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The Effect of Land Use Land Cover Change on Land Degradation in the Highlands of Ethiopia

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Abstract
Land use and land cover change through inappropriate agricultural practices and high human and livestock population pressure have led to severe land degradation in the Ethiopian highlands. This has led to further degradation such as biodiversity loss, deforestation, soil erosion and soil quality. Agricultural and economic growth in Ethiopia is constrained by the deteriorating natural resource base, especially in the highlands where 80% of the population lives. This threat stems from the depletion and degradation of the vegetation cover of the country. Loss of biodiversity is associated with land use/land cover changes that are related to a range of biophysical and socio-economic drivers. The implications of these changes suggest that the land use/cover changes have skewed to the rampant conversion of areas once covered with vegetation to cultivation without adequate use of soil and water conservation and rehabilitation practices. Understanding of the driving forces of land use and land cover change (LULC C) is essential for effective sustainable land resource management. Change in LULC can also negatively affect the potential use of an area and may ultimately lead to land degradation. Improving the understanding of land use and land cover dynamics can help in projecting future changes in land use and land cover and to instigate more appropriate policy interventions for achieving better land management.
Keywords: Deforestation, Ethiopia, land degradation, land use, soil quality.

1. INTRODUCTION

Land use and land cover change (LULCC) are associated with large negative impacts on ecosystems observed at local, regional and global scales. High rates of water, soil and air pollution are the consequences of observed LULCC. Biodiversity is reduced when land is changed from a relatively undisturbed state to more intensive uses like farming, livestock grazing, selective tree harvesting, etc. (Ellis, 2011). Land use change due to deforestation in the tropics was the major contributor to CO_2 emissions in the 1990s, which averaged between 0.5 and 2.7 Giga tone of carbon (GtC) per year (UNFCCC, 2007). These changes alter ecosystem services and affect the ability of biological systems to support human needs, and also determine, in part, the vulnerability of places and people to climatic, economic and socio-political perturbations (Lambin and Geist, 2006). Land degradation, which includes degradation of vegetation cover, soil degradation and nutrient depletion, is a major ecological problem in Ethiopia (Hagos *et al*., 1999).

Like many other developing countries across the globe, significant land-cover changes have occurred in Ethiopia since the last century. These changes were primarily due to anthropogenic activities, in connection with the population increase and due to land use changes, including deforestation, over grazing, and improper cultivation of agricultural land which led to accelerated soil erosion and associate soil nutrient deterioration (FAO, 1986; Hurni, 1993; Gebresamuel *et al*., 2010; Eleni *et al*., 2013). Soil degradation in the form of plant nutrient depletion is the major environmental problems in the highlands of Ethiopia. Among Sub-Saharan countries, Ethiopia is the most seriously affected country by land degradation (World Bank, 1998). A change in the land-cover of an area can negatively affect the potential characteristics of the area, and may ultimately lead to degradation and loss of productivity (Zewdu *et al*., 2014). Land degradation, which is a product of complex interactions of many of the physical and biological variables, reduces the potential capability of soil to produce goods and services. Semi-arid regions are under high pressure to supply the required food for their rapidly increasing populations. Consequent changes in the land-use patterns due to agricultural intensification, together with the harsh climatic conditions including global climate change, have accelerated land degradation processes, with yield reduction in many parts of the arid and semi-arid Ethiopia (Zewdu *et al*., 2014).

The need to achieve sustainable use of soil resource has been an increasing concern to decision and policy makers. This is mainly the concern of many developing countries like Ethiopia, because soil degradation such as soil nutrient depletion and physical degradation have alarmingly increased and become serious threats to agricultural productivity (Kebede and Yamoah, 2009). Increase in population and a continuous decline in the amount of agricultural land have led to an indiscriminate exploitation of natural forests and fragile lands for agriculture, soil organic matter and soil nutrient depletion are among the major forms of soil degradation (Lemenih *et* al., 2005). Surface runoff in the Ethiopian highlands can thus be considered to increase with population growth, land use expansion, and intensification without soil and water conservation, as well as with accelerated land degradation (Hurni *et al*., 2005).

Soil properties response to changes in LUCC was investigated at different points in time and spatial scale. In tropical region, for example, Hartemink *et al* (2008) have studied effects of land cover change on soil resources and the result showed that conversion of climax vegetation to human managed land use systems triggered to cause low soil structure stability, loss of organic matter, reduction in nutrient stock, and reduction in soil organic carbon. In addition, conversion of natural vegetation to other land uses exposes the land for erosion in sloping areas. In this region, Yang *et al.* (2004) also explore that shifting cultivation and establishment of rubber tree plantations showed a decline in concentrations and stocks of soil organic carbon and total nitrogen than natural forest. Recently, Yifru and Taye (2011) have studied soil in different land cover and land use types in Bale, South East Ethiopia. In this study, soil organic carbon and total nitrogen were high in natural forest while these were low in cultivated fields.

