

Land Use Land Cover Change Analysis using Geospatial Tools in Case of Asayita District, Zone one, Afar Region, Ethiopia

Yetnayet Fantaye
Department of Geography and Environmental Studies, Samara University, Ethiopia
P. o. Box 132 Semera, Afar, Ethiopia

Mohamed Motuma
Department of Geography and Environmental Studies, Samara University, Ethiopia

Gebrie Tsegaye
Department of Geography and Environmental Studies, Samara University, Ethiopia

Abstract
Land use land cover change is a complex matter, which is caused by numerous biophysical, socio-economical and institutional factors. The main objective of this study was to analyze Land use land cover change in *Asayita district, Zone one, Afar Region*, Ethiopia. Land sat Satellite image is the main source for the study. Geographic Positioning System data collection instrument was used to collect spatial data from the field. ERDAS IMAGINE 14 and Arc GIS 10 are main software's used to analyze the study. Preprocessing, enhancement, classification and accuracy assessment was the main tasks involved in satellite images processing. Therefore, four major land cover classes were identified based on spectral characteristics of Land sat MSS, image namely, open woodland, Pasture land, bare land and water. The result revealed that barren and open wood land increased at the expense of pasture and water. Therefore, creating awareness among the society concerning optimum use of natural resources, create green economy, conservation systems and their benefits by policy makers and non governmental organization could play significant role in rehabilitation of the environment.
Keywords: Land use, land cover, satellite image, remote sensing

1. Introduction

Human being had been altered the environment for thousands of years to satisfy their basic needs. In the past two centuries the impact of human activities on the land has grown enormously, altering entire landscapes, and ultimately impacting the earth's nutrient and hydrological cycles as well as climate. Significant population increase, migration, and accelerated socio-economic activities have intensified these environmental changes over the last several centuries (Sonneveld, 2002; Zelalem, 2007).

LULC (land use land cover) change emerged in the scientific research on global environmental change, which was emerged in the mid-1970s (Chen Liding and Fu Bojie, 1996). LULC changes are local and place specific, occurring incrementally in ways that often escape our attention. Yet, collectively, they add up to one of the most important facets of global environmental change. Such research project provides important topics in LULC change. Since the time of Malthus, many have supported the notion that human population growth causes land scarcity and the conversion of wild lands to agricultural and other uses, and thus LULC change. Population growth can push the rural poor into marginal lands (Tsegaye, 2007).

The government estimated in the late 1980s that, among Ethiopia's total land area of l.1 million square kilometers, l5 percent was under cultivation and 5l percent was pasture land. It was also estimated that over 60 percent of the cultivated area was crop land. A number of studies indicated that deforestation and encroachment of cultivation into marginal areas were the main causes of LULC change and land degradation in the highlands of Ethiopia (lemlem, 2003). Due to population pressure agricultural practices in many parts of Ethiopian highlands have, more recently, expanded to the more difficult terrain such as to steeper slopes and swampy plains and traditionally untapped part of the environment. This has in turn, created pressure on land, vegetation and water resources. Land use land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes.

2. Problem statement

Resource management is very complex phenomena. This complex nature of sustainable natural resource management demands research that uses a systems approach; research that is interdisciplinary - combining bio-physical and socio-economic dimensions. In the same way lower basins of Awash River in Afar is highly susceptible to LULC change due to natural and manmade drivers such as rapid population growth, over exploitation of resources, introduction of new plant species, and establishment of new mega projects in the basin. Rapid population growth together with new land use planning and new sugar cane plantation practices leads pasture land areas to be cultivated, forest land clearance; woody land and shrub lands are converted to crop land, intensive agriculture and settlement.

Environmental, climatic, and socio-economic problems call for an accurate investigation in the status, causes, processes, and rate of LU/LC changes in the study area. Such inquiry enables researchers, policy/strategy formulators, and aid providers to have accurate data related to the subject and proceed accordingly. Timely and accurate change detection of the natural resources (such as vegetation cover, water, and soil) provides a foundation to clearly comprehend the prevailing interactions between people and the environment. This, in turn, enables the people to manage and use the resources sustainably. Therefore, the study carry out the status of land use land cover of lower basins of Awash River between 2000 and 2015 with a view to detecting the land consumption rate and the changes that has taken.

