Deforestation in Ethiopia: Causes, Impacts and Remedy

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***Abstract* - Ethiopia is an agrarian country with a great topographic range from 110m below sea level at Dalol Depression to 4620m above sea level at Mount Ras Dashin. Because of its topographic variation and location in the tropics, Ethiopia has diverse climate conditions and the resulting diverse ecosystems. As a result, the country is well endowed in natural resources. However, deforestation has gone for the last five decades. Forests which were above 40% of the country's landmass in the beginning of 20th century are reduced into 2.36% in 2000. The main causes are agricultural expansion; the increasing demand for construction material, industrial use, fuel wood and charcoal; lack of a forest protection and conservation policy; absence of a strong forest administration system capable of arresting the rapidly increasing rate of deforestation; lack of effort to ensure the participation of communities in forest protection and conservation and the sharing of benefits, and failure to clearly demarcate and enforce the boundaries of natural forest reserves. Currently, the remaining forests are found in South Western Ethiopia. In northern highlands, one couldn't find forests except old-aged Afromontane forests around the churches and in some inaccessible areas. However, other areas have been completely destroyed and converted to farms and grazing lands. At present there are efforts that the government and local communities are employing. Establishment of protected and forest priority areas, as well as protecting the sacred forest sites and introducing new energy efficient stoves are attempts taken to protect forests in the country. Rehabilitation of forests through afforestation, reforestation and area enclosures with participatory forest management practices are another conservation efforts that the government is implementing. Thus, this review aims to demonstrate the cause and impact of deforestation as well as remedial actions and indicate conservation measures being taken in response to deforestation.**

***Key words* - Causes, Deforestation, Ethiopia, Impacts, Remedy**

I. INTRODUCTION

In an agrarian society like Ethiopia, forestry can play significant role in economic development. The forestry GDP as a proportion of the whole economy and in relation to agriculture has been very low. The share of forestry in the GDP varied between 2% and 2.6% from 1971 to 1985 and declined to 1.9% between 1986 and 1987. The share of forestry in the agricultural GDP varied between 3.8% and 4.8% during 1971-1985 and declined to 3.7% in 1986 and 1987. If direct consumption of commodities such as fuel wood and charcoal and the indirect contributions of forests to watershed management and soil conservation as well as that of forest products utilized in other manufacturing and construction activities are considered in the calculation, the contribution of forestry to the total GDP and agricultural GDP will be much higher amounting to about 10% and more [1].

The major causes of deforestation is rapid population growth, which leads to an increase in the demand for crop and grazing land, wood for fuel and construction [2]. Lack of viable land use policy and corresponding law also aggravated the rate of deforestation. New settlements in forests are increasing from time to time and hence resulted in the conversion of forested land into agricultural and other land use systems. At present, the few remaining high forests are threatened by pressure from investors who are converting the moist evergreen mountain forests into other land use systems such as coffee and tea plantations [1].

II. LITERATURE REVIEW

Causes of Deforestation

Deforestation has been practiced by humans for tens of thousands of years before the beginnings of civilization [3]. Fire was the first tool that allowed humans to modify the landscape [4]. It is used to convert closed forests into more open ecosystems favorable to grazing land and crop cultivation. With the diversification of agriculture, fire became the prime tool to clear land for crops [5]. A typical progress trap is that settlements were often built in a forested area providing wood for some industry (e.g. construction, pottery). When deforestation occurs without proper replanting, local wood supplies become difficult to obtain near enough to remain competitive; leading to the settlements abandonment consequently enforced them to other new settlement area in forests [6]. Meanwhile most of the population in Ethiopia remaining active in the agricultural sector, the main pressure in most areas remained land clearing for crop and cattle farming, particularly at present investors are looking the dry land forests to divert in to commercial crops like tea, coffee and rice cultivation [7;8].

Deforestation is the logging and/or burning of trees in a forested area [9]. There are several reasons deforestation occurs: trees or derived charcoal can be sold as a commodity and used by humans, while cleared land is used as pasture, plantations of commodities and human settlement [10]. The removal of trees without sufficient reforestation has resulted in damage to habitat, biodiversity loss and aridity and deforested regions often degrade into wasteland [11]. Disregard or ignorance of intrinsic value,

lack of ascribed value, lax forest management and deficient environmental law are some of the factors that allow deforestation to occur on a large scale [12]. In Ethiopia, deforestation is an ongoing issue that is causing extinction, changes to climatic conditions, desertification, and displacement of indigenous people. However, among countries with a per capita GDP of at least $4,600, net deforestation rates have ceased to increase [12].