Land use practices affect the distribution and supply of soil nutrients by directly altering soil properties and by influencing biological transformations in the rooting zone. For instance, cultivation of forests diminishes the soil carbon (C) within a few years of initial conversion and substantially lowers mineralisable of nitrogen (N) (Majaliwa *et al*., 2010). Soil quality is a concept that integrates soil biological, chemical and physical factors into a framework for soil resource evaluation (Khormali *et al*., 2009). Lemenih (2004) investigated the effects of land use changes on soil quality and native flora degradation and restoration in the highlands of Ethiopia. Results showed deforestation and then long-term cultivation caused organic matter and total nitrogen decreased and also changes in soil surface (0-10 cm) indicated phosphorous, potassium, available potassium, Ca^{+}, Mg, saturation point and cation exchange capacity. Therefore, the objectives of this review were to assess the effect of land use land cover change on land degradation in the highlands of Ethiopia.

2. Causes of land degradation

2.1. Population growth

In the period between about 1950 and 2000, the population in the Ethiopian highlands is estimated to have increased by a factor of 4, from about 16 million to about 65 million. Of this latter number, about 26.2 million currently live in the Nile Basin area within Ethiopia (362,000 km^2), and an additional 1.4 million in the Eritrean part of the basin (25,000 km^2; Krauer, 2004). Apart from some population movement due to resettlement of people from Tigray and Northern Wollo in 1985, and their return home in early 1990, the main migration policy of the government between 1975 and 2003 was to keep populations in place; that is, no migration was allowed in principle. This led to intensification of land use in the rain fed highlands, resulting in shortening and eventual abandonment of fallow periods, expansion of cultivation land into grazing land, and wherever forests existed, continued deforestation, particularly in the western parts of the highlands (Hurni *et al*., 2005).

Land cover changes are caused by a number of natural and human driving forces (Meyer and Turner, 1994). Whereas natural effects such as climate change are felt only over a long period of time, the effects of human activities are immediate and often radical. Population growth is the most important of the human factors in Ethiopia (Hurni, 1993), as it generally is in underdeveloped countries (Hurni, 1993; Mortimore, 1993).

2.2. Deforestation

In Ethiopia, accelerated deforestation has been taking place since the beginning of the 20th century (EFAP, 1993). Although forests were thought to have covered nearly 40% of the country’s total area at the beginning of the 20th century (Breitenbach, 1961; EFAP, 1993), forest cover today is estimated at only 9% (Alemu and Kidane, 2014). The rate of deforestation is calculated to be between 150,000 and 200,000 ha per annum (EFAP, 1993). But estimates of original forest cover and deforestation rates differ greatly because information is derived mostly from indirect sources (eg, travelers’ accounts) and less often, if at all, from quantitative studies where forest cover is measured at different time intervals. But the general consensus is that the scale of clearance in Ethiopia has been massive (Bewket, 2002). Molla *et al*. (2010) demonstrated that continuous removal of natural land cover (i.e., vegetation) has occurred in the mountain landscape of Tara Gedam and adjacent agroecosystem over a period of 46 years. As a result, more than 70% of the forest and woodland and significant proportions of shrub land and riverine vegetation cover were removed during the same period exposing large areas of the landscape to land degradation.

Deforestation and consequent land degradation are global menaces, and so are they in Ethiopia. The forest degradation in Ethiopia is closely linked to the ongoing population growth. More people generally lead to an increasing demand on land for living and for agricultural production. The situation got more severe in the eightieth when large numbers of people moved to South West Ethiopia in scope of organized resettlement programs. Consequently the pressure on the forest resources themselves increased due to a higher demand on fuel wood and construction timber. Finally, uncontrolled logging and the illegal export of wood stems to urban centers like Addis Ababa is a threat for the natural high forest of the country. The natural regeneration of the forest resources is difficult due to high populations of grazing and browsing livestock within the forests

(Reusing, 2000). Zeleke (2000) observed a reduction of forest cover in central Gojam (Anjeni research site) from 27% in 1957 to 0.3% in 1995. Abate (1994) in western Ethiopia (Dizi research site) observed a similar trend from relatively extensive forest cover in the 1960s. With the exception of these 2 stations, extensive areas around all other stations had relatively little forest cover by the late 1950s (based on the earliest available air photography), and little deforestation has been observed since then.

