Review of Land use and land cover change and its Causes, consequences and environmental implications in highlands of Ethiopia

Tadele Buraka*[a], Mohammed Assen[b] and Eyasu Elias[c]

[a]Assistance professor in soil science in department of Natural resource management, Wachemo University, Ethiopia. [b]Professor in pedology and land evaluation, department of geography and environmental science, Addis Ababa university, Ethiopia. [c]Associate professor, Addis Ababa University and CASCAPE Project, Ethiopia

Abstract

Land use-cover (LULC) is one of the crucial environmental phenomena that affect many parts of the earth's systems including climate, hydrology, biodiversity and fundamental sustainability of land resources on the earth. Anthropogenic factors are responsible for major land use and land cover changes (LULCC). The purpose of this review paper is to assess the LULCC causes, consequences and environmental implications in high land Ethiopia. At the regional and national scales, these changes have profound implications for national radiation and energy balances, alterations in biogeochemical cycles, perturbations in hydrological cycles and loss of biodiversity at genetic and species levels. At the local scale, changes in the use of land and its cover affect watershed runoff, micro-climatic resources, groundwater tables, processes of land degradation and landscape level biodiversity. All these have direct impacts on livelihoods of local communities. These multifaceted environmental impacts can affect immensely food security and sustainable development. Biodiversity is reduced when land is changed from a relatively undisturbed state to more intensive uses like farming, livestock grazing, selective tree harvesting, etc. Population growth, deforestation, institutional factors and built-up land were found to be major causes of LULCC.

Key words: land use land cover, consequence, sustainable, degradation

1. Introduction

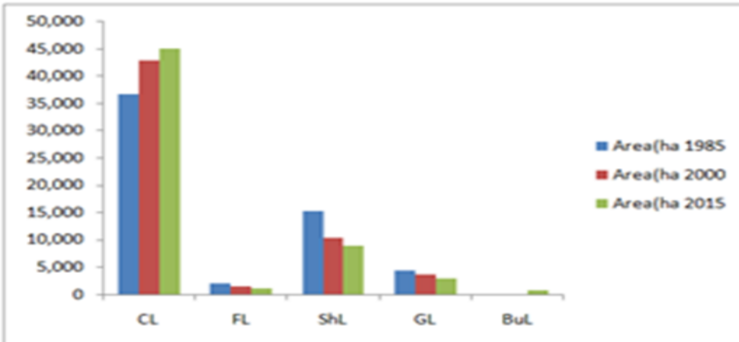
Land use/ land cover (LULC) is one of the crucial environmental phenomena affecting many parts of the earth's systems including climate, hydrology, biodiversity and sustainability of land resources (Gete and Hurni, 2001; Mustard et al., 2004). The conversion of natural land to anthropogenic landscapes represents the form of human impact on the environment (McGranham et al., 2005). A number of studies attempted to investigate the impacts of various LULC including changes on carbon dynamics (Liu *et al.*, 2012a, 2012b; Melillo *et al.*, 2009; Zhang *et al.*, 2010; Zhao *et al.*, 2010; Zhu *et al.*, 2012); hydrological cycle (Qiu *et al.*, 2011, Schilling *et a.,l* 2008); and sediment, nutrient and pesticide loadings (Demissie *et al* 2012; Luo and Zhang 2011, 2010; Ng *et al.*, 2010; Thomas *et al.*, 2009; Wu and Liu, 2012b; Wu *et al.*, 2012b; Zhang *et al.*, 2011). The impacts of LULC change associated with population growth and urbanization, intensified agricultural practices (e.g., improved fertilizer and pest management), the shrinking of grasslands, and deforestation/reforestation have attracted growing concerns on the sustainability of water resources and ecosystems (Jacobson, 2011; Schilling *et al.*, 2008; Sohl *et al.*, 2012a).

Driving forces are generally subdivided into two broad categories: proximate causes and underlying causes. LULC is never static; it constantly changes in response to the dynamic interaction between underlying drivers and proximate causes (Lambin and Geist, 2003). The conceptual understanding of proximate causes and underlying forces has a crucial importance to identifying the causes of LULC changes (Turner and Meyer, 1994). Proximate causes are the activities and actions which directly affect land use, e.g. wood extraction or clearing land for agriculture. The proximate (direct) causes are immediate actions of local people in order to fulfill their needs from the use of the land. These causes include agricultural expansion, wood extraction, infrastructure expansion and others that change the physical state of land cover (Turner and Meyer, 1994; Geist and Lambin, 2002). At the proximate level, LULC change may be explained by multiple factors rather than a single variable (Geist and Lambin, 2002). Underlying causes are the fundamental forces that trigger the proximate causes, including demographic pressure, economic policy, technological development, institutional and cultural factors (Geist and Lambin, 2002; Vancker et al, 2003). Any intervention, therefore, must be geared towards addressing the underlying causes (Bedru, 2006).

Hence, LULC analysis helps decision-makers ensure sustainable development and understand the dynamics of the changing environment. The objective of the review paper is to assess land use land cover change causes, consequences and environmental and socio-economic implications in high land Ethiopia.

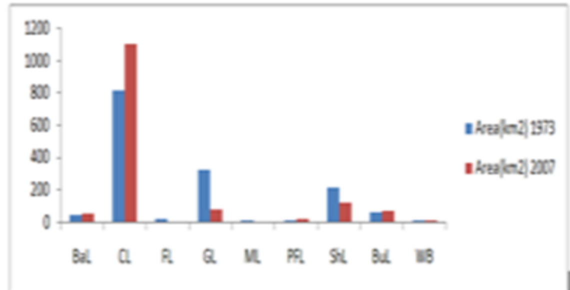
2. LULC Dynamics in Ethiopian Highlands

Under the Ethiopian situations, turning of lands to agricultural land is found to be the major LULC pattern. As studied, this was verified by many empirical studies in the different highlands of Ethiopia. In the Andassa watershed, Northwestern highlands of Ethiopia (Temesgen et al.2017, Figure 1, Table 1), agricultural land expanded from 62.7% in 1985 to 76.8% in 2015. The same land use category changed from 55% in 1973 to 74.9% in 2007 in Modjo watershed, Central Highlands of Ethiopia (Berhan et al. 2014, Figure 2, Table 1). It was observed to grow from 61.5% in 1957 to 74% in 2017 in the Wanka watershed, Northwestern highlands of Ethiopia (Wondwosen et al. 2018, Figure 3, Table 1). This proportion of agricultural change was found to be less in the other parts of Ethiopia. For instance, it increased from 29.5% in 1986 to 38.6% in 2006 in the Ameleke watershed, South highlands of Ethiopia (Gebrekidan et al. 2014, Figure 4, Table 1). As viewed from Table 1, the highest rate of cultivated land expansion was observed in Ameleke watershed, Southern highlands of Ethiopia and the least rate of agricultural land expansion was measured in Wanka watershed, Northwestern highlands of Ethiopia. This revealed that more mismanagement of land use and poor understanding of land use and land cover change impact were occurred in Ameleke watershed, southern highland than Northwestern highlands of Ethiopia. Most of these case studies have recognized a considerable expansion of cultivated land at the expense of other LULC types in the country. Although the expansion rate is different, all studies show that cultivated was expanded at the expense of forest land, shrub and grass land in the different parts of Ethiopia. This might be caused dramatic increment of population growth. Increases in cultivated land at the expense of pastureland, forestland, and woodland were also observed in hilly-mountainous areas in the central highlands (Minta et al., 2018). Such trends are similar with other study conducted in Ethiopia (Gete & Hurni, 2001; Efrem, 2009).