There are many root causes of deforestation in Ethiopia, including corruption of government institutions, the inequitable distribution of wealth and power, population growth and overpopulation, and urbanization [13]. Globalization is often viewed as another root cause of deforestation, though there are cases in which the impacts of globalization (new flows of labor, capital, commodities, and ideas) have promoted localized forest recovery [14].

The degradation of forest ecosystems has also been traced to economic incentives that make forest conversion appear more profitable than forest conservation in Ethiopia [15]. Many important forest functions have no markets, and hence, no economic value that is readily apparent to the forests' owners or the communities that rely on forests for their well-being [16]. From the perspective of the developing world, the benefits of forest as carbon sinks or biodiversity reserves go primarily to richer developed nations and there is insufficient compensation for these services [17]. Developing countries like Ethiopia feel that some countries in the developed world, cut down their forests centuries ago and benefited greatly from this deforestation, and that it is hypocritical to deny developing countries the same opportunities: that the poor shouldn't have to bear the cost of preservation when the rich created the problem [18].

Experts from Ethiopia do not agree on whether industrial logging is an important contributor to Ethiopia deforestation [19]. Similarly, there is no consensus on whether poverty is important in deforestation. Some argue that poor people are more likely to clear forest because they have no alternatives, others that the poor lack the ability to pay for the materials and labor needed to clear forest. Claims that population growth drives deforestation have been disputed; one study found that population increases due to high fertility rates were a primary driver of tropical deforestation in only 8% of cases [20].

Table 1. Ethiopian Forest Information

Total Forest Cover (1000 ha)			
1990	2000	2005	2010
15114	13705	13000	12296
Annual Change Rate (1000 ha), Negative number represents deforestation			
	1990-2000	2000-2005	2005-2010
	-141	-141	-141
Annual Change Rate (percent), Negative number represents deforestation			
	1990-2000	2000-2005	2005-2010
	-0.93	-1.03	-1.08

Source: Ethiopian ministry of water resources 1999

Figure 1. Agricultural expansion affecting Acacia Woodland in Central Rift Valley of Ethiopia

Impacts of Deforestation

Atmospheric Impact

Deforestation is ongoing and is shaping climate and geography of Ethiopia. Deforestation is a contributor to global climate change, and is often cited as one of the major causes of the enhanced greenhouse effect [7]. Tropical deforestation is responsible for approximately 20% of world greenhouse gas emissions. Deforestation mainly in tropical areas account for up to one-third of total anthropogenic carbon dioxide emissions [10]. Trees and other plants remove carbon in the form of carbon dioxide from the atmosphere during the process of photosynthesis and release oxygen back into the atmosphere during normal respiration [9]. Only when actively growing can a tree or forests remove carbon over an annual or longer time frame. Both the decay and burning of

wood releases much of these stored carbon back to the atmosphere. In order for forests to take up carbon, the wood must be harvested and turned into long-lived products and trees must be re-planted. Forests are stores of carbon and can be either sinks or sources depending upon environmental circumstances. Mature forests alternate between being net sinks and net sources of carbon dioxide [21].

Reducing emissions from the tropical deforestation and forest degradation (REDD) in developing countries has emerged as new potential to complement ongoing climate policies. The idea consists in providing financial compensations for the reduction of greenhouse gas (GHG) emissions from deforestation and forest degradation [22]. Ethiopian rain forests are widely believed by laymen to contribute a significant amount of world's oxygen, although it is now accepted by scientists that rain forests contribute little net oxygen to the atmosphere and deforestation will have no effect on atmospheric oxygen levels. However, the incineration and burning of forest plants in order to clear land releases tones of CO_2 which contributes to global warming. Forests are also able to extract carbon dioxide and pollutants from the air, thus contributing to biosphere stability [23].

Hydrological Impact

According to [24] the water cycle is also affected due to deforestation. Trees extract groundwater through their roots and release it into the atmosphere. When part of a forest is removed, the trees no longer evaporate away this water, resulting in a much drier climate which clearly visible in Ethiopia evidenced by the current frequent drought and Elnino. Deforestation reduces the content of water in the soil and groundwater as well as atmospheric moisture. Deforestation reduces soil cohesion, so that erosion, flooding and landslides ensue. Forests enhance the recharge of aquifers in some locales; however, forests are a major source of aquifer depletion on most locales [23].