A group of interacting variables are responsible for the drastic decline of the shrub land and the gain of the shrub-grassland and grassland despite the generally expected overgrazing by livestock and subsequent bush encroachment. The first of these is the extensive use of the woody vegetation for charcoal production and firewood (Tegene, 2002). The study conducted by Gonsamo (1998) very well confirms the fact that the major cause for the extensive destruction of the shrub land in the region is firewood collection and charcoal production for the surrounding markets. It should be noted that charcoal, which causes more destruction of woody biomass than fuel wood, is produced primarily for markets in the surrounding towns.

2.3. Agricultural expansion

Large-scale destruction of forest resources is not the only change that has taken place at the national level. Major land cover changes have also occurred at the local level for all land types. For instance, Abate (1994) reported rotational land cover or use involving cultivation and vegetation (forest and bush) between 1957 and 1982 in the Metu area, southwestern Ethiopia. A significant increase in cultivated land at the expense of forestland was found to have occurred between 1957 and 1995 in the Dembecha area, northwestern Ethiopia (Zeleke, 2000). Tekle (2000) reported increases in open areas and settlements at the expense of shrub-lands and forests between 1958 and 1986 in the Kalu area, north-central Ethiopia. On the other hand, increases in forestland and cultivation land at the expense of grazing land were detected in Sebat-bet Guraghe, south-central Ethiopia, between 1957 and 1994 (Woldetsadik, 1994). The change from reduction of more natural vegetation (natural forest and shrub-bush land) to expanded cultivated land was more of conversion and high change of this type was observed between 1976 and 1986 (Tesfaye *et al*., 2014). Based on a study period of 41 years (1964-2005), Meles *et al.* (2008) reveal unique spatially explicit information on LULC changes indicating a sharp reduction of natural habitats and an increase in agricultural land in the highlands of Tigray, northern Ethiopia.

Land-cover changes are not only cumulative in nature but also the result of a number of interacting variables and processes. The distribution of the various land-cover and land-use types are primarily controlled by factors such as slope gradient, soil depth, terrain configuration, and the demand for fuel wood. Most of the cropland is found in the plains constituting the middle and lower reaches of the catchment, although most of the slopes on the mountainous terrain to the north are also under intensive cultivation. A considerable proportion of the cropland expansion that took place between 1957 and 1986 appears to have taken place along the valley rims in the middle and lower reaches of the watershed. The steep ridges along the eastern edges of the catchment are left out of crop production primarily because of the rugged terrain, very steep slopes, and shallow soils. The presence of the patches of natural vegetation along the western and northern slopes is also attributed to the same factors (Tegene, 2002). The expansion of agricultural land at the expense of other lands indicated increased pressure on agricultural land latter reduces the productivity due to its resources exploitation, unsustainable cultivation and soil fertility decline. These days cultivation through conversion of grazing land or bush lands to cultivated lands is due to high population pressure (Abate and Lemenih, 2014).

2.4. Improper land management

An ecologically balanced ecosystem is one which is in a state of dynamic equilibrium mainly composed of forest land, grass land and wetland that are considered essential components of the environment. These land cover types are ecological assets that are crucial to land protection, biodiversity, and hydrological and geochemical cycles (Turner *et al*., 2000). However, inappropriate land use changes affect their natural ecological functions and lead to a decline in land productivity and loss of biodiversity (Shahid *et al*., 1999). Land degradation could be partly explained in terms of removal of land cover through deforestation and overgrazing. This process leads to soil erosion and land degradation and to the loss of biodiversity as explained in many parts of the world (Hurni, 1988; Houghton, 1994; Rao and Pant, 2001; Zeleke and Hurni, 2001; Zeleke, 2002).

One of the immediate impacts of improper land management such as thinning and destruction of the shrub land is shortage of fuel wood and construction materials for the farming community. This condition forces farmers not only to travel very long distances to collect wood, but also to increasingly burn crop residues and organic manure for cooking and heating. Then latter has grave consequences for the fertility and productivity of the cropland as the action leads to depletion of the organic matter in the cultivated soils (Tegene, 2002). Shortage of land has forced farmers to cultivate steep slopes and shallow soils that are vulnerable to degradation. A previous study carried out by the author indicates that of the total cultivated land in the catchment, 14% is marked by slope gradients of above 27%, while 4% is marked by slope gradient of more than 47% (Tegene, 1998). Additionally, typical cereal cultivation on steep slope at the headwater of Suluh basin, Northern Ethiopia and Steep slopes (>45° slope) used for cultivation (Muluneh, 2010; Asfaw, 2014) (Figure 1).

