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Review Article

Effect of Land Use Land Cover Changes on the Forest Resources of Ethiopia

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Abstract: Land cover change refers to modification of the existing land cover or complete conversion of the land cover to a new cover type. Most of these studies identified that deforestation and expansion of cultivation land in to marginal areas were the principal cause of land degradation. Change in land use and land cover may result in land degradation that manifests itself in many ways depending on the magnitude of changes. All of these manifestations have potentially severe impacts on land users and people who rely for their living on the products from a healthy Landscape. This alteration of LULC type coupled with poor land management practice in the region resulted in exposing of land for erosion hazard, which was later turned to accelerated land degradation. All the factors of deforestation such as the prevalence of various types of agricultural activities, fire wood and charcoal production, cutting trees to fulfill the demand of constructional materials, settlement expansion and income generation are directly or indirectly related to population growth and new settlements. The absence of applicable forest policy is cited as a contributing factor for deforestation in different parts of the world including Ethiopia.

Keywords: Land, Deforestation, Resources

1. Introduction

Conceptual overview of Land Use and Land Cover

Land use and land cover (hereafter LULC) are distinct yet closely linked characteristics of the Earth's surface. Land use refers to the purposes for which humans exploit or immediate actions modifying or converting the land and its resources/covers (Turner et al, 1993; de Sherbinin, 2002). In other words Meyer, 1995described as the use which could be grazing, agriculture, urban development, logging, and mining among many others. Turner et al, 1993 referred land cover as the bio-physical sate of the earth's land surface and immediate sub-surface including biota, soil, topography, surface and ground water, and human structures. Meyer, 1995 put land cover as it could be cropland, forest, wetland, pasture, roads, and urban areas among others.

According to James et al, 1976LULC terms are closely related and in many cases they have been used interchangeably. The purposes for which lands are being used commonly have associated to the types of covers, whether they are forest, agricultural, residential, or industrial. The understanding of use-cover relationship is linked with causes and consequences of LULC change (Turner et al, 1995) because the change in land cover leads to the change in land use (Turner et al, 1993). But de Sherbinin, 2002 put reversely that land use change is the proximate cause of land cover change. The driving forces to this activity could be economic, technological, demographic, scenic and or other factors.

Land cover change refers to modification of the existing land cover or complete conversion of the land cover to a new cover type. Land cover changes are not simple processes. There is a functional and structural complexity between types of land cover change, both in spatial and temporal patterns of change (Lambin and Geist, 2003). Land cover change can be manifested in a form of conversion or modification. The former refers to the complete replacement of one cover type by another. In contrast, the later refers to change in its composition without changing its overall classification (Turner et al, 1993; Turner et al, 1995).

Land use change is the conversion of land use due to human intervention for various purposes, such as for agriculture, settlement, transportation, infrastructure and manufacturing,

parks, recreation uses, mining and fishery (Williams, 1994; Turner and Meyer, 1994; Turner et al, 1995). Land use change is associated with land cover change while land cover may change without the alteration of land use (Turner and Meyer, 1994). As a result, simple land cover classifications are not sufficient for the analysis of change (Lambin and Geist, 2003). Changes in LULC are among the most important themes for the understanding of the pace, magnitude, and spatial reach of changes of the earth's surface and immediate subsurface as a result of human impact (Turner and Meyer, 1994).

Even though, natural processes may also contribute to changes in land cover, the major driving force is human induced LULCs (Allen and Barnes, 1985). Human induced changes in LULC are as old as human kind itself (Turner et al, 1993). The alteration of the earth's land surface due to human action is unprecedented (Lambin et al, 2001). In order to understand the various implications of land cover change, understanding of land use change is essential. Different human driving forces mediated by the socio-economic setting and influenced by the existing environmental conditions, lead to an intended land use of an existing land cover through the manipulation of the biophysical conditions of the land (Turner et al, 1995).

2. Causes of LULC Change

The question of what factors drive LULC change remains largely unanswered (Turner and Meyer, 1994). Recently, human activities and social factors were recognized to have a paramount importance for understanding of LULC change (Geist and Lambin, 2002).