3. Description of the study area

The district is one of the largest Zone in Afar Regional State located in North East side of Ethiopia about 588 km away from the capital city of Addis Ababa (Figure 1). Astronomically, it is located within 8^0 43' 06'' – 11^0 43'58''N latitude and 39^0 34' 50'' – 42^0 28' 32'' E longitude.

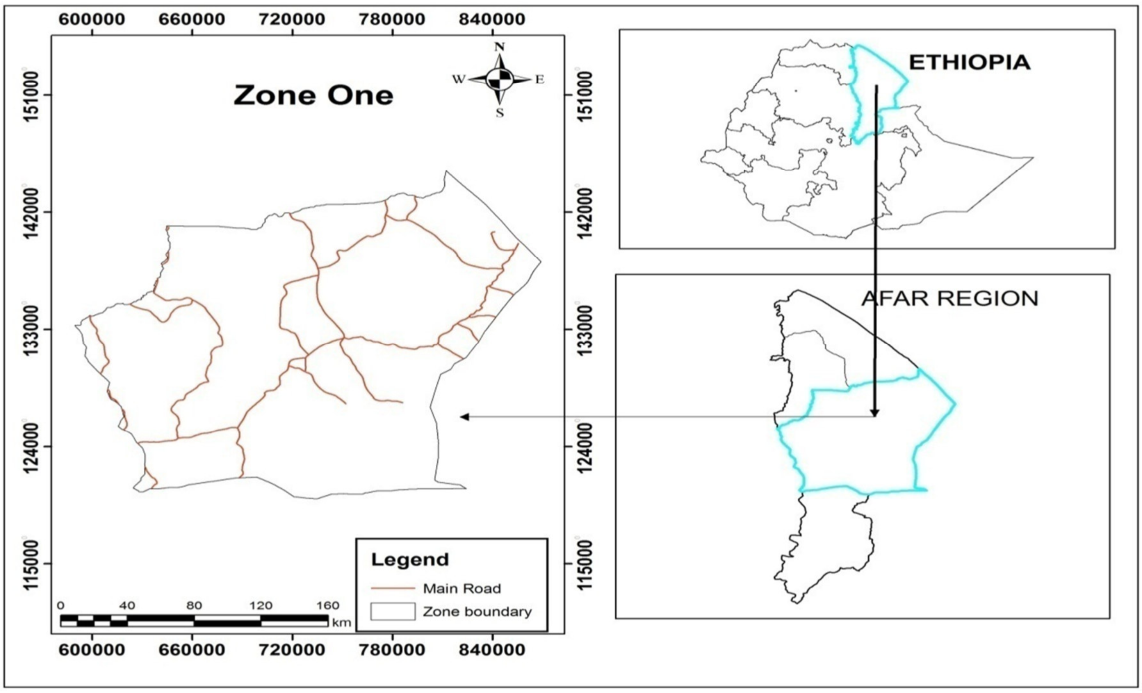

Figure 1 Map of the study area

Climate: Generally the climatic zone of the study area is semi arid which is not cold or hot the annual temperature ranges from 28^0c to 40^0c. And the amount of rain fall also 600mm-900mm per year annually. The maximum temperature range is 32°c to 41°c the annual rain fall is less than 5 inches or (133mm).

Soil: Based on the information obtained from administration office of the study area livelihood are moderately fertile soil of clay, vertisoil, and clay loam soil which is easy and comfortable soil for any kinds of crop production for their main source of agricultural activities.

Farming System: The main farming system is pastoralist and semi-pastoralist. The agricultural production of district is depend up on permanent such as: - Date palm, Mango, Lemon, Banana, Papaya, and The short term of season production is such as: - maize, sorghum, seas am, grand nut, tomato, onion, green pea per etc.

Live stock Production System: Based on the information obtained from administration office of the district livestock production system is mainly dairy, milking, fating and finally selling their live stock to buy their closes and some materials that can help for the livelihood of their life.

