia Only in Gambella region	*Acalpha neptunica, Alstonia boonei, Baphia abyssinica, Celtis gomphophylla, C. toka, Milicia excelsa, Mimulopsis solmsii, Xylopia parviflora, Acacia mellifera, Combretum* spp., *Terminalia* spp.	Little affected and the existing threats are mostly for hosting refugees, and due to dams and large-scale farming
Dry Afromontaine	Dry evergreen Afromontane forest and grassland complex	1,900 and up to 3,400 m asl Central, eastern, south-eastern and northern highlands	*Juniperus procera, Podocarpus falcatus, Prunus africana, Ekebergia capensis, Olea spp. moreover, Apodyttes dimidiate; Allophylus abyssinica, Euphorbia ampliphylla, Olinia rochetiana, Myrsine melanophloeos, Dovyalis abyssinica, Myrsine africana, and Calpurnia aurea*	The most inhabited dry forest zone in Ethiopia; extensive crop cultivation and grazing; Forests significantly diminished

Source: Excerpt from Lemenih and Bongers (2011) Table 17.1, p. 263.

composition, leafing phenology, and other functional aspects (Eshete et al., 2011; Lemenih and Bongers, 2011). Despite the lower timber productivity, dry forests are biologically diverse and have substantial environmental, social and economic importance to people in Ethiopia. They provide habitats for a large number of endemic wildlife, thousands of plants, insects and other life forms; provide ecosystem services like protecting soils, preventing erosion and desertification, regulating freshwater supplies, cooling the microenvironment, and sequestering carbon. They provide recreation, tourism, and inspiration. They generate income for households and the country by providing forest-based raw materials, goods and services (Awas, 2007; Dalle et al., 2006; Lemenih et al., 2003a; Worku, 2006).

Table 5 summarizes the important species for each dry forest vegetation types and threats. Dry forests in CT vegetation types are rich in bamboo and gums and resins but highly threatened by large-scale crop cultivation and fire. In AC vegetation types, trees producing gums and resins are also among the major tree species found in the landscape. Here, pastoralists and agropastoralists occupy most of the land and produce livestock. Dry Afromontane forests (DA) are relatively densely populated .

3.1.2 Tenure conditions and regulations affecting dry forests

Most dry forest resources in Ethiopia have been managed traditionally by rural people rather than by formal institutions (Lemenih and Bongers, 2010). This outcome is the result of the tenure provisions under the 2007 Forest Proclamation, which acknowledges 2 types of forest ownership: State and Private ownership. Private ownership requires regionally-approved management plans

Table 6. Comparison of provisions in 2007 and 2018 Forest Proclamations.

Topic	Forest Proclamations	
	2007	2018
Forest definition	"…a community of plants, either naturally grown or developed by planting and mainly consisting of trees and other plants having woody character	"…trees, plants and other bio-diversity accumulation at and in the surrounding of forest lands, roadsides, riverside, farm, and grazing lands as well as residential areas or parks that grow naturally or developed in some other ways"
Ownership types	Private forest; State forest	Private forest; State forest; Community forest; Association forest
Types of state forest	Protected forest; Other forests with management plans	Productive forest, protected forest, preserved forest
Permitted uses of state forest	Tourism, NTFP collection	- Preserved forest: research, education, disaster prevention, eco-tourism, carbon trade, and other ecosystem services - Protected forest: all utilizations in preserved forests, and other utilization based on management plan; PFM, tree plantation in buffer area; - Productive forest: all utilizations in protected forest; build roads, facilities, and administration to develop the forest
Illegal uses of state forest	Cut/use of endangered indigenous trees without a written permit from the Ministry[a]: Transport of forest products, cut trees, settle, graze animals, hunt, extract honey, carry tools to cut trees.	
Permitted uses of private, community, or association forests	n/a	Obtain title deed for developing forests, use or sell forest products, transfer forest rights, benefit from ecosystem services; access to loans; cut endangered indigenous tree species in private forest, with permit
Illegal uses of private, community, or association forests	n/a	Community/association forest: harvest forest productions without a permit; Cut/use of endangered indigenous trees in community forest
Compensation for expropriation by the state	Unclear	Yes

[a] Referring to MEFCC (2018 Proclamation) or Ministry of Agriculture (2007).

and a permit from the local governing body to harvest and transport forest products (Lawry et al., 2012). These requirements are difficult to attain for most rural households or associations. As a result, most dry forests are legally (*de jure*) owned by the state instead of private owners, and are practically (*de facto*) managed by communities or in open access. Pastoral areas in the CTvegetation type (i.e., Afar, Somali and SNNP regions), most dry forests are found within rangelands managed by various community groups, ethnic groups or clans. They are the de-facto managers of dry forests, although their management objectives focus mainly on livestock production.

The recently issued 2018 Forest Proclamation provides clarity on the rights and responsibilities of non-state actors in forest ownership, namely communities, private owners, and associations (Federal Negarit Gazette of the Federal Democratic Republic of Ethiopia, 2018). One of the objectives of the proclamation is to include communities and associations in forest development, so they can participate in enhancing sustainable forest development, conservation, and utilization. Given that dry forests were de facto managed by communities or in open access, this proclamation can strengthen community rights over dry forest resources, and motivate them to manage forests more sustainably.

Previously, the most common way communities could have legal status over forests was to form cooperatives that managed state-owned forests. These organizations do not easily align with traditional community institutions, are difficult to maintain without outside assistance, and are geared toward economic instead of multiple objectives (Lawry et al., 2012). In (state-owned) communally managed lands, communities do not have the right to exclude outsiders and could lose land rights to large investors without compensation. The 2018 Forest Proclamation addresses some of these issues by explicitly giving rights to private and communal entities to be forest owners. The next step is to establish procedures and institutions for securing those rights, which are now protected by the law.

The proclamation defines forest as "trees, plants and other bio-diversity accumulation at and in the surrounding of forest lands, roadsides, riverside, farm, and grazing lands as well as residential areas or parks that grow naturally or developed in some other ways." Unlike the prior (2007) proclamation, this definition explicitly includes trees and plants on farms and grazing lands as forest, which increases the need for better harmonization between rangeland, farmland, and forest management. There are more provisions for including non-state actors (e.g., communities, associations, and private entities) to take part in forest ownership and management. The proclamation articulates benefit sharing with and participation of communities living around forests. Table 6 compares forest between the uses and management provisions in the 2007 and 2018 forest proclamations.

3.1.3 Actors in dry forest management

The current management of dry forests involves a set of formal and informal actors, who have different roles. At the federal level, several ministries manage land uses and livelihoods that dominate dry forest areas: the MEFCC, Ministry of Agriculture and Livestock[3], Ministry of Federal and Pastoralist Development Affairs. Sub-nationally, each ministry is represented by regional bureaus and experts. MAL not only oversees the development of the agricultural sector but also implements the most extensive land restoration program in Ethiopia (Sustainable Land Management Program (SLMP)), which covers dry areas.

There are publicly-funded universities and research institutions that are focusing on forestry, agriculture or pastoral development, or having relevant programs/directorates. There are also state enterprises involved in the value chains of dry forest products (e.g., Natural Gum Production and Marketing Enterprise, Oromia Forest and Wildlife Enterprise (OFWE)), and agencies managing large tracts of lands in dry forest areas (e.g., the Ethiopian Wildlife Conservation Authority (EWCA) under the Ministry of Culture and Tourism).

Non-state actors include non-governmental organizations (NGOs) with activities in dry forest management (e.g. Farm Africa, SOS Sahel, and International Network for Bamboo and Rattan Organization), international research institutions on forestry and rangelands (e.g., Center for

3 In 2017, Ministry of Agriculture and Natural Resources and Ministry of Livestock and Fisheries were merged to form MAL.

International Forestry Research (CIFOR), and International Livestock Research Institute, participatory forest management (PFM) user groups, and traditional institutions. In every rural region of Ethiopia, there are traditional institutions that manage land and forest resources, including conflicts. Some of them have a strong influence on dry forest management due to the overlap between the lands they manage and dry forest areas. Traditional institutions are particularly strong among pastoral communities in Oromo (Borena pastoral system), Somali and Afar regions. In Afar, for example, most intra-Afar conflicts are resolved outside the court system, following the Mad'aa customary laws; Clan and religious leaders are responsible in conflict resolution among the Somali; while the Borana in Oromia follows the Gada traditional administrative system (National REDD+ Secretariat, 2017). These institutions define rights and responsibilities within ethnic groups, which are essential for managing natural resources.

3.1.4 Demographic pressure and migration

Ethiopia has the second largest population (about 100 million) in Africa after Nigeria, growing at 2.7% annually (UNDESA, 2015). Over 80% of the population resides in rural highland areas and depends on agriculture for its livelihood. In the early 2000s, dryland areas in Ethiopia were sparsely populated, inhabited mostly by pastoralists and semi-pastoralists in the south and southeastern and some sedentary agriculturalist in the north and northwestern parts of the country (Lemenih et al., 2003a). Due to intense competition for farmland in the highlands, there have been population movements into lowland areas with dry forests. They are attracted to jobs in large-scale agricultural investments or the available land. Local communities' tenure over land and forest resources are generally weak, leading to increasing conflicts over land (Rettberg et al., 2017).

Population pressures in the highlands have resulted in rural-to-rural migration from highland areas to lowland dryland areas (IOM, 2008). This migration has led to a growing population in the drylands, accompanied by a growing demand for fuelwood, construction materials, and agricultural lands. Projections of fuelwood consumption in Ethiopia for the period between 2010 and 2030 showed an increase in annual wood fuel consumption by 65% (FDRE 2011). FAO (2005) showed a significant increasing trend of fuelwood demand in the country. Given that 97% of energy in the country comes from fuelwood (WBISPP, 2004) and that the dry forests are the primary source, high demand for fuelwood is significantly accelerating deforestation and forest degradation of dry forests (Lemenih and Bongers, 2010). Sale of wood is also a vital source of income for many rural and urban poor people.

The Ethiopian government strategy for accelerated economic growth encouraged the development of large-scale commercial farming in dryland areas. The dry forests are being cleared for expansion of farmlands by community members - including settlers from national resettlement program - and commercial enterprises. There is population pressure due to natural population growth, and cyclical rural to rural migration. These demographic changes have created high demand for farming dryland areas in the lowland (Belay, 2004; Kebede, 2006; Lemenih et al., 2007).

Expansion of farmlands is one of the threats to dry forests (Lawry et al., 2015; Yonas et al., 2013). Large clearance of dry forest for the expansion of small and large-scale agriculture resulted in the conversion of extensive dry forest into non-forest land. Small-scale agricultural expansion is occurring in dry forests across the country while large-scale agricultural investment is concentrated in the northern, northwestern, western and eastern parts of the country. Such massive deforestation of dry forest accelerates forest fragmentation rates of dry forests in lowland areas (Lawry et al., 2015). Forest fragmentation increases the amount of forest edge relative to the total forest area, which increases plant mortality and may lead to extinction (Fahrig, 2003). Because of this, fragmentation is one of the main threats to biodiversity (Hill and Curran, 2005).