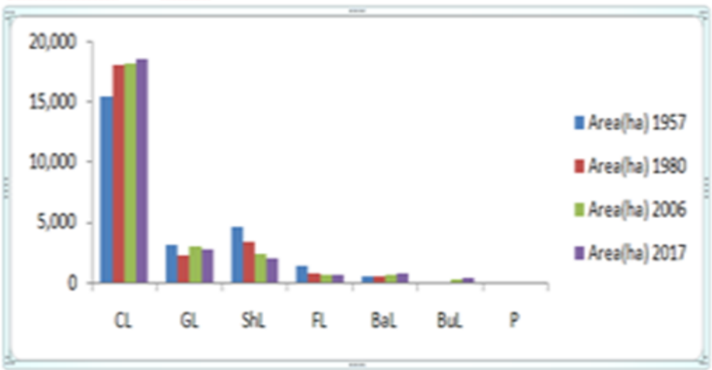
- CL- cultivated land, FL-forestland, ShL-Shrubland, GL-grassland, BuL-built-upland

Figure 1. Land use-cover change in Andassa watershed(1985-2015)



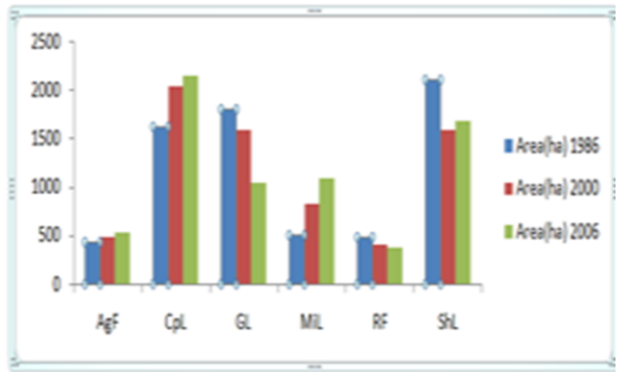
- BaL-bareland, CL-cultivatedland, FL-forestland, GL-grassland, ML-marshland, PFL-plantation forestland, ShL-Shrubland BuL-built-upland, WB-water bodies

Figure 2:-LULC change in Modjo watershed, Central Highlands of Ethiopia(1973, 2007)



- CL-cultivated land, GL-grassland, ShL-shrubland, FL-forestland, BaL-Bareland, BuL-built-upland, P-pond

Figure 3. LULC change in Wanka watershed (Northwestern highlands of Ethiopia) (1957- 2017)



- AgF-Agroforestry, CpL-cropland, GL-grassland, ML-mixed cover land, RF- Riverine forests, SL-Shrubland

Figure 4:- LULC change in Ameleke Watershed (South highland Ethiopia) (1986- 2006)

Table 1. LULC change in Andassa watershed**,** Modjo watershed, Wanka watershed and Ameleke Watersh

Study area	LULC types	Study Years								Change	Reference
		1		2		3		4		Year-1 to final year	
		Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(%)	Temesgen et al.2017
Andassa watershed (Northwest highland of Ethiopia) (1985, 2000 and 2015) (30 years change)	CL	36,820	62.7	42,925	73.1	45,108	76.8			+22.5	
	FL	2068	3.5	1504	2.6	1138	1.9			-45.7	
	ShL	15,377	26.2	10,447	17.	8992	15.5			-40.8	
	GL	4,461	7.6	3783	6.4	2850	4.9			-35.5	
	BuL	35	0.1	101	0.2	672	1.1			+1000	
Modjo watershed (Central Highlands of	BaL	41.5	2.8	53.3	3.6	-	-	-	-	+28.6	Berhan et al. 2014
	CL	812.8	55	1107.2	74.9	-	-	-	-	+36.2	

Ethiopia) (1973 and 2007) (area in km^2) (34 years change)	FL	16.9	1.1	4.3	0.3	-	-	-	-	-72.7	
	GL	319.1	21.6	80.5	5.5	-	-	-	-	-74.5	
	ML	6.3	0.4	4.5	0.3	-	-	-	-	-25	
	PFL	7.9	0.5	18.1	1.2	-	-	-	-	+140	
	ShL	212.7	14.4	125.6	8.5	-	-	-	-	-41	
	BuL	53.9	3.7	74.4	5	-	-	-	-	+35.1	
	WB	6.8	0.5	9.9	0.7	-	-	-	-	+40	
Wanka watershed (Northwestern highlands of Ethiopia) (1957,1980, 2006 and 2017) (60 years change)	CL	15,474	61.5	18,123	72	18,276	72.6	18,610	74	+20.3	Wondwosen et al. 2018
	GL	3,097	12.3	2,282	9.1	2,961	11.8	2,799	11.1	-9.8	
	ShL	4630	18.4	3382	13.4	2355	9.4	1995	8	-56.5	
	FL	1446	5.8	774	3.1	645	2.6	590	2.3	-60.3	
	BaL	493	2	545	2.2	676	2.7	759	3	+50	
	BuL	23	0.09	56	0.22	230	0.91	399	1.6	+1,677.8	
	WB	0	0	0	0	20	0.08	11	0.04	+50	
Ameleke Watershed (South highland Ethiopia) (1986, 2000 and 2006) (20 years change)	AgF	433	6.2	492	7	529	7.6			+22.6	Gebrekidan et al. 2014
	CpL	1626	23.3	2052	29.4	2156	31.0			+33	
	GL	1807	25.9	1601	23.0	1043	15			-42.1	
	MiL	506	7.3	829	11.9	1093	15.6			+114	
	RF	485	6.9	399	5.7	377	5.4			-21.7	
	ShL	2112	30.3	1596	23	1690	24.2			-20.1	

- CL-cultivated land, FL-forest land, ShL-shrubland, GL-grassland, BuL-built-upland, BaL- Bareland, WB- water bodies, ML marsh land, PFL- plantation forest land, MiL- mixed cover, AgF- agroforestry, CpL- cropland, RF- Riverine forests, CpL- crop land, LULC –land use and land cover. **1, 2, 3 and 4 represents first, second, third and fourth years in the study period.**

According to the information available in Table 1 and Figures 1-4, the highest and lowest amount of forest removal occurred in in Modjo watershed, Central Highlands of Ethiopia and in Ameleke wateteshed, South highland Ethiopia, respectively. The reason might be to satisfy the demand of population growth(food, construction, fuel wood) and mismanagement of the land resource in the highest forest removal case study area but the lowest forest removal area showed good management of land resource. Kebrom and Hedlund (2000) have also studied a decrease of forest and shrub lands due to expansion of cultivated land. On the other hand, a report revealed an improvement in expansion of forest and shrub land cover in the Siemen Mountain National

Park of Ethiopia (Menale *et al.*, 2011). This divulged that there was the intervention of removal of forests by plantation and good management of land resource.

As confirmed by studies conducted in the highlands of Ethiopia, built-up area has increased over time. This form of expansion was observed to be changed from 0.1% in 1985 to 1.1% in 2015 being increased by 1000% in 2015 in Andassa watershed, Northwestern highlands of Ethiopia (Temesgen et al.2017, Table 1); about 3.7% in 1973 to 5% in 2007 with an increaing rate of 35.1% in Modjo watershed, Central Highlands of Ethiopia (Berhan et al. 2014, Table 1) and 0.09% in 1957 to 1.6% which was raised by 1,677.8% in 2017 in Wanka watershed, Northwestern highlands of Ethiopia(Wondwosen et al. 2018, Table 1). Similarly, drastic spatial expansion of urban built-up area at the expense of cultivated land is reported in the northeastern and northern Ethiopia (Kebrom and Hedlund, 2000; Gebrelibanos and Assen, 2013). This revealed that the drastic increment of population growth and high demand of construction.

