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Assessment of Land Use/ Land Cover Change Using GIS and Remote Sensing Techniques: A Case Study of Dendi District, Oromiya Regional State, Ethiopia

Abebe Senamaw Kebede
Department of Disaster Risk Management and Sustainable Development, Ambo University, Ethiopia POBox16

Abstract
This study was conducted to assess change in land use/ land cover in Dendi District, Oromiya regional sate Ethiopia. To conduct this study three periods of land sat images (Landsat4-5TM1984, Landsat7ETM^{+}2000 and Landsat 8OLI/TIRS 2017) was used. In addition, field observation, focus group discussion and key informant were employed. Google Earth and global position system (GPS) have been used for ground verification. Data was analyzed by using Arcgis10.1, ERDAS imagie9.3 and Microsoft excels 2007 software. The result revealed in study period there is continuous expansion of cultivated land, which increases with rate of 570.6 hectare per year at the expanse of grassland bush/shrub land and forest areas. While forestland, bush/shrub land ,grassland and water reduce with rate of 93.5 hectare per year, 156.1 hectare per year ,318.5 hectare per year and 2.5 hectare per year respectively. This implies that in study area there loss of vegetation because of expansion of cultivated land. This study recommends applying appropriate land management practices to reverse the undesirable land use/ land cover change in the District.
Keywords: Dendi District, Ethiopia, Land use/ land cover, GIS & Remote sensing

1. Introduction

The earth has been in a state of continuous change since a long time ago. Land use and land cover change (LULCC) refers to human modification of the terrestrial surface of the Earth (Ellis, 2016). It is natural, patterns and trends of the land use and land cover have under gone through changes since the element of land use and land cover is not static. Land use/land cover pattern of a region is an outcome of natural and socio–economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure (Zubair 2006). Land use and land cover change have a great influence in global warming, loss of biodiversity, and impact on human life (Anwar 2002).Being a less developed society, the observed changes of the land is swifter in Africa than in other continents. Increased demand of resources by the alarming growing population has resulted in biophysical resource degradation which would leads to decrease availability of different products and services for human, livestock, agricultural production and damage to the environment as well (Dereje *etal*.2010). Belay (2002) also reported a change in land cover can negatively affect the potential use of an area and may ultimately lead to degradation and loss of productivity.

In Ethiopia, many researchers have studied land use and land cover change at the local level, mostly on a catchment scale (Alemayehu, 2010). For instance Mengistie *etal*.(2015) investigated a significantly reduction of natural forest cover and grasslands, but an increase of croplands between 1973 and 2012 in Munessa, Shashemene landscape of the Ethiopian Highlands. Eleni *et al*.(2013) also showed a significant decrease of natural woody vegetation of the Koga catchment since 1950 due to deforestation in spite of an increasing trend in *Eucalyptus* tree plantations after the 1980's. Similarly Woldeamlk and Solomon(2013) reported a reduction of natural vegetation cover, but an expansion of open grassland, cultivated areas and settlements in Gish Abay watershed, north-western Ethiopia. In contrast Amare(2016) reported that area of forest and grassland increase with area of 357.7 and 338.3 ha respectively between 1973 to 2011 periods in Infraz watershed , northwestern Ethiopia. Similarly The size of forest cover increased by 10.5% between 1994 and 2007 around Laelay-Koraro , middle highland of Tigray Ethiopia (Thadiparthi and Mekonen, 2011). Hassen *etal*.(2015) reported that area of bush/ shrub land ,grass land , forest land and lake surface diminish with rate of 24.0, 7.6, 6.1 and 3.7 ha year1, from year 1957 to 2007 in lake Hayq drainage basin Ethiopia. Wakjira *etal*.(2016) states that there is decreasing proportion of forest land from 12.82% to 7.63%, and Water body from 0.42% to 0.22% for the recent period between 2001 and 2010 in Gilgel Gibe, Omo Gibe Basin, Ethiopia. Study done in Dendi district reported that there is forest cover reduction by 80.15% in the district from 73 to 2005 with deforestation rate of 660.33ha per year (Berhan 2010). Land use and land cover changes in response to urban growth also reported by some studies ,Mesfin(2009) identified a significantly increase of urban areas from 34% in 1986 to 51% in 2000 in Addis Ababa, Ethiopia by the expense of agricultural land and vegetated areas driven by population growth. Expansion of urban areas annually from 1957 to 2009 has been identified by Nigussie *etal*.(2012) in the urban fringe of Bahir Dar area as a consequence of increasing population.

