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Land Use/Land Cover Dynamics in the Western Highlands of Ethiopia: The Case of Meta Robi District

Fekadu Nemera[1] Abule Ebro[2] Tessema Zewdu[3]
1.Adami Tulu Agricultural Research center, P.O.Box 05, Ziway, Ethiopia
2.International livestock Research Institute (ILRI), Addis Ababa
3.Haramaya University, Haramaya

Abstract
The objective of the study was to evaluate the land use/land cover dynamics in Meta Robi district, West Shoa of Ethiopia. Satellites images of 1986, 2000 and 2013 were used for the study. Global positioning system and topographical maps of scale 1:50,000 for ground verification; field observations. 30 farming household's interview was to get additional information. ERDAS Imagine 2010 and Arc GIS 10.2 software were used for satellite image processing and data analysis. The collected data was analyzed mainly using quantitative method. The results of satellites images and household interview showed that there were an expansion of agricultural land and settlement and decrease of forest and grasslands from 1986 to 2000. Thus, proper cultivation of the land with appropriate implementation of soil fertility management measures and a forestation and reforestation activities are recommended.
Keywords: Land use, land cover, Dynamics, Change analysis.

INTRODUCTION

Land cover is the physical and biological cover of the surface of land, whereas land use is the result of human activities. The process that alter the land use land cover such agriculture, forestry and settlements considered as human induced driven forces of land use land cover (Foley et al., 2005). Therefore land cover changes are the outcome of these various interacting variables and process. Due to these process and factors such as slope gradient, soil depth, terrain configuration and the demand for fuel wood the distribution of land use and land cover varied (Hussein, 2012). Changes in land use have occurred at all times in the past, present, and are likely to continue in the future (Lambin *et al*., 2003; Moser, 1996). As human population growth continues at alarming rate, uncertainly the deforestation, wetland drainage and grasslands degradation in parallel of expansion of agricultural land continue in alteration of land use land cover significantly. Various researchers agree that the land use land cover has been changed due to natural and human induced factors. Large scale environmental phenomena such as land degradation and desertification, biodiversity loss, habitat destruction and species transfer are consequences of land use changes by converting natural land covers (Amare, 2015).

Like elsewhere, parts of the world and Africa land use land cover in Ethiopia are dramatically impacted by anthropogenic effects rather natural phenomenon. Recent investigation and findings show that the land use lands cover of the country undergoing under influence of these factors. Eyayu *et al*. (2010) reported that dense forest was declined from 9.99 to 2.06% between 1957 and 1980 and again from 1957-2003 reached 2.89% which indicate over a period of these years dense forest shifted to agricultural lands, grasslands, shrub lands and settlements size has been declining (Amare, 2015).

The study area was experienced several dynamics of land use/land cover dynamics through times. The grazing lands and other land use were shifted to crops land and settlements due to human population.

The land use/land cover analysis provides the baseline data required for proper understanding of how land was used in the past and what types of changes are to be expected in the future. Accurate information on land-cover changes and the forces and process behind is essential for designing a sound environmental planning and management.