As indicated in Table 1, the highest amount of grassland destructed from 1973-2007 periods in Modjo watershed but the lowest amount of grassland transformation occurred from 1957-2017 in Wanka watershed. This ultimately has its negative repercussion on soil fertility as organic fertilizers availability (dung and compost) would be reduced (Worku et al. 2016) and there is a loss of additional income source which can be obtained from sale of animals and animal products. Other studies conducted in the southern part of the basin have also documented similar observations. For example, Assefa and Bork (2016) reported a reduction of grassland in the southern part of the basin around Chencha and Arba Minch as a result of rapid population growth and agricultural expansion in the areas. Wagesho (2014) reported a reduction in grassland in Bilate and Hare catchments due to the expansion of settlement and agricultural activities in the landscape. LULC changes due to the effect of resettlement have been documented in other parts of the country as well. Yonas et al. (2013) reported high degradation of rangelands in southwestern Ethiopia following the government resettlement program. Similarly, Reid et al. (2000) reported rapid LULC changes in Ghibe valley, southwestern Ethiopia, caused by the combined effects of resettlement and drought induced migration from some areas of northern Ethiopia.

Bareland showed that increment from 2.8% in 1973 to 3.6% in 2007 being increased by 28.6% in Modjo watershed and from 2% in 1957 to 3% in 2017 which was expanded by 50% in Wanka watershed (Table 1, Figure 2 and 3). As indicated in Table 1, the higher expansion occurred in wanka watershed than in Modjo watershed. This may be due to severe soil erosion that resulted from topographic nature of the area and intensive cultivation with poor land management. Similarly, Land degradation is caused by intensive cultivation without appropriate land management (Maitima et al. 2009).

Moreover, there is a change in extent of other land use types including marsh lands and other water bodies as reported from different parts of the country (table 1). For instance, marshland decreased by 25% between 1973 and 2007 in Modjo watershed but plantation forest increased by 140% and water body raised by 40% from 1973 to 2007 in Modjo watershed; water body increased by 50% from 1957 to 2017 in Wanka watershed and mixed cover land increased by 114% from 1986 to 2006 in Ameleke watershed were showed that increasing trend in the study periods (Table 1). This revealed that the land resource management issues varied from place to place based on population consumption demand and understands the impact of land use land cover change.

3. Causes of LULC change in Highlands of Ethiopia

3.1. Population growth

Population growth is associated with increase in resource consumption, which causes expansion and intensification of land use, overutilization of biological resources and exploitation of marginal lands and the breakdown of traditional resource management systems (Temesgen et al., 2017; Berhan et al.2014;Wondwosen et al., 2018; and Gebrekidan et al., 2014). According to Solomon (1994), LULC changes and socioeconomic dynamics have a strong relationship; as population increases the need for cultivated land, grazing land, fuel wood; settlement areas also increase to meet the growing demand for food and energy, and livestock population. Spatial and demographic changes in Ethiopia have an acute impact on agricultural land and the supply and amount of fuel wood in the surrounding areas (Kebrom, 1999). The population pressure has also been found to have negative effect on shrub lands, reverine vegetation and forests in Kalu district (Kebrom, 1999), riverine trees in Chemoga watershed (Woldeamlak, 2002), and natural forest cover in Dembecha Wereda north-western Ethiopia (Gete and Hurni, 2001).

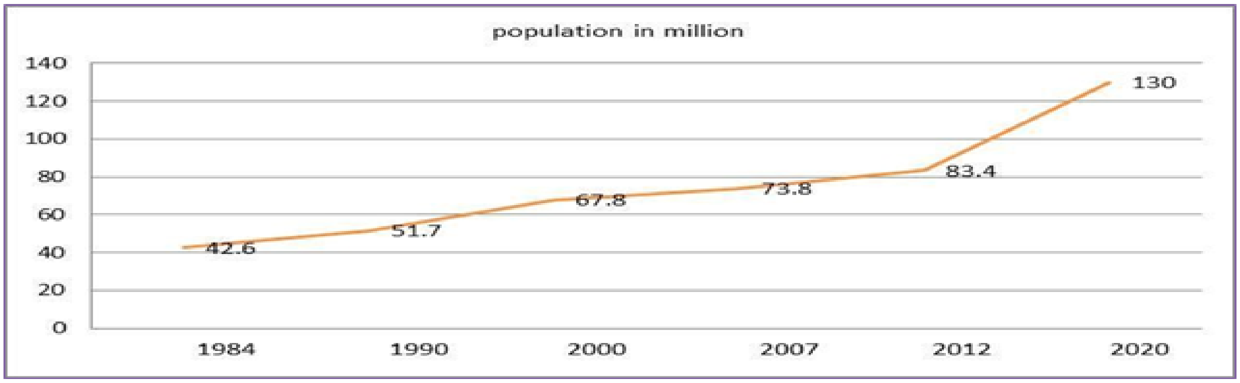


Figure 5: Trends in human population growth, Ethiopia (Source: Ethiopian Biodiversity Institute, 2014)

In Ethiopia, Population increased from 42.6 million in 1984 to 83.4 million in 2012, which increased by 40.8 million (Table 2). Demographic pressure is one of the underlying causes of LULC dynamics (Lambin, 2003). In the Ethiopian highlands, it forms one of the main causes of LULC dynamics and deforestation (Hassen and Assen, 2017; Gebrelibanos and Assen, 2013; Bewket and Abebe, 2013; Asmamaw et al., 2011).

3.2. Agricultural expansion

In highlands of Ethiopia, the transformation of uncultivated land to cultivated land is due to the increasing demands of food production. Agricultural lands are expanding at the expense of natural vegetation and grasslands in different study areas (Temesgen et al., 2017; Berhan et al.2014; Wondwosen et al., 2018; Gebrekidan et al. 2014). Similar results were analysed by Gete and Hurni (2001) in Dembecha area of northwestern Ethiopia; Gessesse and Kleman (2007) in South Central Rift Valley Region of Ethiopia; Rientjes et al.(2011) in Upper Gilgel Abbay catchment of Blue Nile basin; Gebremicael et al. (2013) in Blue Nile basin; Temesgen et al.(2014) in Dera District of Northwestern Ethiopia; Solomon et al.(2014) in Birr and Upper-Didesa watersheds of Blue Nile basin, where the agricultural land increased significantly whereas forest land has shrunk. 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.

3.3. Built-up area expansion

As observed above, in all case studies, built-up area expansion was observed in the highlands of Ethiopa (Temesgen et al., 201 Berhan et al. 20147; Wondwosen et al. 2018; Table 1. Similarly, spatial expansion of urban built-up area at the expense of cultivated land reported in the northeastern and northern Ethiopia (Kebrom and Hedlund 2000; Gebrelibanos and Assen 2013).

3.4. Deforestation

Forest cover decline was among the rapid land cover changes of the last decade in tropical region (Lambin et al, 2003). In Ethiopia, similar results were analysed by Gete and Hurni, (2001) and Woldeamlak (2002) in North western part of Ethiopia; Gessesse and Kleman (2007) in the central rift valley region of Ethiopia; Berhan, (2010) in Western part of Ethiopia. In Ethiopia, accelerated deforestation has been taking place since the beginning of the 20th century (EFAP, 1993). Available studies indicate that only 2.2% of Ethiopia and 5.6% of the highlands region are covered with forest (Berry, 2005). According to Alemu (2008) the annual rate of deforestation in Ethiopia is estimated to be between 150,000-200,000 ha which are changing from time to time. 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 agro-ecosystem over a period of 46 years and 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.

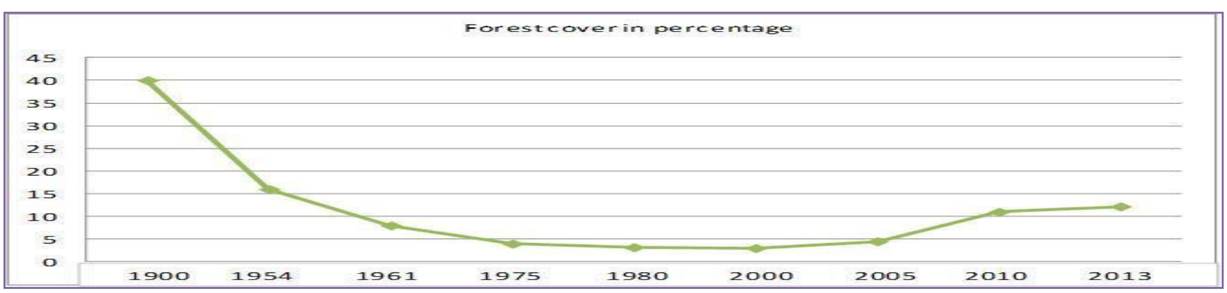


Figure 6: Trends in change of forest cover (Source: Ethiopian Biodiversity Institute, 2014)

In Ethiopia, forest land decreased 40% in 1900 to 12.5% in 2013 which was changed by -27.5% (Table 3).