In Ethiopia, there are nearly 2 million refugees and internally-displaces peoples, mostly hosted in 27 refugee camps in 5 regions: Tigray, Afar, Benishangul-Gumuz, Somali and Gambella regional states. Demand for fuelwood and construction materials are high, leading to rapid degradation and loss of forests in areas surrounding these camps. These regions have high proportions (>64%) of areas in dry forest biomes. In Somali and Afar regions, refugee camps are concentrated in the desert and semi-desert scrubland (DSS), a vegetation type spread across

the border with Eritrea and Somalia. As of May 2017, the Melkadida cluster of refugee camps in Somali region (located on DSS vegetation type) registered 212,023 refugees (25% of total refugees in Ethiopia); in the same period, around 34,900 refugees entered from Eritrea into Afar, and would have passed through or stayed in areas with DSS vegetation types (Friis et al., 2010; UNHCR, 2017). Many refugee camps and transit centers are also located in the CT biomes, notably in areas in Gambella and Benishangul-Gumuz regions bordering Sudan and South Sudan. Gambella hosts 364,364 refugees, while Benishangul-Gumuz hosts 55,739 refugees. Most camps in Gambella are found in the wooded grasslands of western Gambella, whereas in Benishangul-Gumuz they are found in CT deciduous woodlands (Friis et al., 2010; UNHCR, 2017). Considering the low population of Benishangul-Gumuz (983,000) and Gambella (386,000), refugees are putting significant pressures on local natural resources, including dry forests (CSA, 2012).

Climate change is a significant environmental, social and economic threat facing the drylands. In general, climate change brings increasing temperature and evapotranspiration, declining precipitation, increased risk of extreme precipitation, and increased seasonal irregularities (IPCC, 2001; Kharin et al., 2007). The effects of climate change impact the productivity of grasses and other feed sources, growth rates of trees/shrubs, the demographic behavior of plant populations, phenology of organisms, range and distribution of species, and composition and dynamics of many plant communities (Menges, 2000; Walther et al., 2002). Plant composition could shift from drought-intolerant to drought-tolerant species or vegetation types (Alward et al., 1999; Brown et al., 1997). Trends of reduced precipitation and rapid land degradation or conversion have made desertification one of the challenges for dry forests in Ethiopia (Hawando, 1997).

Climate change models predict increased floods around the world (Kundzewicz et al., 2007). In the drylands of Ethiopia, flash floods are particularly disastrous. In April 2018, several cases of flashfloods in Somali, Oromia, and Afar regions left hundreds of thousands of people in need of immediate humanitarian assistance (Reliefweb, 2018). Over the years, these floods have caused significant loss of life and property (Lemenih and Kassa, 2010).

These climatic disturbances result in reduced productivity of drylands, affecting livestock productivity and the overall socio-economic development (Safriel et al., 2005). The dryland areas in the southern and southeastern lowland of the country are the most food insecure. It is very common to see most pastoralists and agro-pastoralists and their livestock experience starvation and – at times - death. To address these issues, Ethiopia is active in multi-country initiatives to reverse the pace of desertification. In 1997 Ethiopia ratified the United Nations Convention to Combat Desertification (UNCCD), a legally-binding international agreement that applies explicitly to the drylands. Ethiopia is one of 20 partner countries of the Great Green Wall initiative led by the African Union. This initiative aims to establish an 8,000 km green wall of trees facing the Sahel and Sahara, stretching from Senegal to Djibouti.

3.1.5 Natural threats to forest health: fire, invasive species, pests and diseases

Human-induced fire is one of the factors that affect the dry forest resources of Ethiopia (Lemenih et al., 2007). These fires occur in northern, northwestern and western dryland areas of the country, and are widely practiced annually for clearing forests and establishing farmlands. Most of the human-induced fires are attended, managed and controlled by the community members who set them. Nevertheless, there are also fires set recklessly or accidentally that spread to large areas, resulting in severe economic, political, social and environmental devastation in Ethiopia. Such fires occur every year in different parts of Ethiopia (Asfaw, 2006).

Repeated fires and intensive grazing in dry forests could ultimately change species composition of the forest; fire-tolerant trees unpalatable to grazing animals become more dominant (Borman, 2005; Platt et al., 1988). Fire management methods need to take into account traditional practices and the livelihood benefits of fire. Borana pastoralists practiced prescribed burning, i.e., planning and applying fire to a specific area and a specific time, to control encroaching bushlands such as those shown in Figure 12. This practice was banned, resulting in bush encroachment, affecting feed supply for local livestock (Angassa and Oba, 2008; Coppock, 1994).

Figure 12. Thorny bushes encroaching into lands previously used as grazing lands by pastoralists.

Photo by Abeje Eshete.

Another challenge for dry forests is invasive species. Of the hundreds of alien plant species introduced into Ethiopia for their ecological, economic and social benefits, or unintentionally through trade or aid shipment, 22 are considered invasive (Etana, 2013). Among them, *Prosopis juliflora* ("prosopis" or "mesquite") is the most invasive and challenging to control. It invaded more than 1.2 million hectares of land in Ethiopia and spread at a rate of between 20,000 and 50,000 hectares per year in Afar region alone (MoLF, 2017; Tilahun and Asfaw, 2012; Wakie et al., 2014). In the drylands of southern Ethiopia, bush encroachment into rangelands renders it unsuitable for grazing, reduces livestock productivity, and compromises the livelihoods of local people (Coppock et al., 2007; Dalle et al., 2006; Tesfaye and Negassa, 2004).

Insect pests such as termites, bark beetles, boring insects, chewing insects, defoliating insects, sucking insects and gall makers cause damages to dry forests (Assefa and Abate, 2018; Gezahgne et al., 2017), They tend to be overlooked until there are visible economic losses (Ciesla, 1994; Zwolinski et al., 1990). A pathogenic funguse, *Lasiodiplodia theobromae*, can cause disease on *Boswellia papyrifera* (Gezahgne et al., 2017). Tree diseases in Ethiopia are not managed systematically, except for commercially important cash crops like *Coffea arabica* (Ferdu et al., 2009). Over 49 different species of insect pests damage *Coffea arabica*, the most important export product in Ethiopia (Abebe, 1987; Mendesil et al., 2007). Insect pests can stunt or kill plants; termites can kill 90% of newly transplanted *Eucalyptus sp* seedlings, while long-horn beetles (*Idactus spinipennis* Gahan) can cause 7-8% mortality/ha/year of *Boswellia papyrifera* (Abdurahman, 1992; Agena, n.d.; Negussie et al., 2018). Eshete et al. (2012) and Yirgu (2016) reported insect pests that damage the seeds of *Boswellia papyrifera*, *Cordia africana* and several *Acacia* species, and prevent them from germinating.

3.2 Major land uses and livelihoods

3.2.1 Land uses

Dry forests in the lowlands, corresponding to the AC/CT biomes, are located in harsh environments, relatively isolated from markets, urban centers, and public services compared to dry forests in the highlands (i.e., DA biome). The main land uses in the AC/CT biomes include agriculture (16%), grasslands (23%), shrublands (24%), bare land (17%) and forest (20%) (See Figure 11). In Amhara, SNNP and Tigray regions, agriculture occupies more than 1/3 of the lowland drylands within these regions.

A livelihood zone study in 2009 shows that in AC/CT vegetation types support pastoral, agropastoral and crop-based livelihoods. The division of livelihood zones follows the division of vegetation types shown in Figure 14 almost precisely. Agropastoral and pastoral livelihoods are dominant in the *Acacia-Commiphora* vegetation types found in eastern and southern Ethiopia, mainly in Afar, Somali and Oromia regions. Crop-based livelihoods dominate the *Combretum-Terminalia* vegetation types in western Ethiopia, mainly in Gambela, Benishangul-Gumuz, Amhara and Tigray (See Figure 14). SNNPR is in the transition area between these two livelihood groups. These dry forest areas were historically sparsely populated by sedentary farmers in the north and north-west of Ethiopia and pastoralists and agro-pastoralists in the central Rift Valley, south and southeastern parts of Ethiopia (Lemenih et al., 2003a).

Dry forest vegetation is particularly important to rural communities for food and nutritional value, medicine, fodder, wood for construction and energy, and natural gums. Fodder from dry forests are especially important in times of drought (Eshete et al., 2005; Gebrehiwot et al., 2003; Lemenih et al., 2007a)

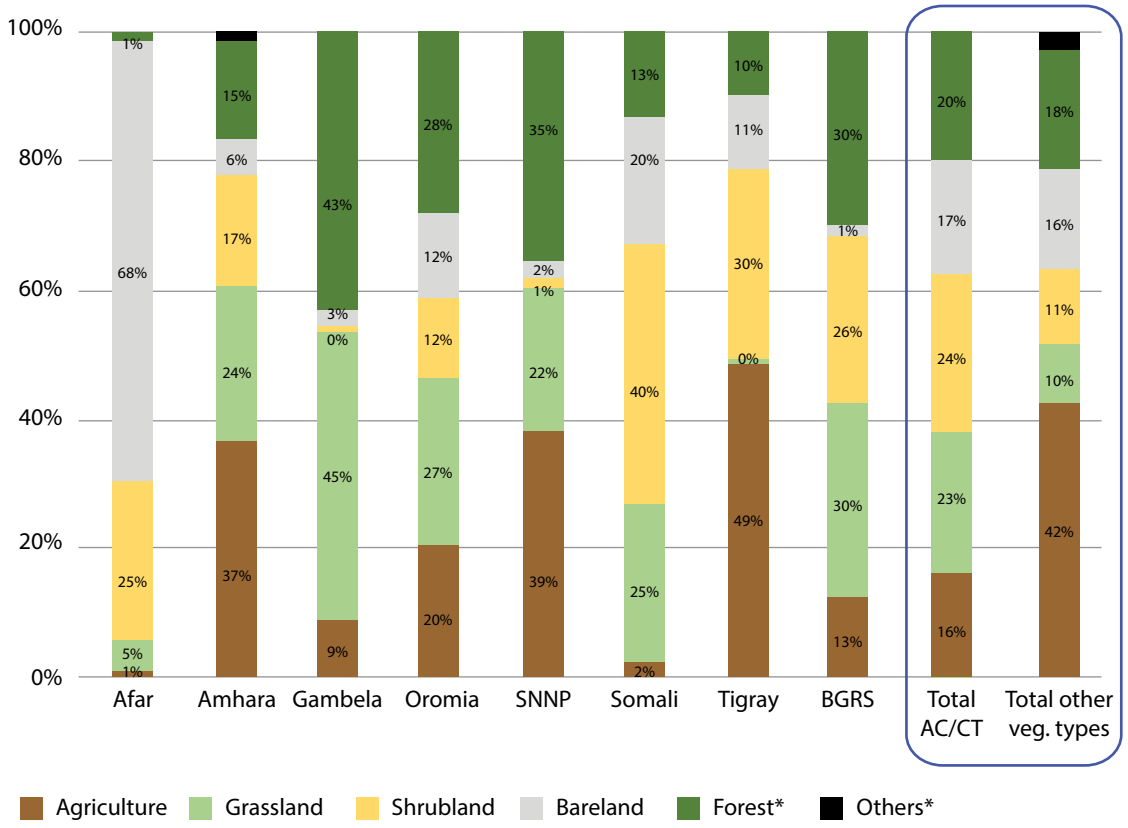

Figure 13. Land uses in (lowland) AC and CT vegetation types by region.