3.1 Materials and Methods

Both primary and secondary data was collect and organize in logical manner. The primary data are collect directly from the sources especially for land use land cover analysis and verification. Secondary data are those published and unpublished documents from varies sources. Landsat ETM+ of 2000 and 2015 satellite image are the main sources for the study. The types of data for the research are both spatial and attribute GIS data types. The spatial or location information of varies data was collect by instrument called GPS (Geographic Positioning System). The satellite images and other maps used in this study were projected to a common coordinate system (Universal transverse Mercator (UTM), Zone 37 North, Datum: Adindan) and resample to the same spatial

resolution.
In this study three types of digital image processing operations were used: image rectification and restoration (preprocessing), image enhancement and image classification.
Preprocessing is aimed to correct distorted or degraded data to create a more faithful representation of the original scene. This typically involves the initial processing of raw image data to correct for geometric distortions, to calibrate the data radiometrically, and to eliminate noise present in the data.
Image enhancement is a procedure applied to image data in order to more effectively display or record the data for subsequent visual interpretation. Normally, image enhancement involves techniques for increasing the visual distinction between features in a scene. Linear Stretch, which is one of the Contrast Stretching techniques, is the uniform expansion of limited image levels range to fill the range of display values (0-255). Subtle variations in input image data values would now be displayed in output tones that would be more readily distinguished by the interpreter. Light tone areas would appear lighter and dark areas would appear darker.
Image Classification digital image classification is the process of assigning pixel to classes. Usually, each pixel is treated as an individual unit composed of values in several spectral bands. By comparing pixel to one another and to pixels of known identity, it is possible to assemble groups of similar pixels into classes that match to the informational categories of interest to users of remotely sensed data.
Unsupervised classification uses statistical clustering techniques to combines pixels into groups (classes) according to the degree of similarity of their brightness value in each spectral band then combines and re-labels spectral classes into real land cover type as unambiguously as possible using maps and field based knowledge. We understand the spectral characteristics of the terrain in the area of interest well enough to properly label certain clusters into a specific information class (land cover type).
Supervised classification is the process of using a known identity of specific sites (through a combination of fieldwork, analysis of aerial photography, maps, and personal experience) in the remotely sensed data, which represent homogenous examples of land cover types to classify the remainder of the image.
Maximum likelihood classifier this classifier assigns a pixel with maximum likelihood into a corresponding class. This was based on training sets. The sample points collected during fieldwork were all used for validating classification results. A focal majority filter in Arc GIS was used for smoothing the classification results.
The accuracy of classification was carried out by means of a confusion matrix generated through overlaying of the classified maps and the test samples. The image classification accuracy was further assessed by calculating the Kappa coefficient ‘ k ’ .
The kappa statistics is an estimate of measure of overall agreement between image data and the reference (ground truth) data. Its coefficient fall typically on a scale between 0 and 1, where the latter indicates complete agreement, and is often multiplied by 100 to give a percentage measure of classification accuracy. Kappa values are also characterized into 3 groupings: a value greater than 0.80 (80%) represents strong agreement, a value between 0.40 and 0.80 (40 to 80%) represents moderate agreement, and a value below0.40 (40%) represents poor agreement. Final land use land cover maps were produced by combining supervised and unsupervised image classification techniques. Post classification and spectral change detection approach was employed to obtain the difference change map.

4. Result

4.1 Land use land cover of 2000

Generally, the accuracy of assessment for all LU/LC mapping was good. In principle, it is clear that the number of LU/LC classes for all period should not be the same and equal since there is a change. New classes may be created and old ones may disappear. But for change detection purpose the new and old classes would be merged during the change detection analysis and therefore only those permanent ones are presented here in the analysis of this research.