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. According to Geist and Lambin (2002), 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). 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). Underlying driving forces, i.e. including demographic pressure, economic status, technological and institutional factors, influence LULC in combination rather than as single causations (Turner and Meyer, 1994). The underlying factors have multi-scale sources. Global factors that influence local agricultural marketing or international tourism can be indirectly responsible. Regional factors like the presence of road, access to market, political turmoil and armed conflict may be a direct source of influence in the decision process of land use. Loss of productivity coupled with population boom may be considered local factors. Thus the proximate causes are only manifestations of the underlying causes. Any intervention, therefore, must be geared towards addressing the underlying causes (Bedru, 2006).

These two major categories of causes operate at different levels. Proximate causes operate at the local level (individual farms, householders, or communities); on the contrary, the sources of underlying causes are at regional and national levels such as districts, provinces, or countries. Underlying causes are often external and beyond the control of local communities (Lambin et al, 2003). Hence, LULC dynamics is a result of complex interactions between several biophysical and socio-economic conditions which may occur at various temporal and spatial scales (Reid et al, 2000).

In most developing countries population growth has been a dominant cause of LULC change than other forces (Sege, 1994). There is a significant statistical correlation between population growth and land cover conversion (forest change) in most of African, Asian, and L/American countries (Turner and Meyer, 1994).

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 scrublands, 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).

The rapid increasing population pressure on the highlands of Ethiopia brought significant change in land use patterns mainly caused by increasing agricultural production. In this region, cultivated lands showed slow but continuously increasing trend at the expense of forest and grasslands over the last four decades (Gete, 2000; Kebrom and Hendlund, 2000). Unlike these studies, Muluneh (2003) reported for Sebat Bet Guraghe that population growth was found to have a positive impact on forest cover.

In other words the understanding of institutional causes (i.e. political, legal, economic, and traditional) and their interaction with individual decision making are important in explaining land use changes (Lambin and Geist, 2003). Institutional causes need to be considered at micro and macro levels because the implementation of macro policies is practiced at the local level. LULC changes are influenced significantly when macro policies undermine local policies (Lambin et al, 2003) in that the structure of local and national polices may

determine local people's access to land, capital, technology, and information (Lambin and Geist, 2003). Lack of well-defined policies and weak institutional enforcement may facilitate changes of land use. On the other hand, restoration of land use is possible if there are appropriate land use policies in place. In most developing countries communal (traditional) land holding systems have been shifted to a formal (state) holding system (Lambin et al, 2003). The policy in developing countries of price control on agricultural input and output and self-sufficiency in food have all influenced land use changes (Turner et al, 1993).

The absence of applicable forest policy is cited as a contributing factor for deforestation in different parts of the World including Ethiopia. The lack of appropriate land use and forest policies and the absence of corresponding laws are responsible for decline of forests in south-western Ethiopia. The promotion of industrial crops with high return has encouraged the direct clearance of forests. 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 change and resource degradation have also been affected by land tenure system and government policies (Amare, 1996). According to Solomon (1994), their impact was more than population increase. For instance, rapid expansion of crop cultivation at the expense of forests occurred due to the land reform policy changes of 1975 (Solomon, 1994). In Dembecha, northwestern Ethiopia the efforts of farmers to overcome conflicts in the farming system has not been systematically supported by stable institutions and policies (Gete and Hurni, 2001) which has a significant contribution for sustainable land resources management.

3. Impact of LULC Changes on the Environment and Forest Resources

The growing population and increasing socio-economic necessities creates a pressure on LULC. This pressure results in unplanned and uncontrolled changes in LULC. 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 etc (Seto et al, 2002).

LULC is increasingly recognized as an important 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. It has become one of the major issues for environmental change monitoring and natural resource management. LULC and its impacts on terrestrial ecosystems including forestry, agriculture, and biodiversity have been identified as high priority issues in global, national, and regional levels (Fuchs, 1996 cited on Zhang et al, 2009). According to Houghton (1995); Thenkabail (1999); Helmer et al (2000) as cited on Boakye et al (2008), LULC leads to degradation of forest or woodland and these have impact on catchment processes and biochemical cycles and leads to soil erosion and water shortage not only in the regions immediately affected by deforestation, but also in reasonably distant areas. There are also incidental impacts on environment due to land use change from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by troposphere ozone resulting from automobile exhaust. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere.

Loss of biodiversity, soil degradation, and environmental deterioration are largely results of LULC change. An example of the negative effects of LULC change is that land productivity declines under continuous cultivation, overgrazing and soil erosion (Muluneh, 2003).