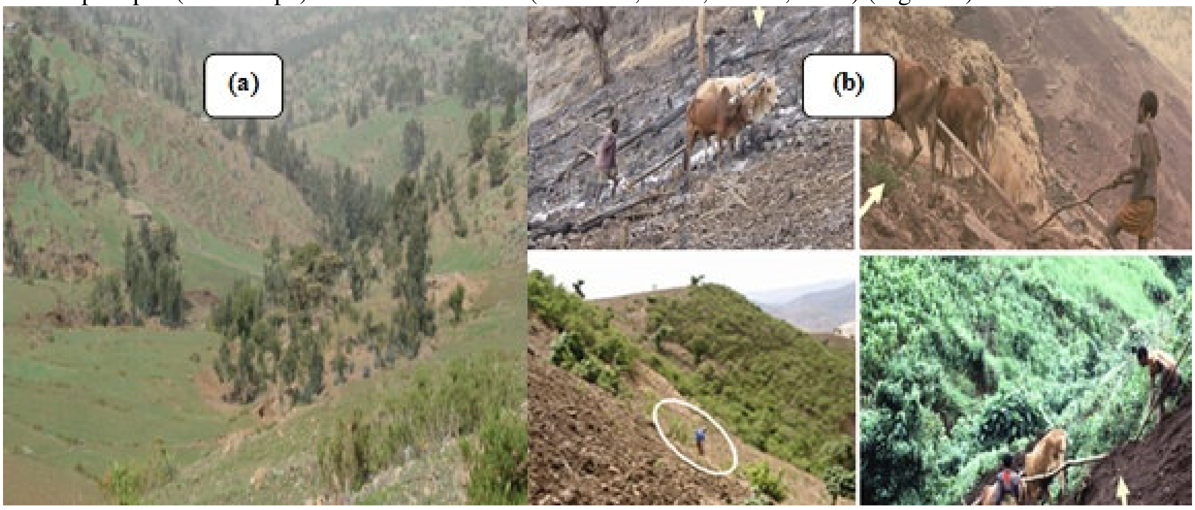

Figure 1: Typical cereal cultivation on steep slope at the headwater of Suluh basin, Northern Ethiopia (a) and Steep slopes (>45° slope) used for cultivation (b) (Muluneh, 2010; Asfaw, 2014).

3. CONSEQUENCES OF LAND DEGRADATION

3.1. Soil loss

Land cover is one of the factors that determine the rate of soil loss due to erosion. It influences both the erosivity of the eroding agents and the erodibility of the eroding subject (Morgan, 1995). From the point of view of exposure of the land to erosive storms, which are typical in the area, the land cover types in the watershed can be classified into 2 classes: (1) land that is bare when the erosive rains occur, and (2) land under good vegetative cover when the rains begin, which is protected from the threat of erosion (Bewket, 2002). Cultivated fields and part of the grassland and degraded land constitute the first category, whereas the rest of the land cover types can be included in the second. Accordingly, the part of the watershed subject to possible maximum soil loss accounted for 70%, 73%, and 70% of the total area in 1957, 1982, and 1998, respectively (Bewket, 2002). According Mekuria and Veldkamp (2005) the overall calculated mean annual soil loss in closed area varied between 2.6 and 98.5 t/ha/year. Mean annual soil loss in free grazing lands varied between 25 and 121.5 t/ha/year.

Betrie *et al*. (2011) had observed the average sediment yield of 131 $\times 10^6$ ton/year at the outlet of the upper Blue Nile basin. Nyssen *et al*. (2011) also studied the effect of conservation tillage (permanent bed system) in northern Ethiopia. The result revealed decreased runoff (51%) and soil loss (81%) which allows protection of the down slope areas from flooding. Continuous investments in water resource management in the Blue Nile Basin suggest a need for efficient and effective mechanisms to improve water capture and agricultural output in the highlands of Ethiopia. Approximately two thirds of the area within the Blue Nile Basin is located in the highlands of Ethiopia. This area receives relatively abundant rainfall (800 to 2,200 mm per year), with the majority falling during the kiremt rains (June-September) that supply the main meher cropping season. Agricultural production in the highlands is dominated by cereal crops, which necessitates frequent soil mixing and provides very little ground cover during the kiremt rains, thus rendering it more susceptible to erosion and land degradation (Haileslassie *et al*. 2008).

In terms of soil loss due to erosion, estimates vary by location, which reflects the varying Ethiopian landscape, management practices and soil characteristics within and between districts. Hurni *et al*. (2009) measured soil erosion rates on test plots and estimated a loss of 130 to 170 mt/ha/year on cultivated land. The average annual soil loss in Medego watershed in the north of Ethiopia was estimated at 9.6 mt/ha/year (Tripathi and Raghuwanshi, 2003). The average annual soil loss due to erosion in the Chemoga watershed in the Blue Nile Basin was estimated at 93 mt/ha/year (Bewket and Sterk, 2005). Shiferaw (2011) estimated soil loss in Borena woreda in south Wollo using the Revised Universal Soil Loss Equation (RUSLE, which allows for spatial modeling of soil loss) and found that annual soil loss ranged from no loss in the flat plain areas to over 154 mt/ha/year in some steeper areas.