3.5. Institutional and policy factors

According to Wondwosen et al. (2018), in the study period (1957–2017), the political system of the country has been changed two times, one in 1974 and the other in 1991. This resulted in a redistribution of land that increased land fragmentation. The 1974 transition period of government change gave room to the destruction of forest cover. In addition, in 1991 there was a huge destruction of government controlled communally planted trees that mainly consisted of *Eucalyptus globulus*. The policy of food self-sufficiency based on surplus crop production has also been realized at the expense of forest degradation in south-western Ethiopia (Million, 2002). Land use-cover change and resource degradation have also been affected by land tenure system (Amare, 1996, Solomon, 1994, Gete and Hurni, 2001). According to Solomon (1994), institutional and policy factors impact was more than population increase.

In the other parts of World, Changes in land use in several Asian countries during 1952- 1995 has been attributed to commercialization as well as government policies (Fox and Vogler, 2005). Long *et al.* (2007) indicated the industrialization, urbanization, population growth, and China’s economic reform measures as the four major driving forces contributing to land-use change in the studied area.

4. Consequences of land use /land cover change (LULCC)

4.1 Impact of LULCC on resources degradation

4.1.1 Soil erosion

Several studies indicate that rates of soil erosion are affected by land use and land cover changes. Land use is considered as one of the five major Wishmier and Smith soil erosion factors (Morgan, 2005). Calculated study on soil loss revealed that the soil loss from free grazing lands exceeds that of closed areas by 47% (Mekuria and Veldkamp, 2005). Hawando (1997) estimated that erosion causes 7.8 billion tons of soil loss in Ethiopia per year due to negative effect of land use-cover change. The soil loss from the cultivated land was greater than the maximum tolerable amount of soil loss which is 10 ton/ha per year in Ethiopia (Hurni and Messerli, 1981; Hurni, 1985). As reported by Hurni (1993), Ethiopia has been described as one of the most serious soil erosion areas in the world with an estimated annual soil loss of about 42t/ha/yr from croplands, resulting in an annual crop production loss of 1 to 2% because of aggressive LULC. Hurni (1988) shows that the consequence of soil loss has direct result of past land use-cover change and its management practice in Ethiopian highlands. Further exceptional soil loss was also registered up to 212 ton/ha per year due to negative effect of LULC in highland of Ethiopia (Haile et al., 2006). The soil loss from cultivated land has reached up to 300 ton per hectare per year in Ethiopia (Hurni, 1993; Herweg and Stillhardt; 1999; SCRP, 2000). Adimassu et al. (2014) has found greater soil loss from un-conserved cultivated land comparing with cultivated land conserved by soil bund. Defersha and Mesele (2012) have also found higher soil loss from cultivated land than other LULC types. LULCC could be the reason of reduction of the value of soil (Erkossa et al., 2015). Girmay et al. (2009) has found no significant difference in soil loss among grassland, enclosure and plantation sites. Grassland has lower soil loss than cultivated land and bare land (Defersha and Mesele, 2012). These studies confirm that soil loss from the cultivated land and other degraded land can be significantly reduced when lands are converted into plantation and especially enclosure. Unless intervention implemented for proper land use and land cover management, soil loss will be significant environmental and socio-economic problem in both local and global level.

4.1.2 Soil quality (SQ) deterioration

Land use-cover can influence soil chemical and physical properties because of different anthropogenic activities, namely tillage, livestock trampling, harvesting, planting, application of fertilizer etc. The highest (6.05) and lowest(5.44) soil pH were found under the forest and cultivated lands, respectively, in Zikre watershed, North western Ethiopia(Yihenew et al., 2017, Figure 7, table 2). The same parameter changed from 6.1 in natural forest to 5.4 in cultivated land in North wellega, Ethiopia (Assefa and Alemayehu, 2016, Figure 8, Table 2). It was detected to raise from 5.61 in grassland to 5.06 in plantation forestland in Abechikeli Mariam, Northwestern Ethiopia(Yihenew and Getachew, 2013, Figure 9, Table 2). pH was found to be less in the other part of Ethiopia. For example, it raised from 5.52 in grassland to 5.01 in both natural and plantation forestlands in Aferfida georgis, Northwestern Ethiopia(Yihenew and Getachew, 2013, Figure 10, table 2). Continuous cultivation practices, excessive precipitation, steepness of the topography and application of inorganic fertilizer could have attributed as some of factors which are responsible for the reduction of pH in the different land use-cover soils. The other reason could be higher microbial oxidation that produces organic acids, which provide H^+ to the soil. Mohammed (2003) concluded that the lowest value of pH under the cultivated land could be due to the depletion of basic cations in crop harvest and leached to streams in runoff generated from accelerated erosions. Generally, the pH values observed in the study area are within the ranges of strongly acidic to slightly acidic reactions according the rating of Foth and Ellis (1997). Land use-cover change and continuous total biomass removal may also be attributed to observed changes in pH (Saikh et al., 1998).

The mean TN was significantly different among land use-cover types. The average values of TN were highest (0.23%) in natural forestland and lowest(0.12%) under the cultivated land in Zikre watershed, Northwestern Ethiopia(Yihenew et al., 2015, Figure 7, Table 1). Other studies conducted in Northeastern part of the Ethiopian have also documented similar observations. For example, it increased from 0.3% in cultivated land to 0.4% in both natural forest and grassland in Northwestern Wellega, Ethiopia(Assefa and Alemayehu, 2016, Figure 8, table 2). The same nutrient changed 0.26% and 0.08% under natural forest land cultivated land, respectively, in Abechikeli Mariam, Northwestern Ethiopia(Yihenew and Getachew, 2013, Figure 9, Table 2). Total nitrogen(TN) was ranged between 0.07% in cultivated land and 0.23% in natural forest land in Aferfida Georgis, Northwestern Ethiopia(Yihenew and Getachew, 2013, figure 10, Table 2). The N contents in the study sites were lowest in cultivated land of Aferfida Georgis(Northwestern Ethiopia) to highest in natural forest land of Zikre watershed (North-Western Ethiopia) based on classification of Landon (1991). Similar to organic carbon, there were significant variations in total nitrogen among different land use-cover in order of fallow land < cultivated land < grassland < forestland in Southeastern Ethiopia (Abera and Belachew, 2011). 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 because 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). This indicates vegetation restoration and proper land use-cover management have implication for improvement of soil nutrients. This is due to more tillage and no addition of fertilizer that replaced the removed TN by continuous tillage (Worku et al., 2014).