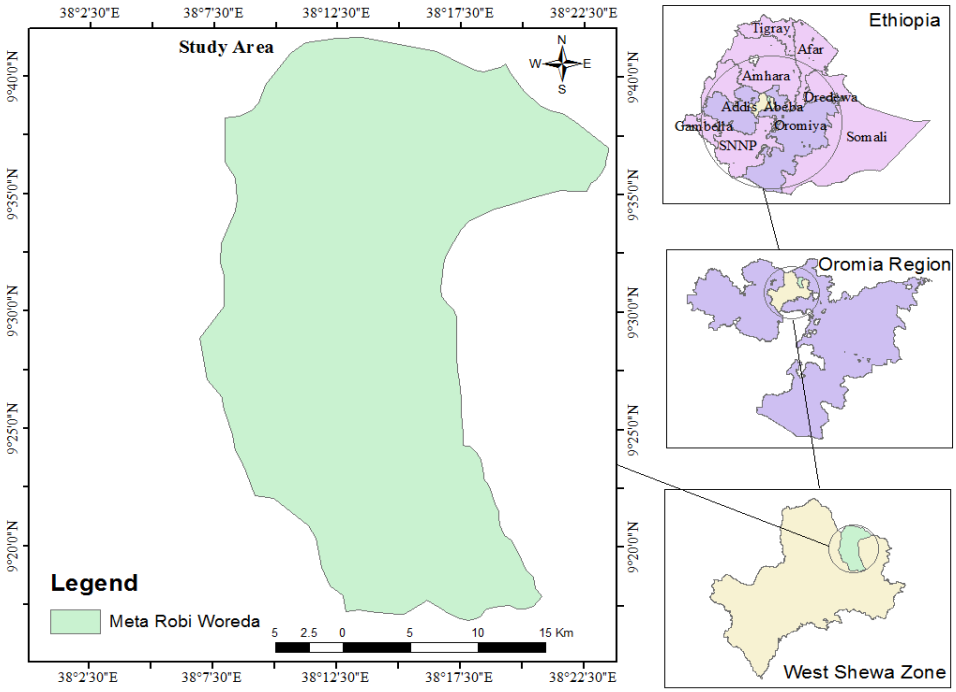
Therefore the general objective of this study is to analyze the extent, pattern driving forces altered the land use land cover as well as its socio economic and environmental implications and to give in sight and high light how to moderate the consequences of land use land cover.

MATERIALS AND METHODS

Description of the study area

The study was undertaken from May 2015 to October 2015 at west Shewa zone Meta Robi district is located between 9°19 N latitude and 38°10 E longitudes. The average elevation is 2473 meters above sea levels. The study area is located at 101kms from the capital city of the country Addis Ababa at west.

Fig. Map of study area



The total human population of the study area is 166,472. Of which 82,482 are male and 83,990 are female (CSA, 2015). The total land area of the study area is about 93,769 hectares. The crop land shared 51,762.9 hectares, where as grazing land, forest lands and other land uses shared 11,775.94, 6,792.75 and 23,437.4 hectares. The district has 41 rural kebeles and 5 peri-urban towns (yadessa *et al.*, 2016).

The minimum and maximum temperatures of the district are 15 and 31°C respectively. The district receives an average of annual rainfall ranging from 750 to 1,300mm. The main rainy season is from June to end of September.

According to yadessa *et al*. (2016) the topography of the district is characterized by flat land, valley, mountains and rugged area estimated to be 60%, 8%, 9% and 23% respectively.

The soil types of the district are classified into Humic Nitosols, one of the best and most fertile soils, can suffer acidity and phosphorous-fixation, and it becomes very erodible (FAO, 1974).

The livelihood of the farmers depend on the production of cereals, pulses and oil crops along with livestock that is kept on natural pasture and crop residues (FAO, 2011).

Methods of data collection

The main ultimate goal of this study was to provide reliable and concise information to local community, decision makers concerning on the trend, rate, and distribution of land use/land cover dynamics in the study area in both quantitative and qualitative form.

Sources primary data

The primary data sources were generated based on field observation, focal group discussion with key informant's interview. Additionally ground survey was conducted using GPS and digital camera in order to check the current feature of the study area.

Key informant interview:

In addition to the ground surveying, interviewees were carried out individuals who have lived long time in the study area and had detail information about the past and present LU/LC types. The key informants selected were elder peoples, PA leaders, development agent (DA's). Purposive types of questions were asked to get the general information about the study area. Such information served as a means to cross check the remote sensing data.

Secondary data

Satellite images of 1986, 2000 and 2013 Digital Elevation Model 30m by 30m and 180 and 30 house hold interview were used.