Land use dynamics is the major environmental problem in Ethiopia (Berhan 2010). Land use change, caused by human activities accelerates the rate of deforestation, soil erosion and loss of biodiversity. As (Gete 2000;

Amare 2007 and Birru 2007) reported land use land cover change causes dramatic land degradation in high land of Ethiopia . LULCC can be associated with degradation of environmental resources was also reported by (Belay 2002; Mohammed and Tassew 2009)

To understand how land use land cover change affects and interact with earth system (e.g. hydrosphere , biosphere and atmosphere), accurate information is needed on what type of change occur where and when it occurs and the rate at which change occurs (Lambin 1997). Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use system to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population.

Despite numerous studies were conducted in Ethiopia, elsewhere up to date and area specific information is needed. There have been no studies of land use/land cover in Dendi district, which is an important consideration for environmental interpretation and in the development of integrated natural resource management practices. The objective of this study is there for to assess change in land use/land cover in the past three decades in the district. Remote sensing (RS) and GIS(geographic information system) data have been one of the most important data sources for studies of LULC spatial and temporal changes.

2. Materials and Methods

2.1. Study area description

Dendi district found in West Shewa Zone, Oromiya regional state, Ethiopia. The district lies in the coordinate from 8°43' north to 9° 17′ north latitude and 37 ° 47′ east to 38°20′ east longitude (Figure1). It covers an area of 99012.2hectar. The altitude ranges from 1440m to 3260m masl. It have annual temperature and rainfall of 17.5°C and 1225mm. Agriculture is the backbone of the local community economy and about 89.6% of the population is engaged in this activity(WSZARDO, 2016). Dendi District is covered with evergreen isolated forests with various types of vegetation such as higher trees, shrubs and ground cover grasses .

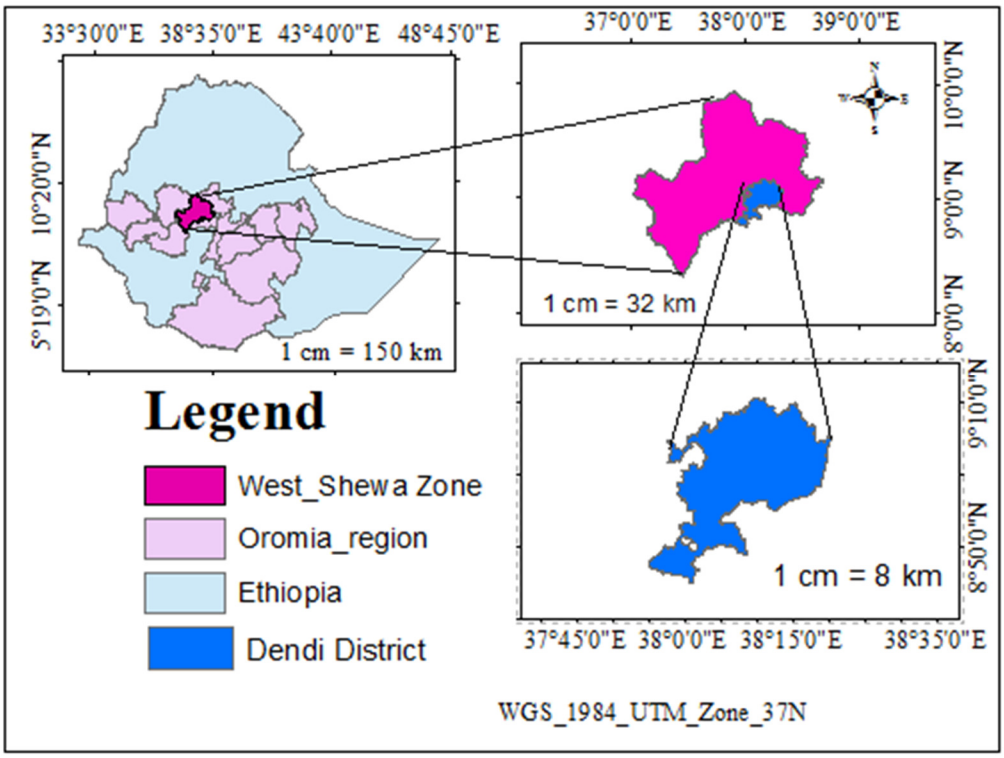

Figure 1. Location map of study area

2.2. Data source

The study was conducted by using three period of satellite imaginers Landsat8(OLI-TIRS), Landsat7(ETM^{+}) and Landsat4-5(TM)) was used for the analysis. The detail of the spatial data used in this research are tabulated in table1. Topographic map in scale of 1:50,000 scale and global positioning system for ground verification were used. In addition, field observation and three focus group discussion, 09 key informant interviews within the farming household have been conducted to get additional information.