Tsegaye *et al*. (2012) studied the effect of land use land cover change on soil erosion in the Central Rift Valley of Ethiopia. The result revealed soil loss amounted to 31, 38 and 56 t/ha/yearin 1973, 1985, and 2006, respectively, indicating a rapid increase. The rate of change in soil loss from 1973 to 2006 (1.2 Mt/ha/year) is a direct reflection of the ongoing reduction of vegetation cover. Similarly Zenebe (2009) documented an annual soil loss varied from 7.49 t/ha/year in field pea plot in 2007, to 60.44 t/ha/year in faba bean plot in 2006. Average soil loss in field pea plots was found significantly ($p < 0.05$) lower than faba bean.

Although it is statistically non-significant, the average soil loss from field pea plots is also lower than from wheat plots by 17%. This implies that agronomic measures of soil management has paramount role for enhancing soil fertility which in turn reduced soil erosion and sedimentation.

3.2. Soil quality degradation

Land use can influence soil chemical and physical properties because of different anthropogenic activities, namely tillage, livestock trampling, harvesting, planting, application of fertilizer etc. Researchers have showed that linkage between land uses and soil properties, particularly in relation to soil nutrients and carbon sequestrations (Agbede, 2010; Nega and Heluf, 2013). Unsustainable agricultural practices along with many other physical, socio-economic and political factors have been the driving forces of land degradation. Land-use changes especially cultivation in deforested and in unsuitable lands may rapidly diminish the soil quality, as ecologically sensitive components of the habitats are not able to buffer the adverse effects. As a result, severe deterioration of the soil quality may result, leading to a permanent degradation of land productivity, and land degradation increases agricultural costs to maintain soil fertility (Abera and Belachew, 2011; Mojiri *et al*., 2011). Hence the overall conceptual framework of land degradation is indicated in (Figure 2).