Methods of data analysis

The contribution of land use/ land cover types on the recorded change in the study area is the primary determinant factor. In order to clearly assess the changes of land use and land cover in the study area, determination of type and size of classes is significant. Accordingly, based on the information's obtained from the key informants past knowledge, visual interpretation of remotely sensed satellite image and using field observation over all seven land use and land cover classes were identified for this study.

Before the undertaking the classification correcting the data for sensor irregularities and atmospheric noise was performed using ERDAS IMAGINE 10.2 software. To facilitate supervised classification; unsupervised classification and aerial photo image fusion was done. For each land use and land cover class, signature was prepared using training area and significant spear ability is obtained. The classification of land use/land cover was undertaken based on supervised classification.

The comparison of land use and land cover statistics assisted to identify the amount of changes per hectares, percentages, extent, and rate of changes between 1986 and 2013. Observed change was simply calculated by subtracting the recent data from the former/previous one (1986-2000 and 2000-2013). Geographical extent of each land use and land cover type was computed for each time interval and changes in the trend dynamics of different periods were traced. Land use/ land cover conversation rate and extent were computed in terms of percentage and area change. The land cover conversion matrix analysis was conducted in ERDAS IMAGINE 10.2

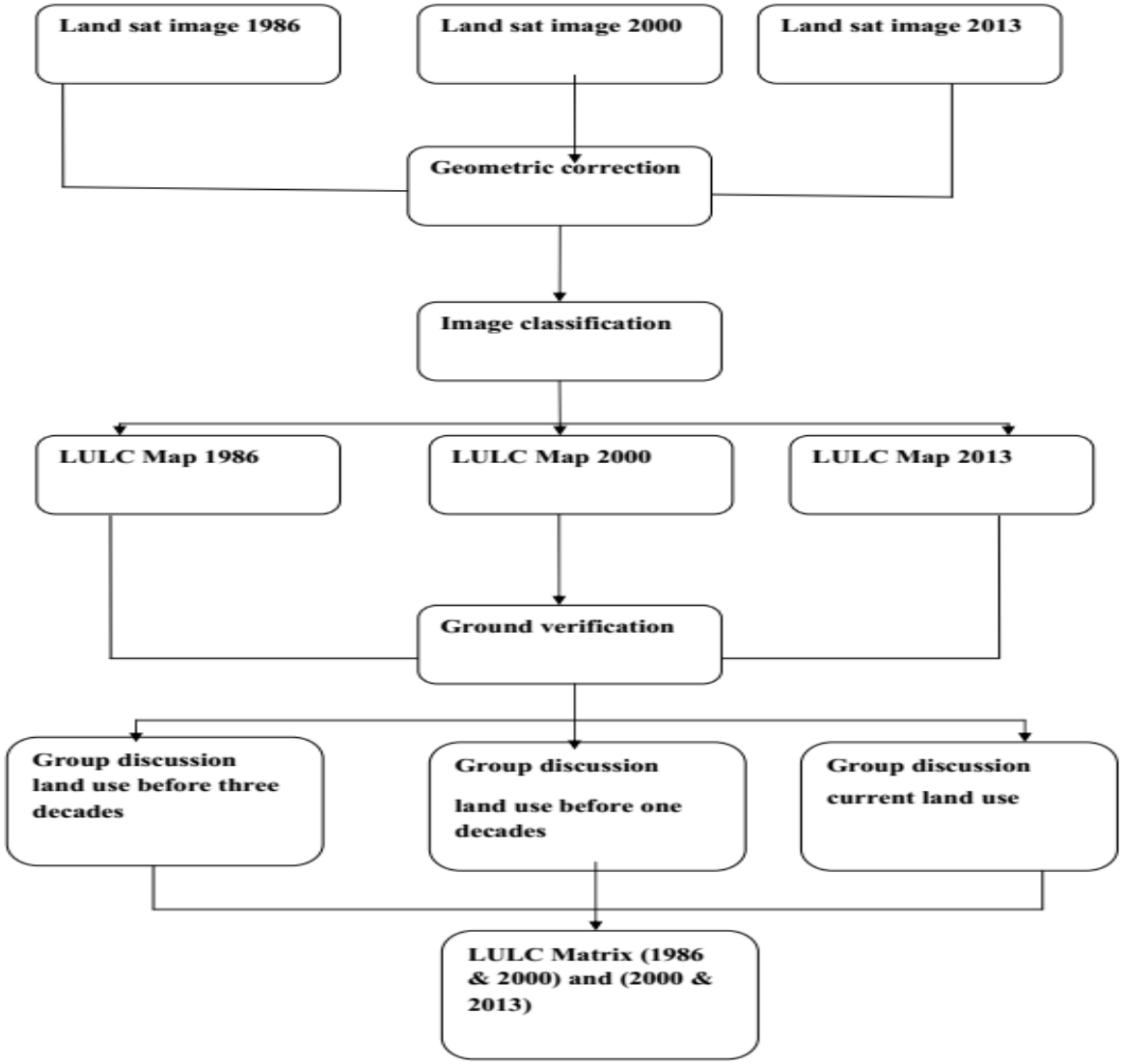


Fig 2. Methodological frame work

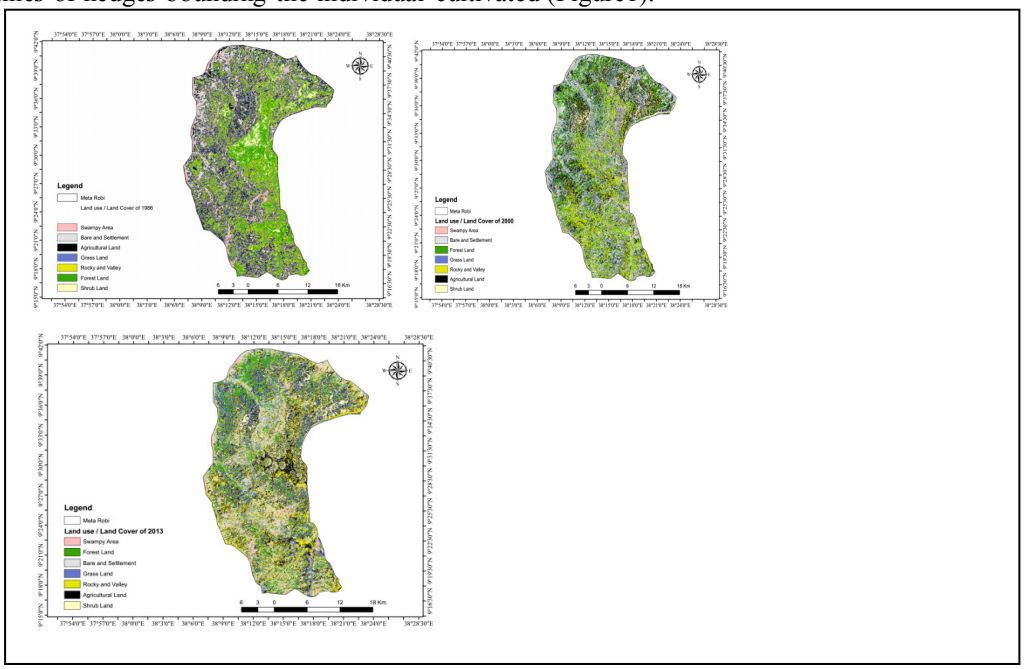
RESULTS AND DISCUSSIONS

The information generated from key informants, field observation and analysis of land sat images were the main tools to classify and interpret the LU/LC classes in the study area. Hence, the total coverage or size of the area was estimated to be about 90535 ha. From the three satellites images processed seven categories of land use were recognized and observed, these categories were repeated themselves in all over the three years in different dimension. The dynamics of land use cover growth parameters is a long term process which required investigations on land use land cover and the interaction of these components with the ecological and social.