Table 1. Satellite image used for LU/LC change analysis and their characteristics

Satellite image	Sensor	path/row	Acquisition date	Resolution (m)	source
Landsat8	OLI-TIRS	169p54r	17/Feb/17	30*30	USGS
Landsat7	ETM^{+}	169 p54r	19/JAN/2000	30*30	GLCF
Landsat4-5	TM	169p54r	09/JAN/1984	60*60	GLCF

2.3. Image pre-processing and classification

Before doing change detection image pre-processing like layer staking, geometric, radiometric correction and image enhancement was applied.

Image classification was undertaken using hybrid classification methods involving both unsupervised and supervised techniques among different classification algorithms. Maximum likelihood was used for supervised classification by taking ground control points for five major land use land cover class(Tabel 2) .This LULC types were identified with the help of visual interpretation elements and the different reflection characteristics of the feature in the satellite images of 1984, 2000 and 2017.

Table 2: Description of land use/land cover categories considered in image classification

LULCC	Description
Forest	Areas covered with dense trees, which include both *Eucalyptus* and coniferous trees, and riveren trees
Cultivated land	Areas used for rain fed crop production and scattered rural settlements usually associated with cultivated lands
Bush/shrub land	Land covered by shrubs and bushes and sometimes with scattered small trees mixed with grasses.
Water	Areas covered by Lake in the catchment permanently
Grassland	Land covered by grasses and used for grazing, as well as bare land that have little grass or no grasses cover.

2.3.1. Accuracy Assessment

Accuracy classification assessment was carried out to verify to what extent the produced classification is compatible with what actually exists on the ground (Congalton 1991). It involves the production of references (samples) that evaluate the produced classification. These references were produced from Google Earth (by observing and recording identifiable Coordinate points of features) and GPS points during fieldwork, which were independent of the ground truths used in the classification. Table 3 shows result of accuracy assessment established in three periods of classified images in study area

Table 3. Accuracy assessment for the classified image

Year	Overall Classification Accuracy	Overall Kappa Statistics
1984	85.59%	0.7980
2000	84.76%	0.7945
2017	87.27%	0.7986

2.3.2. Data analysis

ARCGIS 10.1, ERDAS imagine 9.1 and Microsoft excel were employed for satellite image processing and land use land cover change analysis. The rate of change was calculated for each land use/ land cover classes as rate of change (ha/year) (Abate 2011)

$$\text{Rate of change (ha/year)} = (A - B)/C \quad \text{----------Equation 1}$$

Where, A = Recent area of the land use and land cover in ha

B = Previous area of the land use and land cover in ha

C = Time interval between A and B in years

Overall change matrix was constructed to understand or observe the magnitude of change between different land use land covers.

3. Results and Discussions

According to the result cultivated land constituted the largest coverage in the study area. Of the total area of the district cultivated land accounted for 33411.0ha, 47368.8ha and 52240.3ha respectively in year 1984, 2000 and 2017 respectively. While water body cover smallest area in study period (Table 4).

Table 4.LU/LC change of study area (1984, 2000 and 2017)

LuLc class	1984	2000	2017	Rate of change hectare/year		
	Area(ha)	Area(ha)	Area(ha)	1984 to 2000	2000 to 2017	1984 to 2017
Cultivated land	33411.	47368.8	52240.3	423.0	147.6	570.6
Grassland	33125.	22772.5	22616.1	-313.7	-4.7	-318.5
Bush/shrub land	23473.	21940.3	18321.0	-46.5	-109.7	-156.1
Water	830.2	748.6	748.7	-2.5	0.0	-2.5
Forest	8173	6181.9	5086	-60.3	-33.2	-93.5
Total	99012.2	99012.2	99012.2			