Table 2. Soil quality analysis in different watersheds of Ethiopia

Study sites	LULC type	pH (H_2O)	TN (%)	Av. P ($mgkg^{-1}$)	OM (%)	CEC ($Cmol(+)kg^{-1}$	Reference
Zikre watershed (North-Western Ethiopia)	NF	6.05	0.23	4.40	5.01	35.44	Yihenew et al., 2015
	CL	5.44	0.12	6.18	2.57	26.08	
	PF	5.68	0.17	2.56	3.48	27.89	
	GL	5.65	0.15	1.33	2.98	31.97	
Northeast Wellega, Ethiopia	NF	6.1	0.4	3.6	9.0	32.85	Assefa and Alemayehu, 2016
	GL	5.7	0.4	2.1	7.3	25.65	
	CL	5.4	0.3	3.7	4.6	20.19	
Abechikeli Mariam(Northwestern Ethiopia)	GL	5.61	0.17	2.67	4.88		Yihenew and Getachew, 2013
	CL	5.37	0.08	3.15	1.70		
	PL	5.06	0.13	3.84	3.35		
	NF	5.07	0.26	4.97	8.50		
Aferfida Georgis(Northwestern Ethiopia)	GL	5.52	0.15	2.61	4.82		Yihenew and Getachew, 2013
	CL	5.21	0.07	3.26	1.58		
	PL	5.01	0.11	3.84	3.32		
	NF	5.01	0.23	4.86	8.48		
CL-cultivatedland, NF-natutal forest, PL-plantationland, GL-grassland							

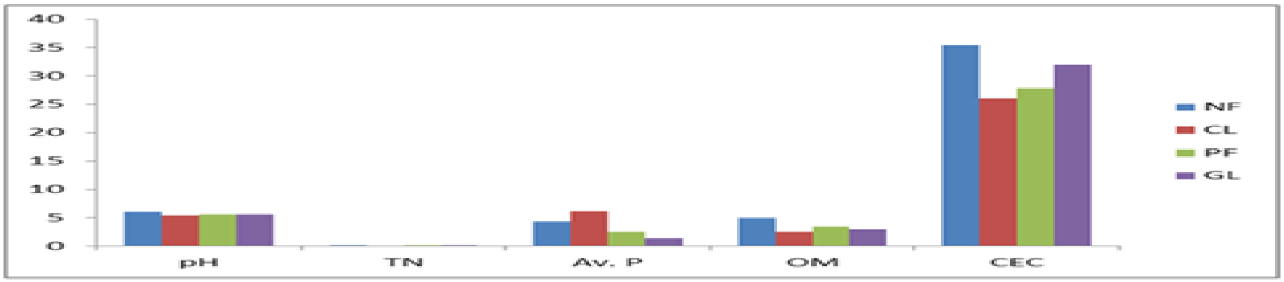


Figure 7: Soil quality in different LULC types in Zikre watershed (North-Western Ethiopia)

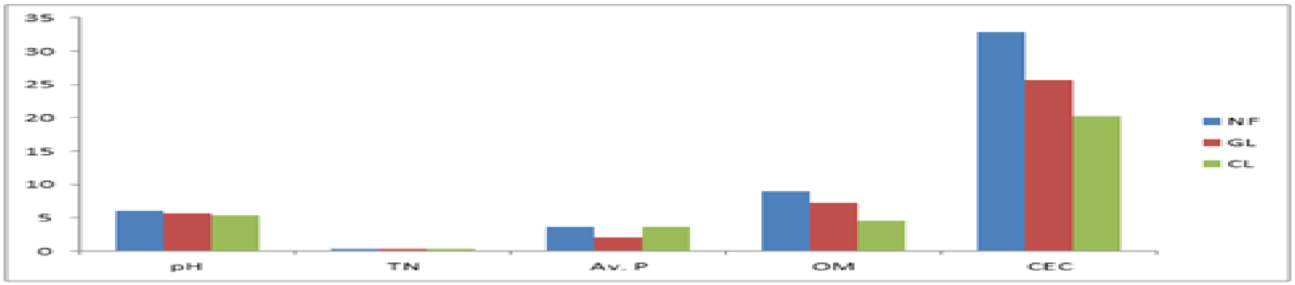


Figure 8: Soil quality in different LULC types in Northeast Wellega, Ethiopia

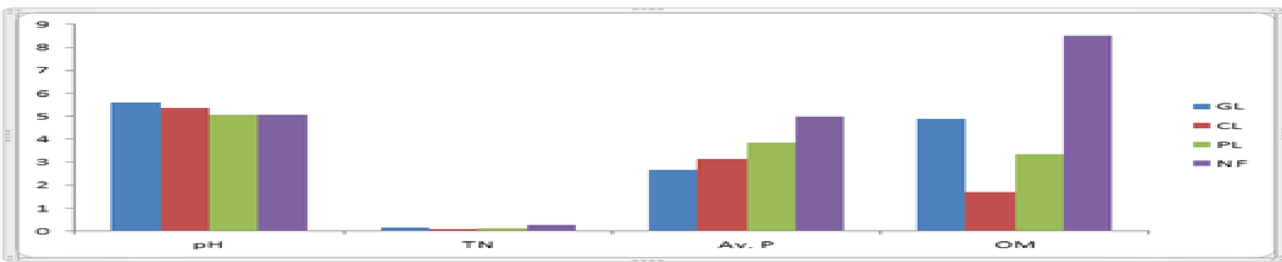
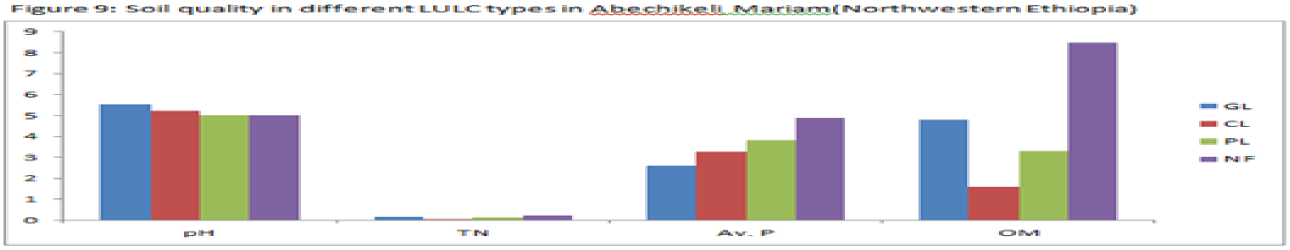


Figure 9: Soil quality in different LULC types in Abechikeli Mariam(Northwestern Ethiopia)



TN-Total Nitrogen, Av.P-available phosphorus, OM-Organic matter, GL-grassland, Cultivatedland, PL-plantation forest, NF-Natural forest

Figure 10: Soil quality in different LULC types in Aferfida Georgis(Northwestern Ethiopia)

Phosphorus is one of yield limiting primary macronutrient. There was a significant difference of available P(av.P) contents among various land uses-cover categories (Table 2). In the Zikre watershed, North-Western Ethiopia(Yihenew et al., 2015, Figure 7, table 2), soil Av.P varied from the highest (6.18 mg kg^{-1}) in cultivatedland and the lowest (1.33 mg kg^{-1}) in grassland. Av.p was detected 3.7 mg kg^{-1} in cultivated land and 2.1 mg kg^{-1} in grassland in Northeast Wellega, Ethiopia(Assefa and Alemayehu, 2016, Figure 8, Table 2). The same soil quality parameter was observed to raise 3.15 mg kg^{-1} in cultivated land to 4.97 mg kg^{-1} in natural forest in Abechikeli Mariam, Northwestern Ethiopia(Yihenew and Getachew, 2013, Figure 9, Table

2). In the Aferfida Georgis, Northwestern Ethiopia(Yihenew and Getachew, 2013, figure 10, Table 2), av.P was ranged from lowest(2.61 mg kg^{-1}) in grassland to highest(4.86 mg kg^{-1}) in natural forest land. The av.P content in the cultivated land appeared to be significantly higher than the rest land use types in Zikre watershed and Northeast wellega, Ethiopia. This could be due to the application of Diammonium phosphate (DAP) fertilizer on the cultivated land. Similar findings were reported by Gebeyaw (2007) and Woldeamlak (2003). The av.P content in the natural forest land appeared to be significantly higher than the rest land use types in Abechikeli Mariam and Afirfida georgis sites. This might be due to the natural forestland contained relatively higher concentration of av.P as a result of high organic matter which released phosphorus during its mineralization. Moreover, decomposing of OM releases acids that increase the solubility of calcium phosphates (Ahn, 1993; Thompson & Troeh, 1993; Havlin et al., 1999). Available Phosphorus is higher on plantation forest lands than grasslands in all case studies, 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). According to Mulugeta and Karl (2010), AP was significantly different between the conserved and non-conserved fields. The variation was reported to be due to the soil OM content difference.