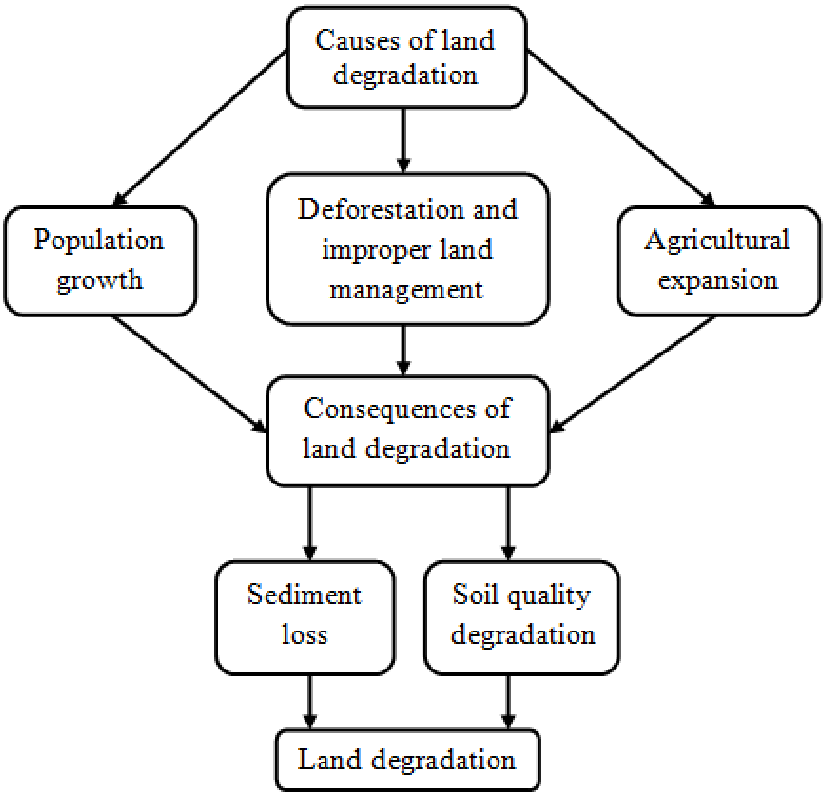

Figure 2: The cycle of processes leading to and perpetuating land degradation

The overall results of the study by Haile *et al.* (2014) showed that the chemical properties (OC, TN, available P and pH) significantly changed in response to land use and management (Table 1). The results reported in current study showed that soil pH significantly varied among land uses. Soil pH under enset farm was significantly higher as compared to woodlots and cereal farms. The higher soil pH under enset soil could be attributed due to higher values of exchangeable bases in the enset soil. The content of exchangeable base namely, Ca^{2+}, Mg^{2+} may be changed due to the application of large amount of household refuses and wood and /or biomass ash. In addition, by-products from enset processing may also be contributing factors as it temporarily burned inside enset farms (Haile *et al*., 2014). However, woodlots and cereal land had similar lower soil pH. Lower content of exchangeable base may be contributing factors for the observed changes due to high uptake of exchangeable base by eucalyptus species. On the other hand low pH under cereal lands may be caused due to complete removal of crop biomass. Continuous total biomass removal may also be attributed to observed changes in pH (Saikh *et al*., 1998b). The lower level of pH under cereal land may be also attributed due to the long-term application of chemical fertilizer mainly urea which may rise the carbonate level of the soil (Haile *et al*., 2014).

Table 1: Soil chemical properties in relation to land use in different highlands of Ethiopia

Property		pH	OC and OM (%)	TN (%)	P (ppm)	Ca cmol(+)/kg	Mg cmol(+)/kg	CEC cmol(+)/kg	References
Depth (cm)		0-15	0-15	0-15	0-15	0-15	0-15	0-15	
Types of land use	Enset	6.31± 0.15a	3.09± 0.13a	0.26± 0.01a	22.52±1.70 a				Haile *et al*., 2014
	Cereal	5.78± 0.11b	1.50± 0.12b	0.13± 0.02b	17.63±1.69 a				
	Grazing	6.09± 0.04ab	2.31± 0.25c	0.20± 0.02a	15.73±1.95 a				
	Woodlots	5.63± 0.01b	2.14±0.19bc	0.19± 0.01ab	15.80±2.00 a				
Types of land use	10 AC US		2.4ab	0.27ab	4.5ab	9.2ab	0.4a	52.2ac	Mekuria and Veldkamp, 2005
	10 AC MS		2.8ab	0.34ab	5.8ab	5.7a	0.5a	54.5a	
	10 AC FS		3.0a	0.34ab	6.0ab	8.7ab	0.8ab	55.5a	
	C1US		1.5b	0.20b	3.0b	15.4ab	1.3ab	39.6b	
	C1MS		1.5b	0.21b	3.7ab	17.6ab	1.4ab	40.9b	
	C1FS		1.9ab	0.24b	4.1ab	27.0b	1.4ab	41.0b	
Types of land use	Agricultural	7±0.2a	0.95±0.1 a	0.12±0.01a	12.3±0.55a	11.9±0.25a	6.29±0.59a	16.5±0.95a	Gebrelibanos and Assen, 2013
	Natural Forest	8±0.1b	4.8±0.23 b	0.25±0.00b	8.7±0.5b	1.2±0.03b	11.7±0.62b	34±0.48b	
	Grass land	6±0.1a	0.84±0.12a	0.08±0.01a	3.6±0.38c	12.2±0.51a	8.61±0.37c	25.5±0.53c	
	Plantation	5.8±0.04c	3.8±0.3c	0.17±0.0c	6.6±0.37b	13.8±0.38c	8.82±0.27c	31.2±0.38b	
Types of land use	Agricultural	6.34±0.7b	3.081±0.3b	0.150±0.06 b	6.044±0.8b			36.82±8.7a	Worku *et al*., 2014
	Grass land	6.29±0.5b	3.461±0.57b	0.170±0.07 b	2.242±0.06 c			42.35±1.1a	
	Agroforestry	6.61±0.5a	5.60±1.27a	0.28±0.06a	33.2±1.72a			44.07±7.9a	
	Shrub land	6.32±0.3b	4.04±1.13a	0.20±0.05a	22.15±1.13 a			36.30±1.3a	

Different letters along the column indicate significant differences between mean values of the different land use types at $p < 0.05$ (Tuckey HSD). 10 AC (ten years closed areas); C1 (free grazing land used as a control for 10 years closed areas). US, MS and FS are upper, middle and foot slopes respectively.