Based on author's calculations (Sources: Friis et al., 2010; www.gadm.org, 2015b). Harari region was omitted due to small AC-CT area; "Forests" include dense woodlands and bamboo; "Other" includes built-up areas, plantations and water bodies.

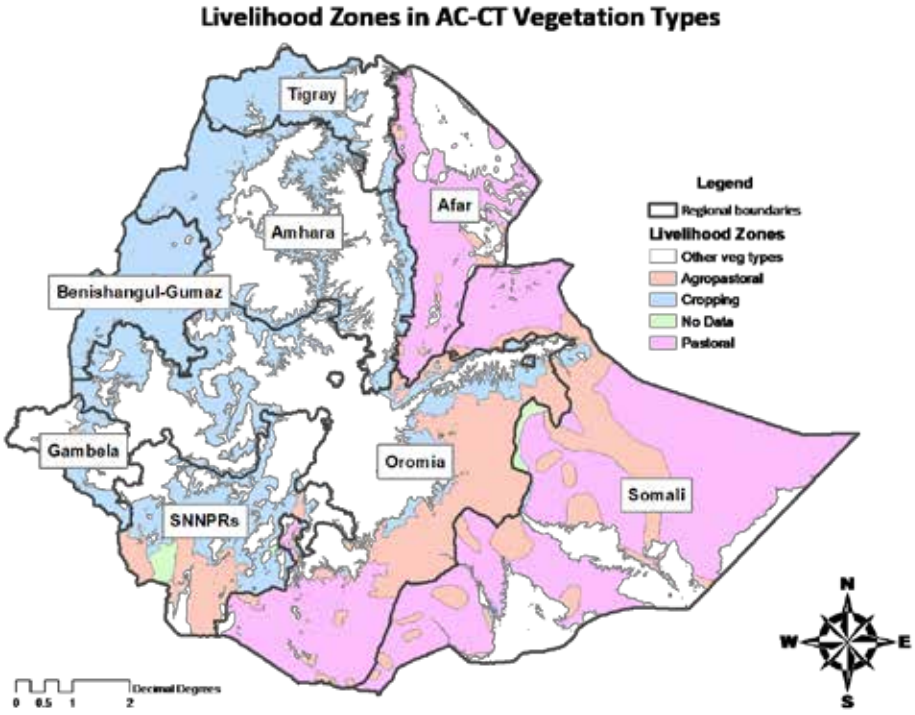

Figure 14. Livelihood zones in lowland vegetation types (AC-CT).

Sources: Regional boundaries (www.gadm.org, 2015b), Potential natural vegetation (Friis et al., 2010), Livelihood zones (MoARD 2009).

3.2.2 Livelihoods

Pastoralism and agro-pastoralism

Over 40% of Ethiopian livestock populations are found in the lowland dryland areas where pastoralism and agro-pastoralism are the main livelihood strategies (FAO 2009; Bekele and Amsalu 2012). The dry forests in the dry lowland areas, notably in the AC biomes, are either unmanaged or managed by traditional governance systems (Tedla and Lemma 1998). Dry forest areas experience high grazing pressure from livestock reared by long-existing and newly migrated communities (Tedla and Lemma 1998). With higher population pressures in the dry forest biomes, the size of grazing land is shrinking over time.

In the Borana rangelands (Oromia and Somalia regions), the incorporation of agriculture into pastoralism (i.e., agro-pastoralism) is a relatively recent experience for most pastoralists. Crops can only be produced in areas with enough water, and take away land that would normally be used for dry-season grazing. Livestock rearing remains the primary source of livelihood among agro-pastoralists in that area (Tolera and Abebe, 2007). In the Somali region, the regional government has heavily invested in building the infrastructure and human capacity needed for agro-pastoralism (Mohamed, 2017).

During the rainy season, highland communities challenged with a shortage of grazing lands in their areas of origin move their livestock to other grazing lands, with dry forests, mainly in the northwestern part of the country (Tegegne et al., 2009). The recurrent and extended drought in drylands also motivates migration of considerable number of human and livestock population to dry forest areas that are relatively in a better position for food and feed (Lemenih et al., 2003a).

Small-scale agriculture and agroforestry

In the CT and AD biomes, cropping (sedentary agriculture) is the primary source of land-based livelihoods (see Figure 14). The cropping systems are diverse and include agroforestry (e.g., in the form of scattered trees and boundary trees)

and cattle production. In these same areas, the government made available 3.3 million hectares of land in federal land banks with parcels of at least 5,000 ha. These parcels are planned to be allocated to large-scale investors (See Figure 4).

3.3 Management conditions

Ethiopia has formulated and implemented some legal and policy frameworks, established relevant institutions, and developed some strategies related to forest management (See Table 7). These policies, institutions, and strategies give due attention to the conservation and sustainable utilization of all biological and ecological resources of the country, and help the country to get financial and technical support to manage its diversified ecosystems and biological resources sustainably.

Ethiopia has implemented some conservation practices on-site ("in situ") to conserve and promote sustainable utilization of its forest genetic resources in the dry forests (See Table 8). Some are managed by the government, the civil society, or by both. Ethiopia has a network of protected areas that cover 14% of the country's area, with plans to expand to 20% (NBSAP 2015; EBI 2015/17). Ethiopian biodiversity Institute has also conserved 2000 accessions of 260 forest species at its gene banks and established 15 in situ sites in three Regional States of Ethiopia (NBSAP 2015).

Table 7. Legal and policy frameworks, agreements, institutions, and strategies related to forest management in Ethiopia.

Legal and policy framework	The 1995 Constitution of the Federal Democratic Republic of Ethiopia, The Federal Environmental Policy, The National Biodiversity Conservation and Research Policy of 1998, The Agricultural Policy, The Forest Policy, The Wildlife Development Policy and The Rural Land Use and Management Policy.
International agreements	Convention on biological diversity (CBD), the Convention on Combating Desertification (UNCCD), the UNFCCC, Convention on international trade of endangered species of wildlife and flora, International Treaty on plant genetic resources for food and agriculture, World Heritage, Cartagena Protocol on Biosafety to the convention on biological diversity, and acceded to the Nagoya Protocol.
National strategies, action plans, and programs	Two National Biodiversity Strategy and Action Plan (NBSAP), The Conservation Strategy of Ethiopia of 1997, The Regional (Local) Conservation Strategies (specific to each Regional State), The Forest Proclamation and Strategy, The Agriculture and Rural Development Strategy and Action Plan, The Rural Land Use and Management Strategy, The National Strategy and Action Plan For the Implementation of The Great Green Wall Initiative in Ethiopia and The 10 year National Forestry Action Program
Governmental institutions	Ethiopian Biodiversity Institute (EBI); Ethiopian Environmental and Forest Research Institute (EEFRI); EWCA; Ministry of Environment, Forest and Climate Change (MEFCC)[a]; Ethiopian Mapping Agency; Relevant regional bureaus

[a] In October 2018, MEFCC was replaced by the Environment, Forest and Climate Change Commission (EFCCC).

Table 8. Conservation practices in Ethiopia.

Type	Managed by	Example of practices
In-situ	Government	National/regional parks, wildlife reserves, research forests; biosphere reserves, controlled hunting areas
	Government and civil society	Participatory forest management (PFM), area closures
	Civil society	Church forest, sacred forests, community forest
Ex-situ	Civil society	Gene banks; wildlife rescue centers
	Government	Botanical gardens; gene banks

3.3.1 Reforestation, afforestation, forest restoration, and conservation

Common methods to reforest, afforest and restore forests and lands in dry areas include practicing agroforestry on farmlands and establishing area exclosures[4] , smallholder tree plantations on farmlands, and buffer zone plantations around natural forests methods are widely practiced in Oromia, Tigray, Amhara and SNNP regional states (Lemenih and Kassa, 2014). Different methods are useful depending on local conditions. For example, area exclosures are most useful in degraded landscapes, smallholder tree plantations in and around farming homesteads, and agroforestry in agricultural landscapes.

During the early periods of the Derg regime (1975 to 1986), large areas of lands were planted with Eucalyptus, several institutions were established to manage and conduct research in forestry, and around 4.8 million hectares of land was demarcated as National Forest Priority Areas (Teketay et al., 2010). The Ethiopian famine in 1984 put forests as part of a sustainable solution against future famines, and many aid agencies supported activities to alleviate land degradation (e.g., construction of hillside terraces and agricultural bunds). Nevertheless, little action was taken explicitly for reforestation or afforestation (Ayana et al., 2013). The Federal system emerged in 1994 and favored economic growth through agricultural intensification. This system resulted in rapid degradation and loss of dry forests in the lowlands and highlands from large-scale land conversion to agriculture (Lemenih and Bongers, 2010).

Given this historical context, Ethiopia is now striving to balance between deforestation and reforestation to achieve sustainable economic development. Ethiopia is actively engaged several international initiatives on forest restoration, such as the Bonn Challenge, New York Declaration on Forests, reducing emissions from deforestation and forest degradation (REDD+) and the Africa Forest Landscape Restoration initiative (AFR 100). The country is also a signatory to the UNCCD to fight desertification.

Exclosures has been practiced in the Tigray region for at least 20 years to rehabilitate degraded hillsides and increase the diversity of indigenous species through promoting natural plants regeneration (Mekuria et al., 2011). They are areas designated by communities to exclude cultivation, illegal cutting, and livestock grazing. Exclosures contributed to the rehabilitation of over one million ha of degraded land and increased the vegetation cover of the country, providing more fodder and wood, reducing soil erosion, enhancing water infiltration and stream and groundwater recharges, and reducing flood risks (Aerts et al., 2008, 2007; Mekuria et al., 2011; Mengistu et al., 2005).

Agroforestry brings together trees, crops, and livestock. Trees are deliberately maintained or introduced into the land to diversify income, conserve biodiversity, adapt to or mitigate climate change, and enhancing soil fertility (Lundgren and Raintree, 1982; Nair et al., 2009). Fruit-based agroforestry systems around homesteads (mainly Mango tree with annual crop, vegetables, grass species), Moringa based agroforestry and Scattered trees on farmlands (indigenous tree species like *Balanites aegyptica, Adansonia, Tamarindus indica, A. senegal, F. albida,* and *Grevillea robusta*) are recommended in the lowland dryland areas (Tolera et al., 2015).

Smallholder tree plantation is a practice of planting trees in woodlots formed by smallholder farmers, covering increasing large areas of Ethiopia to meet the demand for wood and income (Jenbere, 2009; Mekonnen, 2006). By providing an alternative source of wood products, smallholder plantations contribute to the conservation of remaining natural forests (Zhang and Song, 2006). Smallholder plantations involve different tree species depending on the climatic and environmental conditions of the specific areas. Lowland bamboo, *Acacia polyacantha* and *A. senegal* species are recommended for promoting smallholder plantations in the lowland drylands of the country (Tolera et al., 2015).