Almost all life in the soil is dependent on organic matter for nutrients and energy. The organic matter (OM) content varied widely under different land use systems. As indicated in Figure 7 and Table 2, the highest (5.01%) and the lowest(2.57%) organic matter content was occurred in natural forest land and cultivated land, respectively, in Zikre watershed, North-Western Ethiopia(Yihenew et al., 2015). Organic matter content ranged from 9.0% in natural forest land to 4.6% in cultivated land in Northeast wellega, Ethiopia(Assefa and Alemayehu, 2016, figure 8, table 2). The same soil quality parameter changed from 8.50% in natural forest land to 1.70% in cultivated land in Abechikeli Mariam, Northwestern Ethiopia(Yihenew and Getachew, 2013, Figure 9, Table 2). Similarly, OM content occurred in highest amount in natural forest land than other land use-cover categories. For instant, it was raised from 8.48% in natural forest land to 1.58% in cultivated land in the Aferfida Georgis, Northwestern Ethiopia(Yihenew and Getachew, 2013, figure 10, Table 2). As indicated in all case studies, Soil organic matter in cultivated land use is constantly subjected to decomposition and loss. This divulged that the decomposition rate in cultivated land is higher than other land use types and due to this its loss in different form is increased. It could be attributed to improved aeration that promoted mineralization of OM or owing to the little or no return of plant residues and manures into the soils. Based on the ratings of Landon (1991), it was very low in cultivated land and medium under natural forest land. The conversion of forest ecosystem to other forms of land cover may decrease the stock of OM due to changes in soil moisture and temperature regimes, and succession of plant species with differences in quantity and quality of biomass returned to the soil (Offiong & Iwara, 2012). It is presented that deforestation and subsequent cultivation reduced organic matter (Evrendilek et al., 2004). Moreover, the transformation of forest into cultivated land is known to deteriorate soil physical properties and making the land more susceptible to erosion since macro-aggregates are disturbed (Çelik, 2005). OM is a powerful indicator for assessing soil potential productivity (Shukla et al., 2006). 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). This indicates that soil organic matter quality deteriorates due to land use-cover changes from natural forest to plantation land, grassland and cultivated land. Abera and Belachew (2011) show soil organic carbon was significantly affected by the type of land use-cover systems (forestland, grassland, fallow and cultivated). 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).

The cation exchange capacity of soils (CEC) is defined as the sum of positive (+) charges of the adsorbed cations that a soil can adsorb at a specific pH. The mean values of CEC were highly significantly different among land use-cover systems in different watersheds in Ethiopia(Table 2). The CEC was varied between 35.44 Cmol(+)kg^{-1} in natural forest and 26.08 Cmol(+)kg^{-1} in cultivated land in Zikre watershed and also 32.85 Cmol(+)kg^{-1} in natural forest and 20.19 Cmol(+)kg^{-1} under cultivated land in Northeast wellega, Ethiopia (Figure 7 and 8, Table 2). Compared to the CEC of the soils of forestland, the CEC of the soils of cultivated and grazing lands were decreased (Table 2). This divulged that CEC is highly dependent on soil organic matter and soil clay content. High organic matter and clay contents increase CEC in soils (Yihenew and Getachew 2013). Similarly, Mulugeta and Karl (2010)) supported the idea that high clay soils can hold more exchangeable cations than a low clay containing soils.

Researchers have showed that linkage between land use-cover and soil properties, particularly in relation to soil nutrients and carbon sequestrations (Agbede, 2010; Nega and Heluf, 2013). 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). According to Haile et al. (2014) , soil chemical properties (OC, TN, available P and pH) significantly changed in response to land use-cover change. Land use-cover changes from forest to cropland resulted in reduction of soil pH. This was confirmed by many empirical studies in dissimilar parts of Ethiopia.

4.2. Impact on climate change

LULC change affects carbon dioxide concentration positively or negatively in environment. In Ethiopia, the major activities contributing to GHG emissions in forestry were deforestation for agricultural expansion, forest degradation for fuel wood, and limited formal and informal logging (FDRE, 2011). The agriculture sector (livestock, crop, and forestry) contributed 88% of the total GHG emissions in Ethiopia in 2010 (FDRE, 2011). Other studies, Lawrence and Chase (2010) found that land-cover change results in a widespread regional warming and drying of the near-surface atmosphere but has a limited global influence on near-surface temperatures and precipitation. According to the same researcher, the LULCC induced warming is significantly driven by changes in surface hydrology due to reduced ET, while radiative forcing plays a secondary role. Most studies focused on the influence of LULCC on the surface air temperature, precipitation, and land–atmosphere fluxes (Brovkin et al., 1999; Betts et al., 2007; Oleson et al., 2004; Douglas et al., 2006; Lobell et al., 2006; Bala et al., 2007; Lee et al., 2009). This shows that the land use-cover change has both negative and positive consequences on climate change. Many bacteria and protozoa are sensitive to temperature; hence, climate change would also influence various directly transmitted infections, especially those due to contamination of drinking water and food. Changes in the pattern of rainfall can disrupt surface water configuration and drinking water supplies. Sea-level rise is another environmental consequence of climate change.

4.3. Impact on Hydrologic cycle

Land cover changes interfere with the land phase of the hydrological cycle. According to Kassa and Gerd (2007), impacts of land use-cover change on water resources are the result of complex interactions between diverse site specific factors and offsite conditions in the highland Ethiopia. In highland Ethiopia, land use-cover change have significant influence on quantity or quality of water cycle (Tufa et al., 2014; Legesse et al., 2012, Bewket and Sterk, 2005), stream flow decreases in the total annual flow at a rate of 1.7 mm yr^{-1}(Woldeamlak & Sterk, 2005), increased the surface run-off and reduced water-retention capacity and stream flow, leading to a loss of wetlands and the drying of lakes (Muluneh & Arnalds, 2011). This prediction (ET decreases due to the declined soil water content) can be explained by the substantial urban expansion, which means the increase in impervious areas and produces the increase of surface runoff and the decrease of infiltration (Neitsch *et al.,* 2005b). Surface-water quality is also sensitive to LULC changes, especially due to the intensive nitrogen fertilizer application for boosting crop production.

4.4. Impact on ecosystem service

Ecosystem goods and services are important for sustaining life on earth and maintaining the integrity of the ecosystem. Among human activities that reduce ecosystem services include LULC change in a given area driven by agricultural activities, settlements, built up areas and mining (Kindu et al., 2016), leading to environmental resource degradation (Lemenih and Teketay, 2005; Kidane et al., 2012). The impacts of LULC change on ecosystem services vary across space and time (Costanza et al., 1997, 2014; deMarko and Coelho, 2004; Hu et al., 2008; de Groot et al., 2012; Haines-Young et al., 2012; Bryan, 2013). Provisioning services such as water for drinking, power production, industrial use, and irrigation, and regulating services such as water purification and erosion control are some of the benefits provided by freshwater (de Groot et al., 2010). This environmental resource degradation causes the reduction in ecosystem services (Feoli et al., 2002; Slaymaker, 2010; Kindu et al., 2016). The forest change represents a vital ecological space for birds, mammal species, and water supply. Land use-cover change also interrupts the regulating and provisioning services of ecosystems, in particular nutrient cycling, the global carbon cycle and the hydrological cycle (GEF, 2006).Among the main effects of human activities on the environment are land uses and resulting land cover changes. Such changes impact the capacity of ecosystems to provide goods and services to the human society (Burkhard et al. 2012).