The higher SOM, TN and AP contents in closed areas compared to those from free grazing lands can be explained by the difference in soil erosion and biomass return. Reduced erosion is expected to occur in well developed closed areas because the canopy formed by the mature shrubs and under-story vegetation shields the soil from the erosive energy of the falling raindrops and thereby protects it from splash erosion and surface or sheet erosion (Mekuria and Veldkamp, 2005). Water infiltration in the soil is enhanced by both preferential flow along trees roots and accumulation of absorbent humus on the soil surface, thereby significantly reducing the volume, velocity, and erosive and leaching capacity of surface runoff (Jiang *et al*., 1996). However, land use for free grazing land is related to soil management practices that have commonly been very destructive to the soil and have caused serious erosion. Therefore, differences in soil erosion control contribute to the significant difference in nutrients in closed areas and free grazing land soils (Mekuria and Veldkamp, 2005). In addition, less biomass return causes the reduction of SOM, TN and AP in free grazing lands (Mullar - Harvey *et al*., 1985). The most evident impact of grazing on the rangeland ecosystem is removal of a major part of above ground biomass by livestock. Therefore the input of aboveground litter to the soil decreases (Mekuria and Veldkamp, 2005). Any reduction in litter inputs may have important consequences for soil nutrient conservation and cycling (Shariff *et al*., 1994).

Because the different slope positions have similarities in vegetal canopy and ground vegetation cover, the variation in soil nutrients at different slope positions in closed areas can only be explained through the difference in soil erosion rates. Results from this study showed that upper slope positions in closed areas had higher rate of soil erosion. This is mainly due to the steepness of the US positions compared to MS and FS positions. Nutrients in the upper slope positions can be dissolved and washed by runoff and might be deposited in the middle and foot slope positions (Mekuria and Veldkamp, 2005). Significant differences (at $p < 0.05$) between land uses were found for SOM, TN and AP and exchangeable bases and CEC. Five and ten years' closed areas had higher levels for SOM, TN, AP and CEC compared to free grazing lands (Table 1). The difference in soil nutrients content between the land use types is mainly due to differences in soil erosion and biomass return. The calculated soil loss revealed that the soil loss from free grazing lands exceeds that of closed areas by 47% (Mekuria and Veldkamp, 2005).

Forest soil had significant higher quantity of organic matter followed by plantation forest soil (Tukey's test; Table 1). This is obviously attributed to the addition of plant residues on the surface of these soils and their reduced rate of disturbance. As compared to the soil of natural forest, the amount of soil organic matter in plantation, grassland, and cultivated land has declined by 22.5%, 80%, and 82.5% respectively (Gebrelibanos and Assen, 2013). The lower organic matter content in cultivated and grassland soil is attributed to anthropogenic factors (e.g. reduced biomass return as a result of removal of plant and animal organic sources, and livestock grazing) that enhances organic matter loss by hastening oxidation. The relatively better organic matter content in the soil of plantation forest next to soil in natural forest is attributable to higher biomass input. This indicates vegetation restoration has implication for improvement of soil nutrients (Gebrelibanos and Assen, 2013). The depletion of total N in grassland and cultivated land is recorded to be 68% and 56 % respectively as compared to that of natural forest. The removal of the biomass above ground by harvesting crop residue and grazing by livestock is responsible for the observed decline. ANOVA also indicated that there is significant difference in total N among the considered land-use/cover types (Table 1). It is apparent that conversion of natural forest into other land-use/cover results in a decline of total N in the soil as found in the present study. An addition of a relatively higher plant residue and minimal rate of decomposition might be responsible for higher amount of total N in natural and plantation forest soil as described by Khreast *et al.* (2008).

The soil of plantation, grassland and cultivated land are found to be more acidic by 2.2, 2, and 1 unit respectively than the soil of natural forest (Table 1). The relatively lower pH value of plantation forest soil is probably due to the uptake of basic cations in tree biomass and the acidic nature of the litter of the tree species after decomposition. This suggests the need to take precaution in tree species selection for plantation forest because trees differ in litter quality and so in restoring soil fertility. As Table 1 shows, the conversion of natural forest into other land-use/cover has resulted in a decreased soil pH value. This decreasing trend of soil pH suggests a systematic removal of bases by annual crops (Gebrelibanos and Assen, 2013). The relatively high content of available phosphorus in the forest soil next to cultivated land (application of phosphorus fertilizer) could be due to high content of soil organic matter resulting in the release of organic phosphorus. Probably for this reason, available P is strongly associated with soil organic matter. The relatively low exchangeable Ca^{2+} and Mg^{2+} in cultivated and grassland soil is attributed to their continuous removal with crop harvest and cattle grazing. As the level of soil organic matter is low to withhold release of nutrients, soil erosion is also responsible for the low content of exchangeable Ca^{2+} and Mg^{2+} in cultivated soil. Thus, the degradation of organic matter had left the soil of cultivated land with low CEC. Soil CEC is important for maintaining soil fertility as it influences the total quantity of nutrients available to plants at the exchange site (Gebrelibanos and Assen, 2013).