Nature of the land-cover units

Generally, the land-covered by woody vegetation was easily identified on the satellite images by the reddish

shade these cover type impart on the false color composite images. Accordingly the woody biomass was distinguished with a dark tone associated with steeper slopes. The grassland is easily distinguished as the shrubs land that are found interspersed in the grassland appear as dark spots within the light grey matrix of the grass cover. However no clear demarcation between bare land and settlements as both reflections on satellite images of bare land and settlements appeared similar in three years satellite photographs. The swampy area or wet lands were distinguished resembling blue colored from other land cover and land use. The peculiar characteristics of crop lands in three satellite images were linear to curved features of the traditional terraces and the lines of hedges bounding the individual cultivated (Figure1).



Land use type and descriptions

The land use type in the study area extracted from land sat images of Meta Robi described classified as agricultural lands, wet/swampy land, grasslands, shrubs lands, forest lands, rocky and valley, settlement and bare lands. Therefore:

Agricultural lands: Cultivated land includes most flat areas and also some steep slopes where various food crops are grown, either on a rain-fed basis.

Wet Lands/Swampy areas: wetlands encompasses those areas located down in the Meta Robi plain which experience frequent flooding and immersion in water and are covered by wetland vegetation including grasses. The ultimate use of such land was as a grazing and holding place for livestock.

Grasslands: Grazing land: refers to those land units allocated as a source of animal feed, including privately and communally owned grazing areas and also those owned by various institutions (church and school).

Shrub/Bush lands: Includes areas covered with different species of shrubs and bushes with widely varying density from one locality to another, and often found in hilly areas.

Forest lands: Those lands covered by large trees and forests which were planted by human and occurring naturally.

Rocky and valley: Those lands represented by galleys, valleys and rocky areas reflected by black color from image classification.

Bare lands: Includes lands with no vegetation and represented by all whether roads, rocks and streets.

Settlement: Areas covered by dwelling, constructions and small huts in rural and urban,

Sources: (Adapted and modified from: Ali, 2009).

Types and extent of land cover changes

From the three satellites images processed seven categories of land use were recognized and observed, these categories were repeated themselves all over the three years in different dimension. The dynamic changes of land use cover growth parameters is a long term process which require investigations on land use land cover and the interaction of these components with the ecological and social components. The satellite images of three different periods of times revealed that LULC of the study area exhibited different patterns. Accordingly, it is clearly seen that agricultural was expanded from periods of 1986-2000 by 4.8%.

Similarly settlement and bare land increased by (4.4%), where as forest and shrub land altogether declined by (3.4%), Between years 2000 to 2013 forest land decreased by (1.7%) and grass land increased by (1.2%) which indicated forest lands changed to grass land due forest clearing for different purpose and use and this in

line with (Gizaw *et al.,* 1999). The changes between 2000 and 2013 were relatively small compared to 1986 to 2000 due short time interval investigation.

Causes of the land cover changes

Land use and land cover changes result from various natural and human factors within social, economic and political contexts. Hence, the local human activities expressing the drivers can be determined by measuring the rates and types of changes and analyzing other relevant sources of data like demographic profiles, household characteristics and policies related to land resources administration (Hussein, 2012). Land cover changes are the results of the numbers of interacting variables and process. Due to these process and factors such as slope gradient, soil depth, terrain configuration and the demand for fuel wood the distribution of land use and land cover varied. In flat sloppier of mid and upper altitudes the shrubs and forests observed in decreasing trend while the sloppy areas and valleys appeared with dense shrubs.

According to group discussion with key informants the increasing of agricultural land with decreasing of grazing land, forestland and scrublands is the results of population growth at alarming rate and expansion agricultural land for food crop production. The decreased trend of forest land was due to clearing of trees for charcoal to sustain their livelihood. However, according to focal group discussion made, plantation of commercial trees around farm land is increasing due to seek of income generation. The land use land cover changes of study district a cumulative of natural and human induced factors. Over grazing was one factor for decreasing bush land for flat slope mid and upper altitude where large lives talk grazed as results of high population of livestock especially sheep reared in high land production systemic of the study area in agreement with (yadessa *et al.,* 2016).