5. Implication of LULC Change

In all study watersheds and periods, cultivated land, bare land and urban built up LULC categories showed a continuous expansion trend (Table 1, Figure 1). On the other hand, forest, grass and shrub lands revealed a declining trend in the highlands of Ethiopia (Table 1, Figure 1). This has an implication on shortage of fuel wood and construction material, sustainability of land resources subsequently, agricultural productivity declines and out-migration of rural population.

5.1 Environmental implication of LULC

LULC change occurred at the expense of natural forests and vegetation in different parts of Ethiopia(Figure 1, Table 1). The LULC alterations are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods, erosion, climate change etc (Seto et al., 2002), driver of environmental change on all spatial and temporal scales (Turner et al, 1994). LULC contributes significantly to earth atmosphere interactions, forest fragmentation, and biodiversity loss. The major potential environmental implications LUC change can be summarized as follows:-

5.1.1 Biodiversity loss

The expansion of cultivated land and built-up land at the expense of forest, grass and shrub lands may disturb the habitat of biodiversity (Table 1, Figure 1). LULC change has resulted in the loss of fertile soil and biodiversity in different part of Ethiopia (Reid et al., 2000; Dereje 2007; Mengistu, 2008; Dessie & Christiansson, 2008; Kefelegn et al., 2009), historically contributed to loss of plant biodiversity in Ethiopia (Nyssen et al., 2004), contributed to the loss of biodiversity in the Gelana sub-watershed of Northern highlands of Ethiopia (Birhan and Assefa, 2018). 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). Much of the world's natural land cover has been transformed by human activities (Morton et al., 2006), resulting in ecosystem degradation and biodiversity loss worldwide (Green et al., 2005), one of primary cause of biodiversity loss in the world (Tilman et al., 2001). This implies that LULC change caused for the loss of biodiversity in both flora and fauna. The loss of plant biodiversity leads to a decline in ecosystem integrity and loss of plant genetic resources.

5.1.2. Disturbance of climatic conditions and hydrological regimes

In all studied watersheds of Ethiopia, studies have showed that forests were declined due to expansion of cultivated and built-up land (Table 1 and Figure 1). The studies revealed that due to land use-cover change the stream flow for the wet months had increased, while there was a decrease in the dry season (Gerold, 2012; Getachew, 2013), a constant base flow decrease and a high flow increase (Narulita, 2012), reduce infiltration, decrease groundwater recharge, and increase runoff (Bewket and Strek, 2005), both surface and ground water flows are significantly affected (Meyer et al., 1995). This suggests that there will be continuous shortages of water for different uses including home, agricultural and industrial purposes; hence negatively affecting productivity of agriculture and industries.

5.13. Implications for health risk

According to Turner et al. (1996) the release of carbon dioxide to the atmosphere from the global terrestrial biosphere due to land use-cover change has become a serious problem threatening the health of the environment. With the global climate change, these communities have been placed in greater vulnerability as the weather and extreme events have become more unpredictable (Piya et al., 2012). Researchers expect climate change to affect environmental health in multiple, serious ways. With outcomes that vary across region, climate change forecasts predict disease, hunger, and mortality increases due to higher temperatures and altered weather patterns (Costello et al., 2009). The World Health Organization (WHO 2009) estimates that in 2000, climate change caused 150,000 deaths and about 5.5 million disability-adjusted life years (DALYs) to be lost globally. Moreover, the WHO anticipates that negative health outcomes related to climate change will increase sharply, with twice the health burden by 2030 due to worsened health risks and disease-related outcomes (WHO, 2009; Patz et al., 2005). Researchers expect climate change to affect environmental health in multiple, serious ways. With outcomes that vary across region, climate change forecasts predict disease, hunger, and mortality increases due to higher temperatures and altered weather patterns (Costello et al., 2009). The World Health Organization (WHO, 2009) estimates that in 2000, climate change caused 150,000 deaths and about 5.5

million disability-adjusted life years (DALYs) to be lost globally. Moreover, the WHO anticipates that negative health outcomes related to climate change will increase sharply, with twice the health burden by 2030 due to worsened health risks and disease-related outcomes (WHO, 2009; Patz et al., 2005). However, examining this research as a whole clarifies that children, pregnant women, older adults, the impoverished, disabled people, individuals that disproportionately rely on emergency medical services, isolated populations, those with chronic health conditions, and workers in specific occupations will be more vulnerable to climate change (Balbus and Malina, 2009; Costello et al., 2009; Hess et al., 2009; Klinenberg, 2002). Children are particularly at risk for negative climate change–related health outcomes due to many factors, including their relatively greater vulnerability to high temperatures and exposure to air, food, and water pollutants during their development; reliance on others for care; more time spent outside; and the additional years that they can expect to live exposed to higher environmental stressors than adults (Sheffield and Landrigan, 2011). Lacks of adaptation to climate change have increased vulnerability (Cochrane and Costolanski, 2013). As such, this forecasting literature provides planners with vital information to confront the complicated ways in which climate change is expected to influence human health outcomes.

5. Conclusion

Land use and land cover dynamics specifically deforestation has been a global concern, with an adverse implications for human livelihood systems. Long -term land use and land cover (LULC) dynamics information is essential to understand the trends and make necessary land management interventions, such as in the highlands of Ethiopia. The changes in land use-cover aggravate land degradation. The land use-cover change observed in Ethiopia has a negative impact on the environment settings. Deterioration of forest, shrub and grass lands accelerates soil erosion and subsequently results in declines of agricultural productivity as cultivated land expansion at the expense of natural vegetation accentuates soil erosion. Cultivated land expansion at the expense of grass land adversely affects animal rearing practice and in turn additional income from animal and animal products sale. Decision makers should give due attention to the problems and make suitable interventions. Maximizing agricultural productivity by intensification with technology, creating off/non-farm job opportunities in the rural villages and encouraging community participation in the protection of the destruction of forest, shrub and grass lands as well as rehabilitating of bare lands need to be considered. The expansion of agricultural land in the country in general, could be directly related to rapid population growth and resettlement programs. Susceptibility to forest degradation is understood that the forest resources can be influenced or degraded by human activities. In reality, forest resources are degraded not only by human activities but also due to other natural factors too. This is because of the degraded wood lands were changed to shrub lands. Whereas, bare land was continuously increased, because of the new settlers lose of much vegetation for infrastructure and fire wood purpose. Due to these land quality has greatly deteriorated and degraded.

REFERENCES

Abera Y and Belachew T (2011). Effects of land use on soil organic carbon and nitrogen in soils of Bale, South Eastern Ethiopia. J. Trop. Subtrop. Agroecosyt. 14, 229-235.

Agbede TM (2010). Tillage and fertilizer effects on some soil properties, leaf nutrient concentrations, growth and sweet potato yield on an Alfisol in southwestern Nigeria. Soil & Tillage Research 110(1), 25-32.

Alemu G (2008) Forest covers change detection in Goba district using GIS &RS: Department of Earth Sciences. (Unpublished MA Thesis) in Addis Ababa University, Ethiopia.

Asfaw B (2014). Modeling the Effect of Climate and Land Use Change on the Water Resources in Northern Ethiopia: the Case of Suluh River Basin (MSc Thesis).Department of Earth Sciences, Institute of Geographic Sciences, FreieUniversität Berlin.

Assefa, E.; Bork, H.(2016). Dynamics and driving forces of agricultural landscapes in Southern Ethiopia: A case study of the Chencha and Arbaminch areas. J. Land Use Sci. **2016**, 11, 278– 293.

Barbier, E.B.; Hochard, J.P (2016). Does land degradation increase poverty in developing countries? PLoS ONE, 11, 1–12.

Bewket W (2002). Land Cover Dynamics Since the 1950s in Chemoga Watershed, Blue Nile Basin, Ethiopia. Mountain Research and Development 22(3), 263-269.

Bewket W, Sterk G (2005). Dynamics in land cover and its effect on stream flow in the Chemogawatershed, Blue Nile basin. Ethiopia, Hydrol Process 19: 445-458.