Buffer zone plantations are established in the periphery of natural forests to create a physical buffer and provide an alternative to logging within natural forests (Sayer, 1991). Buffer zone plantations create a wide band of exotic or native trees that clearly mark the boundary of the natural forest. These plantations can reduce

4 Exclosure is defined as areas protected from any form of cultivation, cutting trees and shrubs, or grazing by livestock, mainly through social fencing (Lemenih and Kassa, 2014).

conflict by separating wild forest and wildlife from agricultural fields, ensure soil and water conservation on steep slopes, and produce wood needed for local and national use (Rwanda Environment Management Authority/Protected Areas Biodiversity Project, 2007).

The primary method to conserve forests in Ethiopia is by establishing protected areas, including national forest priority areas, national parks, wildlife reserves and sanctuaries, and controlled hunting areas (Vreugdenhil et al., 2012). Most of these protected areas are in the dry lowland areas. In principle, they exclude human and livestock interference. Although there is vast potential for tourism in these protected areas, they have not been managed adequately and face encroachment (Giorgis, 2015).

In the northern, northwestern, and western Ethiopia, the State, private or community-based organizations manage dry forests with economically important non-timber forest products through concessions or short-term leasing (Woldeamanuel, 2011). Most of the management practices in these dry forests are product-specific, e.g., production of gum and resin, bamboo, or medicinal plants. Legally authorized governmental organizations at local level choose the production sites and grant access to the forests for legally recognized entities. Most regional states have developed guidelines for sustainable production of non-timber forest products. Organizations involved in NTFP production submit a management plan for sustainable forest production, investment, and protection. Once this plan is approved, they enter into an agreement with government organizations. The regional authorities are expected to monitor compliance the agreement and regional guidelines (Tolera et al., 2015).

Large areas of dry forests are not under one of the management systems mentioned above, and are de-facto open access legally owned by the federal, regional or local government institutions. In most cases, these institutions lack physical, financial and human resources to implement policies and regulations. Almost none of these forest resources have a management plan so far. These dry forest resources are the most deforested and degraded forest resources in the country (FDRE, 2017).

3.3.2 Forests managed under traditional governance systems

Some dry forests are managed under traditional governance systems (Teketay et al., 2010). The Gada system is one of the oldest known traditional systems for managing natural resources. This system is used mainly in the Borana pastoralist area (Oromia Regional State), dominated by the AC biome. Pastoralists throughout sub-Saharan Africa practice similar systems (Coppock, 1994; Hogg, 1997; Homann et al., 2008; Kamara et al., 2004; Watson, 2003). The system has many decentralized institutions and local regulations that work for the betterment of the natural resources and local people and their coexistence (Watson, 2003). Elders are responsible for the enforcement of local regulations, guiding livestock mobility based on the availability of feed and water resources, rangeland conditions, and carrying capacity of the rangeland (Watson, 2003). People practice the Kobo system in the high forests of southwestern Ethiopia (Tadesse and Woldemariam, 2007). The system provides and protects individual ownership/use rights for a block of forest, avoids open access to the forest, minimizes conflict among individuals and encourages ownership and responsible management of the resource base. Similar traditional systems with a significant role in natural resource management exist in Afar ("Finna") and Somali ("Heera") (Arsano, 2000).

Several traditional agroforestry systems integrate trees into farmland. The Konso people integrate *Moringa* trees into their degraded farm landscapes. Their natural resource management practices have been registered as a UNESCO World Heritage. Shifting cultivation is another traditional system practiced in the northern, northwestern and western parts of Ethiopia. The management systems are, however, weakened by the intervention of non governmental organizations and formal government institutions, which are taking control of the resources, and by the presence of new migrants (Arsano, 2000; Lemenih et al., 2007a; Woldeamanuel, 2011).

3.3.3 Participatory Forest Management (PFM)

PFM is "…a political and socio-economic arrangement through which communities and their elected leaders are made autonomous and accountable in their decision concerning forest governance." (National REDD+ Secretariat, 2018, footnote 16). PFM fills the legal gap that prevents communities from making decisions over local

forest resources. The state and community form a negotiated partnership over forest resource ownership, management, and benefit sharing. These partnerships acknowledge community rights to use and manage forest resources, but not legal titles over the forest. PFM features prominently in Ethiopia's REDD+ strategy and investment plans. Compared to plantations, PFM is much less costly to implement (USD 50/ha for PFM vs. USD 500/ha for plantations)[5], and generates co-benefits such as improved community ownership, governance, and livelihood benefits from the forest.

The geographical focus of PFM has been Afromontane and moist forests in Oromia, Amhara, and SNNPR (Windberg, 2011). Nevertheless, the REDD+ investment plan by the MEFCC included the expansion of PFM in Benishangul-Gumuz and Tigray, where nearly all (98% and 99%, respectively) of forests are in dry forest biomes (See MEFCC, 2017b). Interviews with NGOs supporting PFM suggests that communities managed at least 211,000 hectares under PFM in 2008-2009, but definitive data on the extent and impact of PFM at the national level is not yet available (Windberg, 2011). Others estimate that local communities manage more than 1 million hectares of different natural forests resources of the country through participatory forest management (PFM) scheme (Lemenih and Bekele, 2008).

A key element of PFM is creating and sustaining community institutions, often called Forest User Groups, or Forest Management Groups. These institutions establish bylaws governing forest utilization, protection, and benefit sharing. Forest management activities under PFM includes conducting an inventory of local forest resources, developing a management plan, implementing recommended silvicultural practices, harvesting resource, protecting illegal activities and monitoring the changes in the forest condition. Some PFM communities were involved in enrichment planting of degraded forests and areas surrounding natural forests, fire protection, and forest monitoring (Windberg, 2011).

PFM community groups need support, including building the institutions and institutional capacity, implementing livelihood activities, and establishing links with markets so that forest resources provide tangible and long-term economic benefits. The support has historically come from projects managed by NGOs (e.g., Farm Africa, SOS Sahel, EWNRA, and World Vision). With PFM's inclusion in Ethiopia's REDD+ strategies, there is increasing government involvement in providing the needed support for communities.

3.3.4 REDD+

Ethiopia recently published its National REDD+ Strategy for 2018 to 2030 (See National REDD+ Secretariat, 2018). This strategy builds on a series of engagements with several international initiatives supporting REDD+ readiness and implementation, including the Forest Carbon Partnership Facility (FCPF), UN-REDD+ programme, BioCarbon Initiative for Sustainable Forest Landscapes, and a bilateral agreement with the Norwegian Government on REDD+ implementation. REDD+ is recognized as an instrument in the CRGE to achieve objectives on emission reductions through the forestry sector.

Given that REDD+ focuses on providing climate change mitigation benefits, dry forests are at a comparative disadvantage compared to moist forests due to their low carbon density. Although 80% of Ethiopia's forests are in dry forest biomes, these forests contain less than 40% of the national forest carbon stock (See Table 1and Table 3). Several REDD+ pilot projects underway in Oromia and SNNP regional states, but most are in moist forests due to their high carbon density.

Despite their low carbon density, dry forests are still an essential part of Ethiopia's REDD+ plans. In July 2017, Ethiopia entered into a REDD+ partnership agreement with Norway which includes activities to prevent deforestation and degradation, which could be expanded into Benishangul-Gumuz, Amhara and Tigray regions (MEFCC, 2017b; MOFEC, 2018). Most forests (>97%) in these regions are located in dry forest biomes (See Table 1). Additionally, the National REDD+ Strategy identified several interventions that are particularly relevant for dry forests: (1) Addressing small-scale agricultural conversion, which are relevant for CT and AD biomes. Actions include improving agricultural productivity,

5 Based on estimates by the Oromia Forest and Wildlife Enterprise for the cost of nursery, plantation establishment and maintenance (USD 500/ha) and estimates from Farm Africa and EWNRA for PFM (USD 50/ha) cited in MEFCC (2017b) Footnote 13 and 14.

forest demarcation, and enhancing forest-based livelihoods; (2) Addressing large-scale agricultural conversion, which affect many dry forests in Ethiopia. Actions include better coordination with relevant agencies, strengthening law enforcement, awareness raising, and shifting investments to non-forested areas; (3) Training and extension for sustainable grazing in forests for pastoralists, which correspond to the AD and AC dry forest biomes; (4) Improving forest fire management, by raising awareness and improving local and national capacity for fire prevention and suppression. Since most forest fires occur on dry forest biomes, these interventions would affect dry forests.

4 Guiding principles and options for sustainable forestry in dryland Ethiopia

4.1 Conserving forest resources among growing pressures

4.1.1 Context

As one of the four pillars of the CRGE, forests are strategically placed in Ethiopia's development path. Nevertheless, another pillar of development within the CRGE is putting pressure on forests, namely crop and livestock production for energy security, commodity exports and improving farmer's incomes. Underlying this is a fast-growing population and an acute trade deficit. Agriculture contributes 68% of Ethiopia's employment (World Bank, 2017). In contrast, there are no definitive data on how much forests contribute to employment and household incomes.

The sizeable dry forest resources of Ethiopia have multiple – and sometimes competing - functions and users. For example, the vegetation in the southern and southeastern part of Ethiopia is commonly considered as a forest system and rangeland. Livestock production is the mainstay of most rural households and provides them with multiple products and flexible household capital reserves to manage shocks. Livestock is a significant contributor to the national gross domestic product (GDP), export income, and poverty reduction. On the other hand, grazing pressure from livestock is one of the main reasons that forests are degraded, and reforestation is challenging. Another example is refugee camps, which are mostly found in dry forest biomes. They are one of the leading causes of deforestation and forest degradation due to the high demand for fuelwood and construction materials.

4.1.2 Guidelines

Counteracting pressures on forests requires a better understanding of the real value of Ethiopia's forests, collaboration with stakeholders that stand to lose from forest loss or win from forest gain, and support for enabling conditions to use forests sustainably for multiple objectives. Land use decisions that affect dry forests need to better consider the tradeoffs between short and long terms outcomes, and different types of outcomes (e.g., income, climate resilience, water regulation, food security). We suggest several options:

Taking stock of forest resource conditions at the regional level, their de-facto tenure condition, and the value of their ecosystem services to other sectors (e.g., agriculture, livestock and hydropower production)

As the responsible government level for administering land and natural resources, regional governments need to understand better the resources they have, who manages and lives with these resources on a daily basis, and how their loss would affect other sectors with immediate economic benefits, such as crop, livestock, and electricity production.

Community participation is essential for forest management, especially in dry forest conditions where population density is low, travel costs are high, and there are tenure issues over forests. According to workshop participants, communities are often the last to know that an investor would be taking over land within the area they have considered as their community land, and they lose access to their forest as a result. These kinds of tenure-related issues have led to serious conflicts in Ethiopia.

Although the 2018 Forest Proclamation has made great strides in providing a legal pathway for communities and households to manage standing forests, action is needed to show that this legal pathway leads to real forest ownership. As the development of supporting regulations

takes time, communities can be made aware of this proclamation.