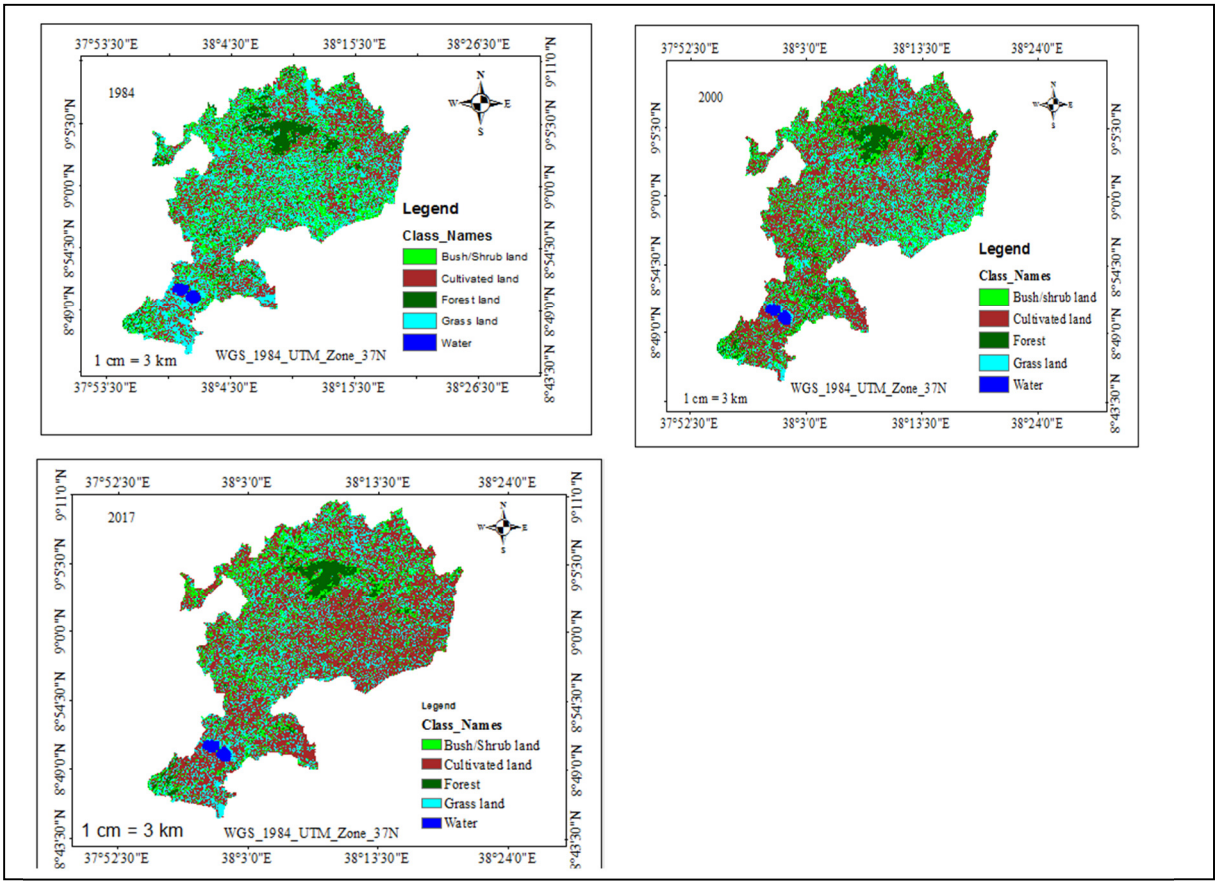

Figure 2. Land use land cover map of Dendi District 1984, 2000 and 2017 period respectively