Inappropriate farming practice and tracing are the other factors contributed for occurrence of repeated landslides which played a role for a change of land use land cover of the study area inconsistence with study by (Tarun *et al.,* 2015). Late season of high rainfall from August to September incredible factor for change of land use land cover by raising ground water level recharge by heavy rainfall favorable for causative factors such as slope material, slope gradient and land use land cover. These heavy rainfall induced landslides in the study area possibly occurred as a result of shear strength reduction of the slope material due to saturation and development of pore water pressures within the slope mass. This fact is evident as most of the past landslides in the study area have occurred within the slopes composed of colluvial and alluvial soils.

Consequences of the land use cover changes

One of the immediate impacts of the thinning and destruction of the shrub land is shortage of fuel wood and construction materials for the farming community. These situations were forced the farmers to use cow dung and crop residue as fuel. The use of crop residue and cow dung leads to aggravated soil nutrient depletion and enhances soil erosion which is factor for gulley formation changes the cover and use of land. The reduced possibility for cropland-expansion and severe shortage of land has also its own impact. The land shortages had compelled farmers to practice continuous cropping and completely abandon even seasonal fallowing. Field observation and discussions with farmers suggested that cropping intensity in the Meta Robi district has been raised to almost continuous cultivation in a situation where little organic matter returns to the soils leads to severe soil erosion and land degradation. Furthermore, shortage of land has forced farmers to cultivate steep slopes and shallow soils that are vulnerable to degradation.

Table1 Land use land cover dynamics from 1986-2013

NO	Area	1986		2000		2013	
		Ha	%	Ha	%	Ha	%
1	Swampy area	4135.7	4.6	5280.8	5.8	5434.7	6.0
2	Bare land and settlement	13897.0	15.3	17815.1	19.7	14828.4	16.4
3	Agricultural Land	16186.3	17.9	20585.6	22.7	19523.6	21.6
4	Grass land	18333.2	20.2	12273.0	13.6	13416.1	14.8
5	Rocky and valley	15386.5	17.0	11462.7	12.7	15655.1	17.3
6	Forest Land	17218.4	19.0	16368.6	18.1	14872.6	16.4
7	Shrub land	5377.9	5.9	6749.2	7.5	6804.5	7.5
	Total	90535.0	100	90535	100	90535	100

Variations on results from change detection analysis are expected and these could change the interpretation for the detected changes (Kashaigili, 2006). In this study some variations on the detected changes have been noted. By examine the change detected matrix (Table 1), it is clear that some of the changes were unrealistic, for instance agricultural land or forest land to swampy area, which could be as result of ecosystem dynamics responses dependent on different factors such as season of image acquired, plant paleontological effects and spectral resolutions. The different plant phonological effects are related to which season an image is acquired on the ground (Kashaigili *et al.,* 2010). The shrubs and forest lands of the study area concentrated to lower altitudes than higher even though the finding by Wondie *et al*. (2012), confirms that the presence of mixed forest and shrub land increased with altitude up to the range of 2,500-3,000m and declined thereafter, indicating that this

altitudinal range supports the optimum distribution of the mixed forest and shrub land. This finding revealed that the study area has undergone notable changes in terms of land use and land cover for the period 1986/ 2000–2000/ 2013. The woodland areas and grass lands were found to be highly impacted, notably by the increased anthropogenic activities. The settlement and cultivated land was found to have consistently increased between the two periods under investigation.

SUMMARY AND CONCLUSION

The land-use land-cover from satellite images of 1986, 2000 and 2013 indicated that grasslands and forest lands decreased in size whereas agricultural lands and settlements increased in area coverage due to the increase of human population.

The land use land cover changes forced farmers to use cow dung and charcoal for fire wood.

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