Re-assert the importance of environmental and social impact assessment in making land use decisions

Environmental and social impact assessments are already required for large-scale investments. They are often done superficially due to the high cost of accessing the area and conducting the studies, and lack of experts at the woreda level. Furthermore, the results of these assessments are rarely internalized into the land use decision-making process, due to limited data sharing between government entities and across levels of government, and inadequate knowledge management. Financing environmental and social impact assessments and leveraging the existing data for effective monitoring is, therefore, key aspects in ensuring better management of environmental and social impacts of land investments . Baseline data on forest cover from various sources (e.g., from federal government and open source data from the Global Forest Watch) can be made available to regional governments for forest cover monitoring, complemented with ground-truthing when forest cover change is detected. The value of such assessments can be quantified through documenting changes related to the establishment of land investments. This can be done using indicators such as the number of local conflicts or protest actions, net (i.e., gain minus loss) of income and employment among local communities in particular and the region in general, and the number of people displaced from and settling into the investment area. Such information signals the magnitude of the potential impact of land investments and the value of re-asserting the importance of environmental and social impact assessments.

Improve data sharing between federal and regional levels

The national forest inventory and the national REDD+ Measuring, Reporting and Verification (MRV) system can provide data on forest resource availability and change across time, and as a land use management tool for regional governments. There can be data sharing agreements between federal and regional levels, and capacity building for land use planning using this – and other – data sources. Ethiopia has started a forest monitoring system that provides land cover assessment every 2 years, managed by the MEFCC. The MEFCC can promote the use of this data to regional land administration bureaus so that they can estimate the impact of land use decisions on forest cover. Conversely, land administration bureaus can share data related to planned land investments, reforestation/afforestation efforts, and local forest management plans.

Clarifying procedures for communities and households to acquire forest ownership rights

Communities and households have been living with and managing forests in Ethiopia, despite not having clear ownership status over these resources. Because of this, decisions are skewed towards short-term gains, since there are no guarantees that they would be able to benefit from any investments in the long term. The 2018 Forest Proclamation provides the framework for communities and associations to sustainably utilize and manage forests, by having provisions for their forest ownership.

These provisions need to be translated into institutions, regulations and clear procedures on how exactly non-state actors can gain ownership rights over forests. In particular, the proclamation states that any forest ownership must be located in areas designated by the government as forest land . This forest land designation process can be a severe bottleneck and could lead to less involvement of communities in forest management if the process is not managed effectively. In particular, there are overlaps in definitions and authority over “rural land” as stipulated in the 2005 Rural Land Administration and Land Use Proclamation (i.e., 2005 Land Proclamation) and “forest lands” in the 2018 Forest Proclamation. The Land Proclamation is geared towards land ownership for agriculture, pastoralism, and agro-pastoralism, but has no specific provisions for forestry despite including forests as part of the definition of rural lands. Ethiopia can build on the experience of implementing programs to provide certificates on agricultural lands, which has been successfully rolled out in several regions.

The development of procedures to secure forest ownership rights should be done in partnership with regional governments and consultation with local communities and organizations, to ensure the procedures take into account local constraints,

Table 9. Forest categories in the 2018 forest proclamation.

Forest category	Definition
Preserved forest ( )	"A forest that is free from human and domestic animal intervention preserved for the purpose of conservation of biological diversity, historical and research purposes."
Protected forest ( )	"A forest that provides various ecosystem services and is utilized in accordance with a forest management plan developed by the responsible body without affecting the sustainability of the forest ecosystem value."
Production forest ( )	"A forest that is mainly developed for economic purpose."

opportunities, and practices, and to gain broad support and legitimacy. Rights and responsibilities attached to forest ownership need to be understood by local regulators, law enforcement agencies, and community leaders and members.

Determination of forest lands according to preserved, protective, and productive forests; Evaluation of existing gazetted forests, and prioritization of new forest areas for gazettement

The 2018 forest proclamation divides forest lands according to three categories, each with different levels of utilization rights (See Table 9). These classifications are spatial planning tools to allow regulators to balance between economic and environmental goals. Given the rapid loss of forests in Ethiopia, the determination of forest lands across these utilization categories need to be done immediately. Several points need to be considered. First, since activities in these forest categories range from strict conservation to production for economic purposes, the technical definitions of each category need to be based on available legislation. Definitions related to nature and wildlife conservation should be established in consultation with researchers, regional governments and police, EWCA, state forest enterprises, existing forest user groups established under PFM, and other government and non-government entities managing or conserving forests.

Second, given that there is no multisectoral land-use plan in Ethiopia, the risk of overlap is high. This risk can be mitigated by starting in areas/sectors with the least conflicting land uses, and being prepared to negotiate. Expect a lengthy negotiation process with other sectors, the land administration, parliamentarians, and regional governments, and allocate staff, funding and time accordingly.

Preserved forests need to be prioritized for gazettement because they are strictly protected from human and animal intervention. Some protected areas in Ethiopia have already been gazetted, but may be experiencing heavy human use. In such cases, consider evaluating the area as protected or production forest. Ethiopia can learn from experiences of de-gazettement in other countries in Africa. Gazettement processes often involve negotiations with local communities, which imply allocating and empowering staff to lead these negotiations on behalf of government authorities and partnering with law enforcement agencies.

Provide technical support and formal training for producing forest management plans at the local level that brings together multiple management objectives

Rights and responsibilities in utilizing protected and production forests as written in the 2018 Forest Proclamation require that forest owners (e.g., communities, private entities, cooperatives) have forest management plans. So far, very few management plans have been prepared and formally implemented. Given the inclusion of new categories of forest owners, there is an increased diversity of forest management objectives that need to be incorporated in management plans such as income generation and protecting ecosystem services. Producing this type of management plan requires technical expertise that is in short supply in Ethiopia. Ethiopia's forest management history has focused on forest conservation and silviculture for even-aged stands. For example, there are very few foresters trained in developing management plans for natural forests incorporating non-timber forest products, edible/medicinal

plants, wildlife, fodder production or sustainable timber production from indigenous tree species. Alternatively, developing forest rehabilitation plans on degraded lands, with explicit objectives of producing fuelwood, generating income, while protecting water sources. The supply of forest experts can be spurred by commercial demand for their expertise. In other countries, such as the US or Sweden, private landholders hire forestry consultants to develop these management plans. In Ethiopia, owners of nearby/adjacent forests (e.g., communities, households, cooperatives) can pool funds and pay for such services.

Realize and improve collaboration between stakeholders with a mutual interest in sustainable management of dry forests

Dry forests provide goods and services crucial for all Ethiopians, such as water regulation, cash income from forest products, fuelwood, wildlife habitat, and edible and medicinal plants. These touch the livelihoods of a broad spectrum of stakeholders, ranging from government agencies, households living adjacent to forest areas, urban households, industries, tour operators, refugee camps and exporters of forest products. Collaborations between these stakeholders need to be supported. Some forms of collaboration are being integrated systematically within government systems. For example, in Ethiopia's REDD+ national strategy, the federal government included Participatory Forest Management (PFM) as an approach to collaborating with local communities. It needs to be further strengthened by empowering local communities, forestry experts and law enforcement agencies to work together.

Many other collaborations can be developed or further strengthened. For example, there are growing realizations that forests, especially dry forests, are allies in another pillar of Ethiopia's development, which is providing electricity through hydropower. Mega-dams are being built in the heart of Benishangul Gumuz, a region entirely located in the CT biome. Several industrial parks are being built across Ethiopia, requiring a steady water supply. Maintaining upstream forest cover would be crucial to ensuring the longevity and smooth water input into these dams and industrial parks. Despite this, there are very few collaborations between those interested in maintaining water supply for the dam, and those managing upstream forests. These collaborations need to be based on mutual benefit and trust, which require a system of accountability based on clear roles, rights, and responsibilities. Ethiopia can learn from experiences in many other developing countries that have established various types of collaborations to manage their forest resources better. For example, Vietnam has established a Payment for Forest Ecosystem Services system, while Indonesia is in the process of scaling up Social Forestry to engage communities in managing state forests.

Prevent dry forest degradation while creating economic opportunities by supporting the establishment and sustainable management of bamboo and tree plantations, and agroforestry to reduce pressure on dry forests

Dry forests are rapidly being degraded due to unsustainable harvest of wood for fuel and charcoal, NTFPs and fodder for livestock. Due to the low biological productivity of these biomes, it is challenging and costly to regain what has been lost. Preventing degradation by providing sustainable and economically attractive sources of forest products is, therefore, a cost-effective strategy. One way is to establish and sustainably manage plantations or practice agroforestry to supply forest products that would otherwise be harvested from natural forests and to replace degraded forest resources. The National Forest Monitoring System (NFMS) within MEFCC can provide information on areas that are experiencing rapid forest degradation or loss and is a useful tool for identifying and prioritizing areas where plantations or agroforestry practices need to be located.

Access to land and markets are the main obstacles for smallholders (e.g., individuals or cooperatives) and private companies to establishing plantations. In Oromia and Amhara regions, smallholder farmers establish *Eucalyptus* woodlots with very little external support due to the high timber demand in urban centers like Addis Ababa and Bahir Dar. Some of these plantations are replacing crop production and are especially prevalent in areas adjacent to main roads and individually-owned or controlled lands. They mainly supply small-diameter poles (5-10cm) and fuelwood/charcoal.

The 2018 Forest Proclamation provides the legal framework that could alleviate the issue of access to land. It stipulates that associations and private enterprises can have ownership of forest lands developed for economic purposes, while communities can manage natural forests. Although the definition of forest in the proclamation does not explicitly include plantations, it does include trees, plants and biodiversity accumulation developed in other ways, which could include plantations.

4.2 Maintaining or enhancing biological diversity to assist forests' multifunctional services

4.2.1 Context

Humans have multiple demands from dry forests, ranging from fodder and fuelwood to water regulation and carbon sequestration. The most cost-effective way to provide such wide-ranging goods and services is to have a biodiverse forest (Isbell et al., 2011; Mori et al., 2016). These wide-ranging goods and services can be produced more effectively and reliably by forests despite changing climates if there is high diversity across forests types and species, and diversity within species (Isbell et al., 2011; Mori et al., 2016; Soliveres et al., 2016). Biological resources are important biotic checks to pests and diseases and serve as a defense line against global climate change. Forest biodiversity ensures forests can be more effective in sustaining human welfare (Cardinale et al., 2012). The loss of biodiversity has the largest impact on the functionality and sustainability of Earth's ecosystems (Hooper et al., 2012).

Despite the existence of national parks, 69 out of the 77 endemic tree/shrub species that are endangered or critically endangered in Ethiopia are found in dry areas[6] (Vivero et al., 2005). Such a decline in biodiversity at different spatial and temporal scale has become a concern in the country, leading to increasing concern and demand for biodiversity conservation (EBI, 2015). Dry forest species with high economic value, such as *Boswellia papyrifera* (frankincense tree) and *Oxytenanthera abyssinica* (lowland bamboo) are the threatened species (IBC, 2012).