Shrinking forest cover lessens the landscape's capacity to intercept, retain and transpire precipitation [9]. Instead of trapping precipitation, which then percolates to groundwater systems, deforested areas become sources of surface water runoff, which moves much faster than subsurface flows. That quicker transport of surface water can translate into flash flooding and more localized floods than would occur with the forest cover [18]. Deforestation also contributes to decreased evapo-transpiration, which lessens atmospheric moisture which in some cases affects precipitation levels downwind from the deforested area, as water is not recycled to downwind forests, but is lost in runoff and returns directly to the oceans [25].

As a result, the presence or absence of trees can change the quantity of water on the surface, in the soil or groundwater, or in the atmosphere. This in turn changes erosion rates and the availability of water for either ecosystem functions or human services. The forest may have little impact on flooding in the case of large rainfall events, which overwhelm the storage capacity of forest soil if the soils are at or close to saturation which in turn dries out the rivers, streams and springs [26].

Soil Impact

Undisturbed forest has very low rates of soil loss, approximately two metric tons per square kilometer. Deforestation generally increases rates of soil erosion, by increasing the amount of runoff and reducing the protection of the soil from tree litter. This can be an advantage in excessively leached tropical rain forest soils in which Ethiopia is part of the tropics [2].

Ethiopia's Plateau was covered of forest millennia ago. Since then it has been eroding, creating dramatic incised valleys, and providing the sediment that causes the flooding of the river in the lower reaches. Tree roots bind soil together, and if the soil is sufficiently shallow they act to keep the soil in place by also binding with underlying bedrock. Tree removal on steep slopes with shallow soil thus increases the risk of landslides, which can threaten people living nearby. However most deforestation only affects the trunks of trees, allowing for the roots to stay rooted, negating the landslide [27].

Ecological Impact

According to [5] deforestation results in declines in biodiversity. The removal or destruction of areas of forest cover has resulted in a degraded environment with reduced biodiversity. Forests support biodiversity, providing habitat for wildlife; moreover, forests foster medicinal conservation. With forest biotopes being irreplaceable source of new drugs, deforestation can destroy genetic variations (such as crop resistance) irretrievably [3].

Since the tropical rain forests are the most diverse ecosystems on Earth and about 80% of the world's known biodiversity could be found in tropical rain forests, removal or destruction of significant areas of forest cover has resulted in a degraded environment with reduced biodiversity [14].

III. REMEDIES

Development of improved stoves

Technical advances in energy efficiency are critical for developing countries like Ethiopia whose populations depend primarily on biomass fuels such as wood, charcoal, dung and agricultural residues. Overuse of these fuels depletes forest resources [28]. In Ethiopia, a unique mode of cooking (Injera baking) requires the bulk of domestic energy demand emanated from forest. In most of the households of the country, this Injera baking is carried out using an open fire /three stone/ system. As it is known, this technique is inefficient and wasteful [29]. To address this problem, many efforts have been and are being made by the government and non-government organizations since the early 1990s. The development of 'Mirt' biomass Injera stove is one of the results of these efforts in the country. These days this stove is being widely promoted due to the fact that it can achieve fuel efficiency up to 50% as compared to the open fire system [30].

Another Lakech ('excellent', 'good') improved charcoal stove could be developed in 1991. Commercial production of Lakech (improved charcoal stove) was started in early 1992 in Addis Ababa. To date, millions of these improved stoves, which save over 25% charcoal relative to the traditional stove, are being in use. This has resulted in the saving of hundreds of hectares of ecologically and economically important dry land forest in Ethiopia ([31].

Each Lakech stove saves an average of 75 kg of charcoal per household per year [30]. This led to savings of over 20,000 tones of charcoal in 1996, worth over £4 million alone. More importantly, the forest savings from the use of Lakech was equal to the equivalent of over 2,000 hectares of important dry land forest in Ethiopia [32]. However, from the earliest days of involvement with household energy in Ethiopia, the international and local experts realized that the single most significant household energy demand side intervention was not in household charcoal use, important as this has been. Rather, the most crucial area for energy savings in Ethiopia is in household bread, or "Injera" baking [32].