The other obvious consequence of LULC change, particularly of deforestation is the shortage of fuel wood. As population increases household energy consumption also increases. Of the total population of the world, 30 to 40 percent largely depends on fuel wood and charcoal. For the poor in rural areas, it is not only a source of energy but a means of income generation too. "*In many parts of the developing world, fuel is scarcer and more expensive than the food that is eaten...*" (Williams, 1994). In Ethiopia, 85 percent of domestic energy consumption is derived from forest products (EFAP, 1993) and this clearing land without selection to expand agricultural lands is the main cause of loss of biodiversity (Girma et al, 2002) or forest degradation.

4. Forest Cover Extent and Its Dynamicity Trend

Globally, about 29 percent of the land surface was originally under forest cover. Presently, however, it is only a fifth of this original remains undisturbed (FAO, 2001). It is estimated that in Ethiopia, 40 percent of the country was covered with forests at the beginning of the 19th century (Dudgeon, 2000). According to EFAP (1993), only 2.7 percent of Ethiopia's land mass is currently estimated to be under forest cover, with a loss of 150,000 to 200,000 hectare of natural forest per annum. One of the problems regarding forest cover in Ethiopia is lack of reliable and accurate information. According to FAO (1993), the country's forest cover in 1989 was 12.9 percent. A decade later, in 1997, the forest cover was estimated to be only 4.2 percent (FAO, 2001). The estimates of the rate of deforestation have also been variable. For example, the annual rate of deforestation estimated by EFAP (1993) ranged between 150,000 and 200,000 hectares per annum. However, FAO (2001) reported a much lower estimate of about 40,000 hectares per annum. This is probably due to lack of consistent definition of what "forest" represents in the different studies and the lack of first-hand information for generating these estimates. From aerial photo interpretation of

forest cover changes, it is remarkable to note the difference between the past and the present forest cover in Ethiopia.

FAO currently presented Ethiopian forest cover information that 11.2% or about 12,296,000 ha are forested. Of this 4.2% (511,000 ha) is classified as primary forest. Ethiopia had 511,000 ha of planted forest. Ethiopia lost an average of 140,900 ha or 0.93% per year between 1990 and 2010. In total, between 1990 and 2010, Ethiopia lost 18.6% of its forest cover or around 2,818,000 ha. The data are presented as the following classified tables.

LANDSAT/TM satellite images from 1986 to 1990 show that Ethiopia's forest cover had since then been reduced to 3.93%, or 45,055 sqkm (Ministry of Water Resources, 1997). The figures refer to an annual deforestation rate of 163.600 ha. This means that up to 1999, the size of Ethiopia's natural high forests has been reduced to 2.36%, respectively 27,059 sqkm. Today, larger forest areas can only be found in very remote and inaccessible areas of South and Southwest part of Ethiopia. A detailed analysis of the density classes shows that between 1973 and 1990, the area coverage of closed forest stands had been reduced from 30,243 sqkm (2.64% of the country's area) to 2,346 sqkm (0.2% of the country's area). The ongoing exploitation could be documented by the fact that within the same time span, the share of severely degraded high forest increased from 0.87% to 3.08%. The following figure shows the extent and the area dynamics of the forest degradation by human impact in Ethiopia between 1973 and 1990 (Reusing, 2000).

As mentioned earlier, different studies made using remotely sensed data of different years, for some parts of Ethiopia indicate that croplands have expanded at the expense of natural vegetation including forests and shrub lands (Selamyihun, 2004; Girmay, 2003; Belay, 2002; Gete and Hurni 2001; Solomon, 1994). While Kebrom and Hedlund (2000) reported that there is an increase in the size of open areas and settlements at the expense of shrub lands and forests. Open areas increased by about 333% while urban and rural settlements increased by about 192 and 57%, respectively in twenty eight years (between 1958 and 1986), in Kalu area of Wello. So one way or another, forest cover of different parts of Ethiopia is under serious threat and this could result a country with very small, sparse and fragmented forests.