6 Based on species found in Afar, Hararghe, Bale, Sidamo, Gamo Goffa, Wollega, Gojjam, Gondar, and Tigray

4.2.2 Guidelines

The following guideline is proposed to maintain and enhance the conservation and sustainable use of biodiversity in Ethiopian dry forests. This particular guide is meant to minimize a variety of negative impacts of different intervention in the dryland areas of the country on biodiversity, particularly when carried out without management standards designed to protect natural assets and promote sound interventions.

Improve knowledge and capacity to manage dry forest resources that enhance their biodiversity values

Technical support and technology transfer need to be provided to a wide range of forest users, such as companies who want to invest in timber plantations, local governments who need to rehabilitate degraded lands, and forest management group members seeking to increase economic benefits from their forest. In particular, they need basic knowledge of forest formations, pasture lands and ecological processes, the value of biological diversity in sustaining a balanced environment, and how this balance affects their livelihood and wellbeing.

Ethiopia already has excellent national policies, strategies, action plans/programs, and international commitments related to conservation of biodiversity. Nevertheless, they are poorly communicated to stakeholders that are outside the realm of forestry or conservation. The concept of biodiversity conservation needs to be made more relevant to the public by raising awareness about how biodiversity affects daily life and sectors outside of forestry, such as agriculture, energy, and manufacturing. Manuals, guides, and other material need to be developed for communicating the underlying concepts, objectives values of biodiversity, and techniques to maintain and enhance biodiversity in dry forests. These materials should be accessible to a wide range of stakeholders, including local forest managers, field personnel, government agencies, the private sector, and the media in a language that is understandable, relevant, and useful.

Ethiopia needs to develop a system to collect, store, and disseminate existing and new data on biodiversity in dry forests. This information includes unique genus, species, populations,

and assemblages of species, habitats, ecosystems, landscapes that are identified as those that need special precautionary measures to protect them. Particular sites and areas of forest and other habitats that provide essential ecological functions should be identified and communicated to the public, notably to local stakeholders. Such a map could be produced through a collaboration between the forest MRV unit within MEFCC and the Ethiopian Mapping Agency. Rare, threatened, or endangered plant and animal species in or adjacent to forest management areas also need to be identified, recorded and communicated to stakeholders.

Develop a national and local land-use plan and enforce forest and environmental policies, proclamations, and laws to address issues of biodiversity conservation and sustainable use in forests

The 2018 Forest Proclamation adopts 3 forest types: preserved, protected and production forests (See Table 9). The next step is to identify and establish areas designated as preserved and protected forests, in close consultation with forest experts, local governments, and communities. In these areas, land use and forest management plans need to be developed to maintain and enhance biodiversity conservation. In areas designated as protected and production forests, relevant policies, laws and regulations, and international agreements and commitments need to be respected to ensure that biodiversity interests are adequately addressed in the management of dry forests. Inconsistent or contradictory forest environment and land-use policies and laws at the national and regional levels need to be identified, reviewed, and modified, notably those that conflict with the objectives of biodiversity conservation and sustainable forest use.

Ensure that local forest management plans address conservation objectives

In the 2018 Forest Proclamation, forest management plans are the essential documents guiding the management of production and protected forests in Ethiopia. These plans need to incorporate conservation objectives, and clearly articulate biodiversity conservation objectives for each area of forest under management. All prescribed silvicultural practices in the management plan of each forest area should strive to reduce their impact on biodiversity and soil nutrients, enhance regeneration of light-demanding species through selective logging or thinning, retain canopy connectivity for canopy-dwelling animals, and reduce the exposure of open ground to rain and sun. Management plans should include precautionary measures to limit or avoid the introduction and spread of invasive alien species, avoid unsustainable levels of hunting and the gathering of non-timber forest products.

Management plans, including rehabilitation of degraded lands, should favor natural processes to bring back native species and enhance the productivity and resilience of the rehabilitated land by providing a diversity of successional vegetation types, increasing the connectivity of forest patches, and allow the dispersal of plants and animals. Threats to local biodiversity need to be identified and managed as part of the forest management plan. Institutions to regulate forest management plans and to monitor its implementation need to be established.

Improve the adaptive capacity of dry forests

Dryland systems are fragile and resilient at the same time. Drylands naturally experience high temperatures, unreliable rainfall, strong wind that cause high evapotranspiration rates and limited moisture availability. All these factors make the ecology of drylands to be a fragile and unstable environment. On the other hand, the people and wildlife that have thrived in these landscapes are very resilient. Pastoralists, for example, control the utilization of natural resources based on their availability and have maintained the ecosystem dynamics to function properly. However, disregarding these dynamics combined with unprecedented changes in climate has led to the reduced adaptive capacity of drylands and their forests.

Steps can be taken to limit and reverse these outcomes. For example, by identifying areas that are highly vulnerable to degradation and irreversible damage, and limiting the use of these areas (e.g., through area exclosures). Landscape restoration plans need to take into account biodiversity values when identifying locations, e.g., by prioritizing areas that can reduce fragmentation of habitats, maintain existing habitats, and establish new habitats to improve ecological connectivity of the landscape. Monitoring and evaluating biodiversity outcomes can provide

timely and useful information to identify problems early, and find practical solutions. Relatedly, an adaptive management approach needs to be promoted to take advantage of new information from the monitoring and evaluation activities. All these actions need to be supported by providing the relevant technical support (e.g., landscape restoration, biodiversity monitoring, and evaluation) and consultation with relevant stakeholders.

4.3 Promoting healthy and vigorous forests and combating difficult growth conditions

4.3.1 Context

Fire, insects, and diseases have caused significant damage to various forest ecosystems (Manion, 1981; Wingfield, 1990). Research so far is limited to the identification of pathogens and insect pests and collecting information on the damage caused by diseases, insect pests and fire on trees and tree products. Quantitative data on the economic, social and environmental damage on natural and plantation forests is lacking. The prevalence and spread of insect pests, disease and fire are likely to increase by the climate change suggesting an increase on the extent of damage in the future associated with the anticipated climate change.

Most foresters in Ethiopia do not fully understand the interaction between fire, livelihoods and dry forest management. For example, foresters working in areas dominated by pastoralism have not integrated the traditional knowledge of using fire for managing grazing lands where dry forests are found. There is also minimal knowledge on how to monitor fire, and integrate cost-effective techniques to prevent fire incidences within forest management plans.

Sustainable management of forest resources strives to have a healthy and productive forest where the damage by the insect pests, disease and fire is kept at a low level (FAO, 2001). To achieve such forest conditions, managers need to understand and anticipate pests, diseases, and fires based on the historical records of their occurrence and the knowledge of the forest and climatic conditions that favor their abundance. The anticipation of their occurrence would help the managers to implement practices in a timely manner (Ciesla, 1994).

4.3.2 Guidelines

Establish a forest protection service within the federal to woreda administration system (e.g., staff to combat pests, diseases and invasive species)

The current federal and regional structures that are responsible for forest protection and conservation need to be better staffed, funded, well integrated into disaster response systems, and acquire knowledge and skills to manage the various kinds of forest threats relevant to their geographical area. It would also be advantageous to establish institutional links between (i) MEFCC, regional forestry bureaus, and existing fire command system; (ii) the forest protection department and the forest rehabilitation department, so that damaged forests can be quickly rehabilitated; (iii) Ministry of Agriculture and Livestock, to harmonize approaches in managing fires for rangeland maintenance, and prevent fires, pest and diseases spreading across forested and agricultural landscapes; (iv) the national MRV system and the forest protection service to exchange information related to forest degradation and loss due to fires, pests, and diseases.

National forest monitoring and management strategies and plans need to integrate objectives related to the prevention, early detection and rapid response, control, and management, and the recovery of damaged resources. Indigenous knowledge and interests of the local communities need to be taken into account. Links between the communities, local, regional and federal experts in pest surveillance survey, monitoring, and management of pests need to be improved.

Develop the knowledge and skills of human resources that can take early measures to avoid the outbreak of forest fire, diseases, and insect pests.

Training programs in fire, pest and disease management are needed, targeting masters and PhD-level experts who can train regional and woreda forestry experts. A forest risk mapping exercise can be done to identify high-risk areas and periods and target them for community outreach and monitoring activities. An economic analysis of

the cost and benefits of avoiding forest fires, pests, and diseases in high-risk regions would be useful to inform budgetary allocation for these activities. Government agencies can take advantage of new open-access earth observation technologies that can help monitor and anticipate fire, pest, and disease outbreaks. For example, there are online platforms (e.g., https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data) that provide daily email updates on occurrences of fire hotspots in areas specified by the user.

Enhance community participation in monitoring and preventing threats to forest health

Communal rights over communally managed forest resources can increase local interest, and clarify roles and responsibilities in maintaining forest health. Communities need clear guidelines on how to prevent, limit, and report fire, pest, and disease events. Woreda forestry experts can benefit from getting outreach tools such as simple illustrations and descriptions of frequently-identified pests and diseases to help them provide extension services. It would also be helpful to have a simple reporting mechanism for community members and woreda forest experts to report fire, pest and disease outbreaks. New smartphone-based apps to facilitate the reporting process from communities/woredas to the national MRV system can be explored. Activities such as join patrol with government staff can be used to enhance links between government and community members.

In high-risk woredas, a committee can be established to monitor and respond to forest threats, and serve as focal points to help in simple actions for monitoring health- and pest-related developments in the forest. Mass media outlets can be engaged to alert communities during high-risk periods (e.g., fire season, disease outbreaks). Contact and regular communications between foresters and pastoralists/agro-pastoralists need to be improved, to exchange information on the current situations and management approaches. Other ways to improve public involvement in forest protection is to have financial transparency in executing forest protection plans and give opportunities to local authorities to administer the budget. Alternative budget sources need to be sought for effective protection measures in collaboration with local communities and authorities. Opportunities for improved community collaboration should be identified by analyzing forest protection experiences and involving local communities in decision-making.

The 2018 Forest Proclamation includes specific articles on the responsibilities of forest owners/users in protecting forests against fires, pests, diseases, and invasive species. Local communities need to be aware of these and other laws and regulations. However, there needs to be increased understanding among forestry officials (i) that fire is a necessary tool to maintain the rangeland health and prevent large fire outbreaks; and (ii) about the manner in which communities use fire. This knowledge would help them to work with communities more effectively.

Protect forests and pastures from adverse impacts of fire

Fire is an essential tool for rural people in dryland areas. Fires can also create large-scale damage to forests and pastures of left unchecked. Knowledge of fire ecology in drylands, the behavior of various species in response to fire, the physiology and biology of fire-affected forests need to be generated, compiled, and shared. Forest fire committees at all government levels should be established so that there are institutions that deal with fire-related issues (prevention and response). Capacity building activities can include raising awareness about the use of prescribed burning in maintaining the forest's biological diversity and providing training in fire prevention and fire fighting techniques to experts and local communities. Forestry professionals should better understand indigenous knowledge on prescribed burning, and combine this knowledge with techniques developed by others (e.g., researchers).