They are relatively highest organic matter (OM) on soils of agroforestry and shrub lands than soils in cropland and grazing lands (Worku *et al*., 2014). It implies there is more supply of litters and return of OM to the soils under agroforestry and shrub land system and low OM on crop lands is due to removal of biomass from the field. In agreement to this, in Southern Ethiopia, OM content of soils in Birbira (*Millettia ferruginea*) dominated agroforestry was higher than the carbon content of soils of open fields (Hailu *et al.*, 2000). Low total nitrogen (TN) is observed on croplands. This is due to more tillage and no addition of fertilizer that replaced the removed TN by continuous tillage (Worku *et al*., 2014). The result of this study agrees with several studies conducted in Ethiopia and elsewhere (Yifru and Taye, 2010; Molla *et al*., 2009). Available Phosphorus is highest on agroforestry and shrub lands while it is lowest on grass lands of all case study areas, which is similar to organic carbon and organic matter (Worku *et al*., 2014). This is in agreement with studies such as Tornquist *et al.* (1999) and Hailu *et al*. (2000).

Abera and Belachew (2011) shows soil organic carbon was significantly affected by the type of land use systems (forestland, grassland, fallow and cultivated). All agricultural fields in the study areas had low organic carbon content according to the classification presented in Landon (1984). Barrow (1991) states that an organic matter content of less than two per cent for tropical soils is an indication of soil degradation involving a highly raised risk of soil erosion. Most cultivated soils of Ethiopia are poor in organic matter contents due to low amount of organic materials applied to the soil and complete removal of the biomass from the field (Gebreselassie, 2002), and due to severe deforestation, steep relief condition, intensive cultivation and excessive erosion hazards (Zewdie, 1999). Similar to organic carbon, there were significant variations in total nitrogen among different land use in order of fallow land < cultivated land < grassland < forestland at Sinana Dinsho district, Bale, Southeastern Ethiopia (Abera and Belachew, 2011). Generally, cultivated soils had significantly lower total N at all depths when compared to grasslands and forestlands, indicating that continuous cultivation ultimately reduces the total nitrogen contents in the soil (Abera and Belachew, 2011).

4. CHALLENGES AND OPPORTUNITIES

4.1. Challenges

Despite the diverse forms that land and soil degradation can take and the range of different factors that combine to culminate in degradation, several attempts have been made to identify the current status and trends. Certain environmental and socio-economic conditions mean that some parts of the Ethiopian highlands are more vulnerable and at risk from land and soil degradation than others. Other sustainable development challenges such as population growth, climate change, biodiversity loss, assessments nevertheless demonstrate that land and soil degradation is a key issue and that it is likely to worsen into the future unless timely action is taken. The land covers dynamics with span of 14 years experienced significant rates of conversion of land cover types, contributed to a number of observed challenges expressed in terms of high rates of degradation and related problems, such as erosion, runoff, loss of vegetation cover, and as consequence a serious decline of crop yield (Byragi and Aregai, 2011).

4.2. Opportunities

Area closure are a type of land management implemented on degraded, generally open access land, are a mechanism for environmental rehabilitation with a clear biophysical impact on large parts of the formerly degraded commons. In closed areas, it is generally believed that the land resources such as soil, wild flora and fauna, or water will be protected from degradation; as a result increasing the agricultural productivity (Aerts *et al*., 2004; Descheemaeker *et al*., 2006). According the study by Nyssen *et al.* (2007) the northern slopes of Mountain Tsibet represent the average change with regard to vegetation cover. The church forest at right (Figure 3) is an old remnant forest, but in 2006 other parts of the slopes have been converted into exclosure. The output of proper land management, results the land cover type showed observable improvements and households perceived the gradual and significant changes in soil fertility and improvements in crop yield (Byragi and Aregai, 2011).

Figure 3: The role of exclosure for rehabilitation (Nyssen *et al*., 2007)

5. CONCLUSIONS

Generally, land use changes and their associated management can influence soil properties in localized area, though the amount of changes could be varied depending upon the extent of human management. Different factors including expansion of cultivated and settlement land, insecure land tenure, lack of alternative sources of energy and construction materials, shortage of agricultural inputs and technologies, the fragile biophysical conditions of the area and lack of early awareness of farmers about soil erosion and soil fertility are obviously responsible for the major land use and cover changes. Land use systems influences soil quality in soils. Accordingly, cultivated soils had lower amounts than other land use systems and all these factors have collectively contributed to the loss of natural vegetation and land resource degradation. The overall consequence of these conversion and modification processes of the land use and land cover is the severe degradation of the natural environment. Suggesting the need for sustainable cropping systems such as crop rotation, addition of organic matter and crop residues to reverse the situation and to overcome the land degradation impact, should be design a sound land use for sustainable agricultural landscape management.

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