Ethiopia meets 96 percent of its energy needs with biomass such as charcoal, wood, dung and plant residues from farming and forestry [32]. Private households consume by far the greatest proportion of the energy generated, namely 88 percent [33]. Half of the energy goes entirely on baking “injera”, a type of round flat loaf made with sour dough. The population, now totaling some 90 million is growing very quickly and so is the demand for biomass. The consequence is constant over exploitation of those forests that still exist. They now cover just 30,000 square kilometers, or only 2.7 percent of the area of the country [34].

Since Mirt was introduced in 1998, the project has achieved much progress in social, economic and ecological terms. In 35 smaller and medium-sized towns, about 100 small businesses have been set up which have manufactured 27,000 Mirt stoves and sold them at a price of between 40 and 50 Birr. A single stove reduces the demand for wood by 570 kilograms per year [35]. The amount of fuel wood saved since the start of the project now totals 16,000 tones. This is equivalent to an area of 2,000 hectares of forest [35]. Each Mirt saves approximately 5 kg of wood per Injera baking session for the average household. Most housewives bake injera twice a week. Thus, the Mirt saves the average household nearly 260 kg of wood a year. This is a significant savings for the average Ethiopian urban household. However, the Mirt saves commercial Injera bakers over 3.5 tons of fuel wood per year [36].

Area closure and soil and water conservation

Efforts to contain the problem of deforestation have been made at several levels. Two of the main activities have been soil and water conservation works, and the establishment of area closures aiming rehabilitation of forest lands to a community-based approach [37]. The important set of activities has been the establishment of area closures. Area closures in the Ethiopian context can be defined as that degraded land has been excluded from human and livestock interference, for rehabilitation [32]. In principle, human and animal interference is restricted in the area closures, to encourage natural regeneration. In practice, however, cattle are allowed to graze freely in several of the area closures. In some areas, soil and water conservation activities are also being undertaken. The inception of area closures dates back to the early 1980s, which coincides with the beginning of large-scale land rehabilitation and soil and water conservation programmes in Ethiopia [37]. The establishment of area closures has been one of the strategies for rehabilitating degraded hillsides within catchments delimited for the rehabilitation and soil and water conservation programmes [37].

Forest plantation as a pathway for restoration

Recent operations on Ethiopia forest plantation through community participation indicates that plantations enhance the recruitment, establishment and succession of native woody species by functioning as foster ecosystems [37]. Forest plantations established on degraded sites long devoid of a native tree cover act as successional catalysts, facilitating the recolonization of native flora through their influence on understorey microclimate and soil fertility, suppression of dominant grasses and provision of habitats for seed dispersing animals [38]. When this natural process is augmented by silvicultural treatments intended to enhance the invasion of native species, plantations may be gradually converted to a forest which resembles a near-by natural forest [7].

IV. CONCLUSION

Forest play indispensable role in the upkeep of an environment that facilitates sustainable development. Forests, apart from their short to long-term positive effects on weather and climatic conditions, are instrumental in controlling soil erosion, land degradation and desertification, problems that appear to have reached their climax in Ethiopia. The main causes of deforestation in Ethiopia are the high population growth, low agricultural productivity, the poor economic performance of the country, shifting agriculture, livestock production and fuel in drier areas.

Deforestation is a contributor to global climate change, and is often cited as one of the major causes of the enhanced greenhouse effect. In addition, shrinking forest cover lessens the landscape's capacity to intercept, retain and transpire precipitation. Instead of trapping precipitation, which then percolates to groundwater systems, deforested areas become sources of surface water runoff, which moves much faster than subsurface flows and then eroding the productive part of the soil.

To minimize the deforestation problem, many efforts have been and are being made by the government and non-government organizations. The development of improved stoves, area closure and plantations are the primary remedial action taken. At present, though there are some efforts by communities or organizations, there is, in general, a lack of tendency to plan, mobilize and implement sustainable afforestation programmes across the nation despite rising problems of environmental deterioration and fuel shortage that is severely affecting local communities in particular and the national economy in general. The government and local development agents should consider the dissemination and production of fuel efficient improved fuel wood and charcoal stoves which were able to reduce the biomass energy consumption by half compared to traditional open fires. As well, a reduction in biomass energy demand results in a reduction of the amount of trees that are removed from the environment.

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