Community involvement in activities related to fire prevention and management (e.g., prescribed burning, establishing and maintaining fire breaks, firefighting, fire reporting, post-fire forest reclamation) need to be encouraged and supported by subnational and national government agencies.

Adopting an adaptive forest management approach

Forest management needs to adapt to unpredictable and changing challenges. Forest managers need plans at multiple spatial and temporal scales and need to be flexible when choosing the most appropriate management

options. The following are adaptive management options that can be practiced to reduce the impact of different factors on the health and vigor of forest resources:

- Changing rotation lengths, in response to changing precipitation and temperature risk;
- Being flexible in the planting seasons, in response to a changing climate and to the success of natural regeneration;
- Enhancing natural regeneration through enrichment planting, where species diversity and potential adaptability are likely to be limited;
- Selecting and planting species and varieties that are less vulnerable to climate change;
- Developing strategies for vulnerable forests to minimize damages from forest fires, pests, and pathogens
- Implementing reduced impact logging or practice selective logging with minimum damage to forest systems

4.4 Enhancing forests' productive and protective capacities

4.4.1 Context

The productive and protective capacities of forests need to be enhanced through adequate management, to ensure that their primary functions are sustained to the satisfaction of forest users. Below are some prerequisites for good forest governance and management:

- Clear delineation of forests' various functions.
- A policy that guides the steps to achieve optimum forest production and protection.
- Quantitative and qualitative objectives for forest management and silviculture.
- A clear government framework defining the scope of forest production and protection.
- Diversified forest management techniques.
- Local understanding of the value of standing forest.
- Linkages between institutions that govern forest resources and forestry research units and academic institutions.

The government of Ethiopia has established protected areas (e.g., national parks, wildlife reserves, sanctuaries, bio-reserves), and production areas (e.g., for gum and resin production, lowland bamboo, rangelands). In large areas of dry forests, borders between forest and non-forest land uses are unclear and needs to be quickly clarified to prevent (further) encroachment (Lemenih and Bongers, 2010). Forests managed under PFM are delineated either for their conservation or production function. Existing forest policy, strategy, and the forest proclamation are guiding the development, utilization, and protection of forest resources. Nevertheless, more locally-adapted and participatory management guidelines and plans are needed, informed by research, academic and civil society institutions, to optimize the productive and protective functions of dry forests.

4.4.2 Guidelines

The following interventions are recommended to enhance dry forests' productive and protective capacities:

Integrate and harmonize the existing forest legal and policy framework with other sectors

The activities of the forest sector involve multiple sectors and demand a broad, inter-sectoral approach at all stages. Other sectoral policies and regulations may also affect the management of forest resources. The following actions can improve inter-sectoral integration and coordination:

- Harmonize forest-related policies and proclamations with the policies and legislation of other sectors like agriculture, energy, and industrial development.
- Increase coordination and cooperation across relevant sectors at different levels, e.g., memorandums of cooperation across ministries/regional bureaus, joint conferences, workshops or training events, and establishing inter-sectoral working groups or forums.
- Revise the existing forest policies to integrate forestry issues into national development and poverty reduction policies.
- Assess integration of the country´s development, climate change, food security, and poverty reduction objectives into the national forest programs.

Review and revise existing forest policies and proclamations at regular and appropriate intervals

Reviewing and revising policies and proclamation is important with acceptable intervals (e.g., 5 -

10 years) to give space for emerging issues and to integrate them into other sectoral policies, including:

- Form derivative regulations/acts to provide clarity on implementing the forest Proclamation.
- Provide support to regional governments in reviewing and revising regional policies/ regulations so that they are harmonized with federal-level policies and proclamations.
- Work with other branches of the government to ensure the allocation of land for forest resources across the landscapes to meet the conflicting societal demands on forest ecosystem services within local forest landscapes.

Implement recommended silvicultural practices and select the most appropriate species

Pressures on dry forest could be alleviated by establishing resilient and productive plantations, woodlots, and natural forests in dry regions. In these forest systems, silvicultural practices that enhance the regenerative capacities of species, diversity of the system and productivity of species need to be promoted. These practices require sufficient technical capacity and forest extension system, with due attention to traditionally marginalized forest users such as women. Some of the recommended silvicultural practices include:

- Selective periodic tree thinning and branch pruning in the productive natural dry forests to supply firewood and construction wood and to enhance plant diversity, stand productivity, and carbon sequestration.
- Where possible practice block harvesting without significant damage to the watershed
- Use sustainable production guidelines for non-timber forest products (e.g., gum and resin, bamboo, edible plants, fodder, and medicinal plants).
- Manage the number of herbivore mammals and apply prescribed fire in protected forest areas, mainly in national parks. The practice would help to ensure maximum niches for biodiversity and increased resilience of the ecosystem.
- Practice assisted natural regeneration either with vegetative offsprings from layering and cuttings or seed banks to secure strong regrowth of species.
- Practice enrichment planting through complementary plantations of the desired species to secure complete regeneration of the forest.
- Construct soil and water conserving structures like contour ditches or swales and practice soil mulching, to maintain or enhance soil fertility and water availability.
- Water and fertilize planted seedlings in the forest.
- Practice different tree tending operations and harvesting techniques that enhance regeneration of plant species as per the ecological requirements of species.
- Select species with better water use efficiency , drought resistant genotypes and fast-growing habit for establishing plantations in dryland areas.
- Plant different species to address different demands and enhance resistance feature of forest due to different threats when soil and projected climatic conditions are appropriate.
- Ensure adequate soil fertility through cultural practices, soil preparation, or fertilization to increase water use efficiency.
- Manage stand density and remove weeds in young plantations to avoid water stress condition.
- Conserve the forest floor, maintain the residue in the forest or use hydrogel to minimize surface evapotranspiration in newly established stands.
- Apply recommended coppice management systems that enable the harvesting of various size classes of products during several stages of the tree crop cycle of tree species to offer more financial flexibility for emerging growers.
- Link with research and academic institution to get new techniques for stand management and regeneration techniques.

Below are some sources of information on species selection and silvicultural practices adapted to Ethiopia's dry forests:

- Species selection tool (Kindt et al., 2015) http://www.vegetationmap4africa.org/Species/Species_selection_tool.html
  This tool works with Google Earth to help 'find the right tree for the right place.' It has data specific to Ethiopia.
- Lowland bamboo cultivation guidelines for Ethiopia (Brias and Hunde, 2009): Book with detailed information on how to cultivate lowland bamboo, from propagation to post-harvest treatment.
  URL: https://www.unido.org/sites/default/files/2010-01/Guidelines_for_cultivating_Ethiopian_lowland_bamboo_0.pdf

- AgroforesTree database (Orwa et al., 2009): Users can search by country and product/service (e.g., gum/resin, food, fodder) and find a list of species names that fit the search. Clicking on a species name leads to more information about its ecology, distribution, and management. URL: http://www.worldagroforestry.org/output/agroforestree-database
- TreeDB: Users who are interested in a particular tree species can enter the species name and get information about its uses, distribution, and management. Although based on similar data used in the AgroforesTree database, the information in TreeDB is more elaborate, but users cannot limit the search by country. This database is suitable for those who want to learn more about usage and management of a specific species. URL: http://www.worldagroforestry.org/treedb/index.php
- Tree-based landscape restoration atlas of Ethiopia (MEFCC 2018): This is an interactive map to help users identify areas suitable for tree-based landscape restoration. More technical details can be found in the accompanying technical report. URL: http://eth.restorationatlas.org/
- Management guide for sustainable production of frankincense (Lemenih and Kassa, 2011b) This manual is developed for extension workers and companies managing dry forests for resin production and marketing. URL: https://www.cifor.org/publications/pdf_files/Books/BKassa1101.pdf

Expand forest cover and optimize landscape and land conservation

Managing dry forests for multiple - and sometimes competing - products and services is essential for meeting the ever-growing demand for forest products and services, which entails a better control over the forest degradation and deforestation processes and (re)establishing forests. One challenge is to get sufficient land to increase forest and tree cover, notably on fragile/marginal landscapes.The following actions are recommended to prevent forest degradation and extend forest cover:

- Collaborate with local authorities and stakeholders to design locally-appropriate forest restoration plans based on the existing analysis of forest restoration potential in Ethiopia (MEFCC, 2018).
- Practice land use planning to allocate lands to different land uses across the landscape in a way that balances economic, social, and environmental values.
- Define ownership for dry forests that are in open access, prioritizing areas that are experiencing rapid degradation or forest loss, and have high environmental values such as around water bodies and biodiversity-rich forests.
- Provide support to local forestry bureaus and experts to improve the management of the remaining dry forest resources.
- Introduce practices that enhance the availability of fuelwood for rural households and improve the efficiency of the production and consumption of wood-based fuels (including charcoal), with particular attention to practices and locations accessible to rural women.
- Incorporate the management of natural lowland bamboo forests and the establishment of lowland bamboo plantations into rural energy and forest restoration strategies.
- Improve the tree cover in fragile land resources like plateau and higher-altitude areas, riverbanks, lakeshores, and other wetlands, around villages and other dwelling sites, in urban areas, and agricultural lands.

Regular assessment and improvement of the economic environment for forest production

Dry forest resources provide subsistence and commercial forest products. The economic contribution of dry forests to rural livelihoods and other productive sectors is, however, still poorly understood. Many dry forest products (e.g., bamboo, medicines, gums, bush meat, fodder, and resins) and services (e.g., tourism, watershed protection) are traded informally or not at all and are poorly regulated and monitored. The economic environment is not conducive for generating employment, tax income or foreign exchange income.The following actions are recommended to overcome these challenges:

- Regularly assess the potential for developing forest-based businesses at the regional level, and facilitate linkages between market actors and forest managers, including local communities and governments.
- Assist producers (including local communities) to expand their trading activities by providing institutional support like micro-credit provision, skills training, organizational

capacity building, and development of value-added products.
- Promote the role of private sector actors in businesses based on sustainable forest management and businesses that provide services to support the forestry sector.
- Increase awareness about provisions in the 2018 Forest Proclamation related to the utilization and commercialization of forest products by communities, associations, and private entities.
- Improve the government regulatory and oversight capacity over private sector entities in the forestry sector.
- Review regulations on taxation and sales of dry forest products and services, to encourage broader participation in formal markets.
- Review the potential economic impact of improving tenure arrangements on forests for the private sector, communities, and associations, to guide government decisions to invest in this endeavor.
- Provide appropriate business support services and a favorable policy environment for trading lesser-known forest products from local to international level.
- Organize and promote producer, processing, and marketing cooperatives to enhance production and diversity of forest-based goods and services.