Solomon (2005) found a decrease pattern of forest cover change between 1957 and 1982 (first period), 1982 and 2001 (second period) and 1957 and 2001 (four decades under study). In 1957 the area under forest cover was 1808.2 ha (11.8% of Sekellaworeda) which declined to 749.3 ha (4.9%) in 1982 and 423.0 ha (2.8%) in 2001. This decline happened throughout the study period, while the greatest deforestation took place between 1957 and 1982. Of the total forest area in 1957, 1058.9 ha, 58.6% was cleared in the first period. In all the periods considered, the area under forest declined by 1383.2 ha (76.5%), from what existed in the base year or 9.0% of the total Sekellaworeda. The annual clearance of forest cover in the first, second and all periods considered was 40.7, 16.3 and 30.7 ha, respectively. Gessesse (2007) also got a harmonized deforestation trend of the study area/ (South Central Ethiopia) with the national forest decline trend. Expansion of agriculture, grazing lands and villages contributed for the forest loss.

Some research findings revealed that an increase in forest cover in eucalyptus growing areas that could contribute for a slow but increasing forest covers (Nyssen et al, 2004). For example, the comparison of forest coverage in Ankober between 1975 and 1986 (Woien, 1995, cited in Nyssen et al, 2004), the land cover dynamics between 1957 and 1998 in Chemoga watershed (Woldeamlak, 2002) and the impact of population on land cover change between 1957 and 1982 in west Guraghe land (Muluneh 1994, 2003) all showed a slow but steady expansion of forest due to increasing cover of eucalyptus trees.

Getachew et al (2010) also found that the woody land cover which is mainly composed of species of *Acacia, Grewia and Commiphora* showed an increasing pattern in Yabello over the analysis period. Of the total land area, the land covered by the woody vegetation in Yabello sampling site was 29% (30365 ha) in 1967, 31% (3097 ha) in 1987 and 36% (40177 ha) in 2002; a consistent increasing pattern throughout the analysis period. Woody land covers increased by about 2% between 1967 and 1987, 5% between 1987 and 2002 and 7% between 2002 and 1967 in Yabello site, giving an average change of 0.2% per year. This reveals that the greatest change in the Yabello was observed between 2002 and 1987.

Cause of forest dynamicity

The major cause of vegetation changes are often the result of anthropogenic pressure (e.g. population growth) and natural factors such as variability in climate (Janetos and Justice, 2000). Due to increasing population growth rates, there have been increasing rates of conversion of forest and woodlands in developing economies all over the world, mainly for the slash-and- burn farming practice (FAO, 1999). Tropical forests are exploited for varied purposes as timber, slash-and-burn cultivation and pasture development (de Moraes et al, 1998).

Despite housing a large diversity of biological resources, biodiversity in Ethiopia is being negatively impacted by human activities (Kebrom and Hedlund, 2000). Assessments of this impact have indicated that forests have become depleted at a large scale as a result of expansion of agriculture and settlement areas (EFAP, 1992). However, large scale forest destruction at the national level is not the only change, rather major land cover changes have also occurred at the local level (Woldeamlak, 2002). These local level changes play a pivotal role in affecting the health and existence of forest ecosystem (Muluneh, 1994).

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 Southwestern 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).

According to Bedru (2006), the major cause of vegetation change is related to activities of cultivation agriculture in this central Ethiopian Rift valley. From 1973 to 2000, agriculture alone was the driving force for 83.4% and 70.1% of the natural vegetation loss in Abijjata Shala Lakes National Park and in Zeway-Awassa Basin respectively.

5. Conclusion

The changes in land use and land cover aggravate land degradation. The land use and land cover change observed in the study area has a negative impact on both the environment and socio-economic settings. 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. However, in this review human activities were taken in to consideration, because the unplanned actions such as illegal logging, exploitation of forest resources for fuel wood and charcoal production as well as expansion of agricultural lands are the main factors that cause forest degradation and land use change. As a result, there was a dramatic expansion of agricultural land within the specified time period because of population pressure and poor land administration. The expansion of agricultural land in the country in general, could be directly related to rapid population growth and resettlement programs. 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 has greatly deteriorated and degraded.

List of Abbreviations

LULC: Land Use Land Cover
FAO: Food and Agriculture Organization
EFAP: Ethiopian Forestry Action Program
Ha: Hectare
Sqkm: square kilometer

Authors' Contributions

I have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; including in drafting the manuscript or revising it critically for important intellectual content; finally i approval of the version to be published; I also agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Competing Interests

There is no, fees, funding, or salary from an organization that may in any way gain or lose financially from the publication of this manuscript, there is no also financial competing interests, and non-financial competing interests (political, personal, religious, ideological, academic, intellectual, commercial or any other) to declare manuscript.

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