EFAP (Ethiopian Forestry Action Program) (1993). Ethiopian Forestry Action Program: The Challenge for Development. Volume 2. Addis Ababa, Ethiopia: Ministry of Natural Resources Development and Environmental Protection.

Ellis E (2011). Land-use and land-cover change. Encyclopedia of Earth. Available at http://www.eoearth.org/article/ Land-use and land-cover change.

European Union Delegation to Ethiopia (EUDE) (2016).Assessing the root causes of recurring food insecurity in Ethiopia; EUDE: Addis Ababa, Ethiopia.

FAO (2016).Global Forest Resources Assessment 2015: Desk Reference; Food and Agriculture Organisation of the United Nations: Rome, Italy; Available online: http://www.fao.org/3/a- i4808e.pdf (accessed on 21 September 2016).

FDRE(2011). Ethiopia's Climate-Resilient Green Economy Strategy; Environmental Protection Authority: Addis Ababa, Ethiopia; p. 188

Gebrelibanos T, Assen M (2013). Effects of Land-Use/Cover Changes on Soil Properties in a Dryland Watershed of Hirmi and its Adjacent Agro Ecosystem: Northern Ethiopia. International Journal of Geosciences Research 1(1), 45-57.

Gebreselassie Y (2002). Selected chemical and physical characteristics of soils Adetresearch center and its testing sites in North-Western Ethiopia. Ethiopian Journal of Natural Resources 4(2): 199-215.

Gerold D, Dagnachew N. (2012). Land Use Land Cover Change in the Katar Catchment, Ziway Watershed, Etiopia.

Getachew M. (2013). The impact of Land use change on the hydrology of the Angereb Watershed, Ethiopia. International Journal of Water sciences.

Hailu T, Negash L, Olsson M (2000). Millettiaferruginea from southern Ethiopia: Impacts on soil fertility and growth of maize. Agroforestry Systems 48, 9-24.

Hurni H (1988). Degradation and conservation of the resources in the Ethiopian highlands. Mountain Research and Development 8, 122-130.

Hurni H (1993). Land degradation, famine and land resource scenarios in Ethiopia. In: Pimentel D, editor. World Soil Erosion and Conservation. Cambridge: Cambridge University Press, pp 27-61.

Jones, A. J., R. Lal, and D. R. Huggins (1997). Soil erosion and productivity research: A regional approach. Am J of Alter Agri (12): 185-192.

Kassa Tadele, GerdFörch (2007). Impact of Land Use/Cover Change on Streamflow: The Case of Hare River Watershed, Ethiopia. Catchment and Lake Research LARS

Kebede F, Yamoah C (2009). Soil fertility status and Numass fertilizer recommendation of Typic Hapluusterts in the Northern Highlands of Ethiopia. World Applied Science Journal 6, 1473- 1480.

Khreast S, Al-Bakir J, Al-Tahhn R (2008). Impacts of land use/cover changes on soil properties in the Mediterranean region of north western Jordan. Land degradation and development 19, 397- 407.

Legesse D, Coulomb CV, Gasse F (2003). Hydrological response of a catchment to climate and land use changes in Tropical Africa: case study South Central Ethiopia.Journal of Hydrology 275: 67-85.

Lemenih M (2004). Effects of Land Use Changes on Soil Quality and Native FloraDegradation and Restoration in the Highlands of Ethiopia, Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala, Swede.

Mekuria W, Veldkamp E (2005). Impacts of Land Use Changes on Soil Nutrients and Erosion in Tigray, Ethiopia. Conference on International Agricultural Research for Development, Stuttgart- Hohenheim, October 11-13, 2005.

Minta, M.; Kibret, K.; Thorne, P.; Nigussie, T.; Nigatu, L. Land use and land cover dynamics in Dendi- Jeldu hilly-mountainous areas in the central Ethiopian highlands.

Ministry of Agriculture and Rural Development (MoARD).Ethiopian Strategic Investment Framework for Sustainable Land Management; MoARD: Addis Ababa, Ethiopia, 2010; p. 158.

Mojiri A, Emami N, Ghafari N (2011). Effects of land use changes on soil quality attributes

(a review). Res. J. Agri. Biol. Sci. 7, 1-3.

Muluneh A (2010). Synthesis of Research on Land Use and Land Cover Dynamics in the Ethiopian Highlands. UNU-Land Restoration Training Programme, Keldnaholt, 112. Reykjavik, Iceland. pp. 39.

Nega E, Heluf G (2013). Effect of Land Use Changes and Soil Depth on Soil Organic Matter, Total Nitrogen and Available Phosphorus Contents of Soils in Senbat Watershed, Western Ethiopia. Journal of Agricultural and Biological Science 8, 206-2012.

Nyssen J, Clymans W, Descheemaeker K, Poesen J, Vandecasteele I, Vanmaercke M, Zenebe

A, Van Camp M, Haile M, Haregeweyn N, Moeyersons J, Martens K, Gebreyohannes T, Deckers J, Walraevens K, (2011). Impact of soil and water conservation measures on catchment hydrological response a case in north Ethiopia. Hydrological Processes 24(13), 1880-1895.

Reid, R.S.; Kruska, R.L.; Muthui, N.; Taye, A.; Wotton, S.; Wilson, C.J.; Mulatu, W. (**2000).** Land- use and land-cover dynamics in response to changes in climatic, biological and socio-political forces: The case of southwestern Ethiopia. Landsc. Ecol., 15, 339–355.

Saikh H, Varadachari C, Ghosh K (1998b). Effects of deforestation and cultivation on soil CEC and contents of exchangeable bases: a case study in Simlipal National Park, India. Plant and Soil 204, 175-181.

Tekle K (2000). Land cover changes between 1958 and 1986 in Kalu District, Southern Wello, Ethiopia. Mountain Research and Development 20, 42-51.

Tornquist CG, Hons FM, Feagley SE, Haggar J (1999). Agroforestry system effects on soil characteristics of the Sarapiqui region of Costa Rica. Agriculture, Ecosystems and Environment 73, 19-28.

Tufa DF, Abbulu Y, Srinivasarao GVR (2014). Watershed Hydrological response to changes in land use/cover pattern of River Basin: A review. International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development 4: 157-170.

Turner RK, Van der Berg JC, Soderquist A, Barendregt A, Vander JS, Maltby J, Ireland VE (2000). Ecological economic analysis of wetlands: scientific integration management and policy. Ecological Economics 35, 7-23.

Van Uffelen, J.-G (2013). From disaster response to predictable food security interventions: Structural change or structural reproduction? In Food Security, Safety Net and Social Protection in Ethiopia: Addis Ababa, Ethiopia, pp. 147–176.

Wagesho, N. (2014**).** Catchment dynamics and its impact on runoff generation: Coupling watershed modelling and statistical analysis to detect catchment responses. Int. J. Water Resour. Environ. Eng., 6, 73–87.

WBISPP (Woody Biomass Inventory and Strategic Planning Project) (2005).A National Strategic Plan for the Biomass Energy Sector: Final Report; Ministry of Agriculture and Rural Development: Addis Ababa, Ethiopia, p. 201.

Worku G, Bantider A, Temesgen H (2014). Effects of Land Use/Land Cover Change on Some Soil Physical and Chemical Properties in Ameleke micro-Watershed, Gedeo and Borena Zones, South Ethiopia. Journal of Environment and Earth Science 4(11), 13-24.

Yonas, B.; Beyene, F.; Negatu, L.; Angassa, A.(**2013).** Influence of resettlement on pastoral land use and local livelihoods in southwest Ethiopia.Trop.Subtrop. Agroecosyst., 16, 103–117.

Zewdie E (1999). Selected physical, chemical and mineralogical characteristics of major soils occurring in Chercher highlands, eastern Ethiopia. Ethiopian Journal of Natural Resources 1(2), 173-185.