Balancing protection and production objectives

The objective of protecting forests while generating economic benefits by producing goods and services from the forests may involve tradeoffs that need to be clarified and reconciled. Some management practices can reconcile these contradictory objectives by promoting forest uses with minimal harm. The following actions are recommended for managing dry forest resources for multiple and competitive products and services in a sustainable way:
- Clarify tenure arrangements and suitable ownership types for dry forests, with emphasis on open access areas and areas that have been managed based on customary rights.
- Use participatory/collaborative approaches to help ensure that competing objectives are reconciled
- Once a forest owner or manager is defined for a particular forest area, identify their primary needs and forest management objectives. Explore types of products and services that can be sustainably obtained in the specified dry forests. Refer to existing sustainable forest management guidelines/toolboxes to design a forest management plan that caters to these needs/objectives (e.g., see guidelines by FAO and ITTO).
- In rangelands, integrate forest management into rangeland management objectives. For example, using prescribed fire and selective tree harvest to decrease woody species cover and increase grass cover.
- Review and revisit national plans and programs for dry forest management.

4.5 Promoting socio-economically relevant forest resources

4.5.1 Context

Dry forests need to be socially and economically relevant for Ethiopia, at the national, regional, and local levels.

4.5.2 Guideline

Demonstrate the economic and employment contribution of dry forest products at the regional level, notably products without market value or that do not generate formal employment

Current efforts to estimate the economic contribution of forests need to be scaled down at the regional level because regional actors are among the most important actors in making decisions concerning land use. Special attention needs to be given to forest ecosystem services, which typically have no market value, and products mostly used for subsistence. There is also a large amount of forest-based activities that do not generate formal employment, such as trading of toothbrush sticks, bamboo culms, bushmeat, and plant-based traditional medicines.

Increase the role of lowland bamboo in land rehabilitation, fuelwood or charcoal generation, supply for construction materials, and income generation from local and international markets

Lowland bamboo is resistant to poor soil conditions, drought tolerant, resilient to climate change, and grows in areas that are vulnerable to desertification. This bamboo can be used to restore degraded lands and can be used for fuelwood,

charcoal, construction materials, furniture, and other processed goods. Since they are fast-growing, using bamboos for fuelwood is recommended to decrease pressure on trees, which are often slow-growing in the drylands. Although bamboo is a significant export product (See Table 2), it is mostly exported raw or with little value addition. By assisting with access to finance, marketing and production technologies in producing value-added bamboo products to small and medium-scale enterprises and cooperatives, local incomes generated from bamboo can be improved. Such support should be prioritized for rural populations living near existing bamboo forests and within a reasonably close distance from markets.

Create supporting regulation and institutions to realize economic benefits from dry forest management for rural communities and small-scale enterprises

The 2018 Forest Proclamation has provided a supportive legal framework to include rural communities and small-scale enterprises to benefit from dry forests. More detailed regulation is needed, e.g., in clarifying the institutions responsible for providing extension services to forest owners, the specific roles of financial and legal institutions in providing loans, and the responsibilities of law enforcement institutions in addressing grievances. In short, an ecosystem of regulations needs to be created to assure that ownership of communities, associations, and private entities over forests would be protected by law.

Provide technical and marketing support to small-scale producers for sustainably utilizing forest products that have competitive advantages

Producers of economically important forest products, such as gums and resins, bamboo, fuelwood, and charcoal, rarely receive any technical and marketing support from the government, although the demand for this support is high. The lack of support has discouraged or hindered the adoption of sustainable production and utilization practices. Many forest products could have competitive advantages in domestic markets, as seen by the massive trade imbalances that exist among wood and bamboo products (i.e., more imports than exports). Ethiopia can also further diversify the production of existing dry forest products, such as gums and resins from species other than *B. papyrifera*, or develop charcoal products from sustainably managed bamboo and mesquite plantations.

Establish viable businesses in sustainable fuelwood and charcoal production using invasive and fast-growing species

Unmanaged stands of lowland bamboo and *Prosopis juliflora*/mesquite are already being used as fuelwood and charcoal in several parts of Ethiopia. This product can be developed into economically attractive and environmentally sustainable businesses if producers are supported with clear use rights over forest resources, technical training, and financing. Potential markets include refugee camps/communities, local industries, and urban centers.

Improve knowledge on bamboo management and utilization among Ethiopian foresters and forest communities

Bamboo is included in Ethiopia's forest definition only recently. Knowledge of bamboos among Ethiopian foresters is minimal due to the strong influence of European silviculture in Ethiopia's forestry education, which focuses on the management of tree species. Foresters have not been trained to manage bamboo forests, which need an entirely different management approach compared to forests dominated by trees. For example, lowland bamboo clumps need to be thinned annually to maintain their health and productivity, whereas the same frequency of thinning would lead to severe degradation in forests dominated by trees. Harvesting bamboo culms too early (before 3 years) or too late (after 5 years) can compromise the productivity of an entire bamboo clump. Because of these characteristics, lowland bamboo can provide short-term income that can be combined with long-term income from timber harvests.

Improving the knowledge on bamboo management, especially among woreda forestry experts and forestry students, can improve the sustainable utilization of bamboo for improving local livelihoods, reduce pressure on natural forests, and shift public perceptions towards seeing bamboo as a valuable forest resource.

Support the establishment and maintenance of forest cooperatives and associations

Thus far, forest associations (e.g., forest management groups) are the leading legal entities at the local level that can legally harvest and market forest products under the PFM framework. In many cases, NGOs established many of these groups using funds from short-term projects on PFM. Although some groups continue to be active after the project ends, others become inactive or ineffective in managing the forest in the long run. The lack of effective institutions can pose risks to the forest in the long run, e.g., elite capture, and difficulties in implementing forest management plans. Such institutions need to be supported more sustainably to outlast short project cycles, e.g., by creating a self-financed network of FGMs. These networks can pool together resources to organize activities or hire experts.

Recognize communities and rural households as potential investors

The concept of 'investor' needs to be expanded to include community groups and individual rural households. Thus far, they are the primary figure in managing dry forests by monitoring forests, harvesting, utilizing, and commercializing forest products. In some cases, they have also contributed to conserving and rehabilitating forests. These actions involve investments in time, money, and labor, which have never been formally recognized. The investments made by local communities and individual households are clear indicators that they are interested in managing the forest resource. These community investments can be harnessed by providing programs targeted to engage communities in economic activities involving dry forest management. Such programs, for example, could combine financing and technical assistance to establish community-owned forests, nurseries, or plantations.

Exploring options for payment for environmental services

Create and raise awareness for governmental institutional and local communities about the potential of dry forest resources for payment for ecosystem (PES) service, starting with erosion control in upper catchments of hydroelectric dams, and water supply for companies producing bottled drinks. There need to be further discussions with the potential buyers of the services, e.g., Ethiopian Electric Power Corporation (EEPCO) or various industrial estates, on how to streamline PES into their business operations.

4.6 Awareness raising, education, and capacity building

4.6.1 Context

Some factors contributing to the continued deforestation rate in the dry forest resources are related to public awareness, education, and capacity building, including:

- Gaps between awareness of problems facing dry forests and actions to combat the problems, including how to mobilize, allocate, and use funds and other resources to spur action.
- Scarcity of empirical data demonstrating the socio-economic significance of these resources, leading to poor integration of dry forests into development planning.
- Lack of a clearly defined institution to manage, utilize, and conserve dry forests at the local level, which exposes them to open access.
- Lack of knowledge on how to sustainably and profitably produce economically important dry forest products.

Ethiopia has established a forest education and research system to address some of these issues. Forestry education started in Ethiopia at the then Wondo Genet College of Forestry in the 1970's with a two-year diploma program. The Swedish government's developmental aid supported this program through the Swedish International Development Agency (SIDA). SIDA invested in developing infrastructures and teaching capacity. The diploma program has mainly focused on timber production neglecting other forest issues. Forestry education at BSc, MSc, and Ph.D. levels started in Ethiopia since 1987, 1995 and 2012, respectively when an initial number of students enrolled were 15, 15 and 11, respectively. The number of enrolled students increased to 400 – 500 and 60 for BSc and MSc programs, respectively. The development aid from the Swedish government has also helped build human resource capital to develop a cadre of forestry teaching staff holding MSc degrees.

The forest education is now fully supported by the Ethiopian government, and integrated into

the Ethiopian education system until almost all universities in the country are offering forestry courses, often under the department of natural resource management. The content of the curriculum changed to comply with the current demand for forest production, protection, biodiversity conservation, sustainable utilization, climate change, wildlife, and ecotourism.

The quality of education is declining due to the increased number of students coupled with a shortage of resources, and a decrease in the field-based practical education. As a result, the forestry or natural resources curricula in Ethiopia is not keeping with forest management challenges of the times (Dessie and Tadesse, 2013). Temu et al. (2008) suggest to link forestry to other land use and environment disciplines, carve out a distinctive content for forestry education, and transform forestry education in Ethiopia. These actions, however, require new financial resources beyond the current aid funding for education or development. The current curricula do not support national objectives such as forest restoration, forest sector development, and enhancement of forest contribution to livelihoods. In particular, forestry education in Ethiopia has neglected the social aspects of forest management, such as forest economics, participatory approaches, forest policies, and forest products commercialization. Participation of women in higher ranks of research, policy-making, and industry is extremely low.

4.6.2 Guidelines

The following actions/activities are suggested to raise awareness, improve forest education to build institutional and human capacity to manage dry forests in Ethiopia sustainably:

- Introduce a forestry curriculum that includes social aspects of forest management, forest economics, forest restoration, forest monitoring, and business management.
- Align forestry education with the national forest development plan, including building capacity to domestically produce, process, add value and market dryland wood and nonwood forest products
- Engage CSOs and schools to organize regular awareness campaign on the ecological, cultural, social, and economic importance of dry forest resource.
- Create and raise awareness among local communities about the income generating potential of dry forests, sustainable management techniques, and environmental benefits of forests, including benefits related to climate change.
- Integrate of dry forests into development planning by policymakers.
- Encourage collaboration and exchange of teaching staff/experts with universities, research institutes, and forestry ministries in other countries with dry forests.
- Provide viable forest extension services that satisfy the needs and demands of communities, particularly the most vulnerable and marginalized groups.
- Organize regular experience-sharing among woreda and zonal experts across dry forest regions on best practices to protect, conserve, and sustainably utilize dry forest resources.
- Engage local communities in dry forest management and provide training and support, as guided by the 2018 Forest Proclamation. Ensure that local communities' interests and demands are taken into account in local forest management plans and strategies.
- Promote and scale up best dry forest management practices including successful adaptation measures, new management approaches, and efficient participatory resource use and conservation.
- Revise the current forest education curriculum and provide technical training programmes that combine action research with studies of the social and economic impacts

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About 80% of forests in Ethiopia are dry forest. For the last 20 years they have been subject to land use changes, and replaced by agricultural land and settlements. This situation may be due to the little recognition, at the national level, of the actual and potential contribution of dry forests to the national economy, especially as a source of income for the poor and for exportation.

Despite this situation, the Government of Ethiopia has made sustainable forest management a priority, and it includes the management of dry forests. This *Guidelines on Sustainable Forest Management in Drylands of Ethiopia* provides information on the national context on dry forests, and practical guidelines adapted to the Ethiopian context. It fills important gaps that should help decision-makers to understand better the role and value of dry forests in the country. It shows that dry forests should be sustainably managed and protected for all the economic, social, and environmental services that they provide, and pleads for a better recognition of such an important ecosystem.

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