The quantitative evidence obtained through interpretation of satellite images indicated that the study area has undergone significant LULC change. As shown in(Table 4 and Figure 2) area of cultivated land increases with rate of 423ha/yr from 1984 to 2000. However, from year of 2000 to 2017 the rate of increment reduces (147.6ha/year).In study period (1984 to 2017) cultivated land increase with rate of 571ha/year. This indicted in the area there is expansion of cultivated and rural settlement. This increment was at the expenc of grazing land, bush/shrub land and forestland. As shown in (Table 5) grassland was the major contributor to cultivated land. This was also confirmed during field observation and from local in habitats that there was continuous expansion of cultivated/settlement to marginal areas like grazing and bush/shrub lands. Increases in small-scale farming carried out by resource poor farmers are held accountable for decreases in areas covered by grassland, natural forest, bush/shrub land. This finding was in line with Abate (2011) that the fast growth of agriculture up to 44% was due to the conversion of forest, shrub, and grassland to agricultural land between 1972 and 2003 in Borna woreda of South Wollo highlands, Ethiopia. In support of this idea Temesgen *et al.* (2017) reported area of grazing land reduces from 7.6 to 4.9% 1985 and 2015 in Andassa watershed , Blue nile basin Ethiopia. This finding is contradict with finding of Solomon *etal.* (2013) who reported that area of grazing land increases from 4 to 19% from year of 1958 to 2001 in upper Didessa watershed Ethiopia.

Area of bush/shrub and forest could also reduce with rate of 156.1 and 90ha/year respectively from year of 1984 to 2017.As shown in (table 4) rate of bush/shrub land degradation is high from year of 2000 to 2017. However, rate of forest degradation reduce from year of 2000 to 2017 as compared to period of 1984 to 2000. As confirmed

from key informat interview and focus group discussion from year of 2000 to 2017 in the area there is expansion of *Eucalyptus* plantation as compared to year 1984 to 2000.As Abyot *etal*. (2014) asserted The area of forest reduces with rate of 120ha/year from year of 1973 and 2003 in Banja district, Amhara region, Ethiopia. While, some studies conducted in the previously degraded parts of northern Ethiopia, revealed improvement of vegetation cover due to plantation and enclosure of the previously degraded hillsides in the period since the 1980s. For example, a study conducted by Woldeamlak (2002) in Chemoga watershed, East Gojjam revealed the increased of forest cover at a rate of 11 ha per annum from 1957-1998, even though it is *Eucalyptus* plantation. Similar study by Amare (2007) and Amare *et al*.(2011) in Eastern Escarpment of Wello, Ethiopia and Munro *et al.* (2008) in Tigray highlands disclosed that vegetation cover improved since the 1980s owing to land rehabilitation efforts of the community supported by the government and multilateral donor agencies.

Surface area of Lake Dendi reduces with rate of 2.5ha/year from year of 1984 to 2000 but from year of 2000 to 2017 there is no significant change in the area. As confirmed from intensive focus group discussion and key informant interview sedimentation was the major driving force for the reduction of lake areas in study district. This finding is consistence with the idea of (Shimelis *etal.* 2009). Who reported area of lake Alemaya has reduced from 393.6 ha to 226 ha within a span of 37 years (from 1965 to 2002) because of sedimentation . Lake surface area were diminished by 3.7ha/year were reported by Hassen *etal*.(2015) between 1957 and 2007 in lake Hayqe Ethiopia drainage basin .As shown in (Table 5)water resources were the contributor for grazing land this is confirmed from classified image(Figure 2). Which indicate areas, which were covered by water in year 1984 was converted in to grazing land.

Table 5. Land use land cover change matrix from 1984 to 2017

Change from 1984/to	Land use land cover class to 2017				
	Cultivated land	Grass land	Bush/shrub	Water	Forest
Cultivated land	19619.46	8084.79	5361.39	0	345.33
Grass land	18925.02	8341.47	5294.7	0.09	563.94
Bush/shrub	12121.11	5376.51	5279.58	0	695.97
water	0	81.54	0	748.62	0
Forest	1574.73	731.79	2385.36	0	3480.75

Conclusions

The quantitative evidence obtained through interpretation of satellite images indicated that the study area has undergone significant LULCC. During the analysis period (1984 to 2017) cultivated and rural settlement constituted the largest coverage in the study area. Of the total area of the district cultivated and rural settlement, land accounted for 33411.0ha, 47368.8ha and 52240.3ha respectively in year 1984, 2000 and 2017 respectively. The result revealed that shrub/bush land , forest land , water , grass land have decline over a period of 33 year while cultivated land expanded during the same period . For the whole period cultivated land expanded by 570.6ha per year. While grass land, bush/shrub land, forest land and water decline 322.1, 156.1, 89.9 and 2.5 ha/year in the same period . Therefore, there is a need for sustainable management of natural resources. Hence proper land use planning is needed otherwise the natural resources for example forest and water bodies might be under threatens in future.

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Competing interests

The authors declare that they have no competing interests.

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