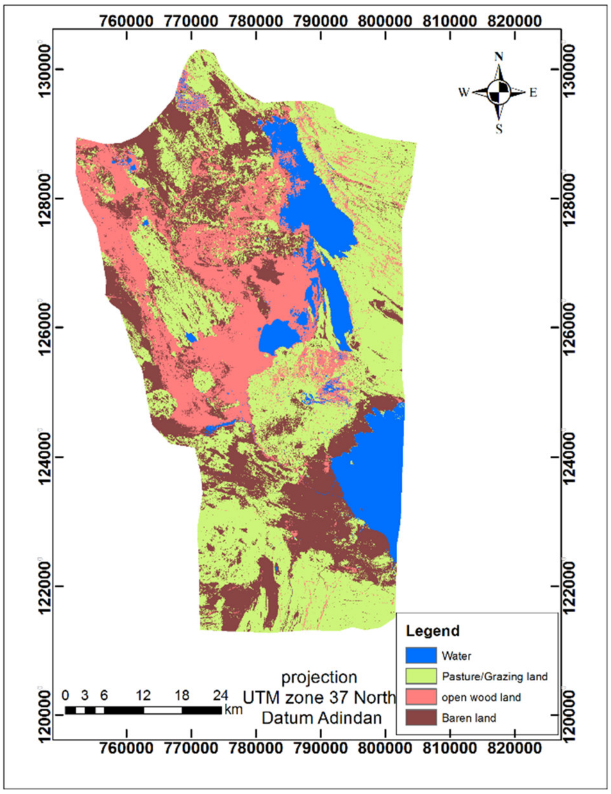

Figure 2 LU/LC map of the study area (2000)

Four land cover classes were identified based on spectral characteristics of Landsat MSS, image. These include the open woodland, Pastureland, Bare land and water (Figure 2). The LU/LC map of the area had been developed from the satellite images following the different principles and procedures of image analysis.

A) Water class refers to rivers and water bodies in the study area.

B) Open woodland: This land cover includes short trees and bushes, which have an opened canopy and contain grass under the canopy.

C) Pasture land: This land cover includes grass lands, grazing areas dominantly covered with grasses. There might have also sparse vegetation with it.

D) Bare land: This land Cover class represents areas that are covered by either rock outcrop or bare-soil or rocky and rugged topography areas.

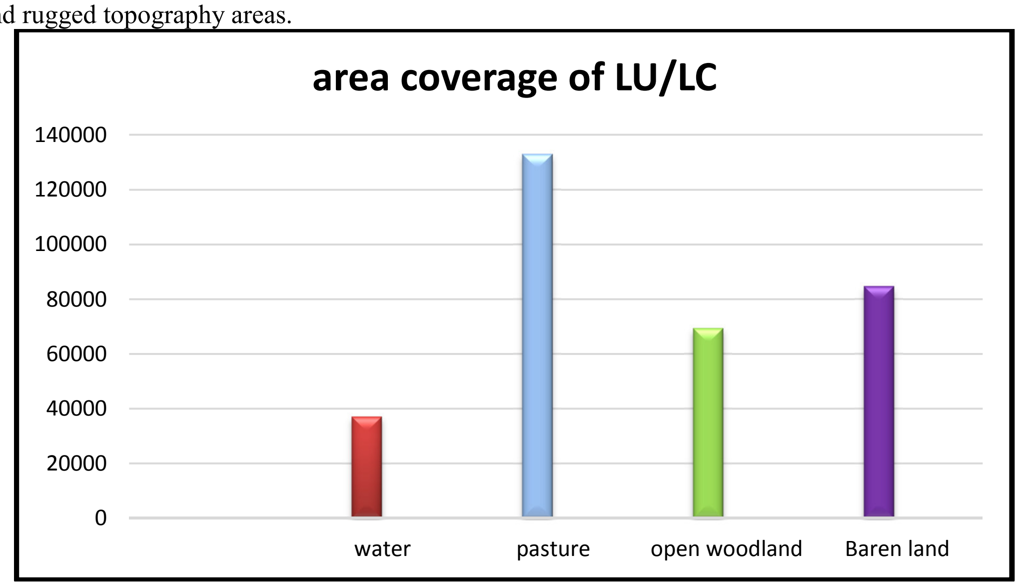

Figure 3 area coverage of LULC 2000

Figure 4.2 Indicate that pasture or gazing land was covered a large area of proportion followed by barren land open wood land and water. This shows that the area is suitable for grazing for livestock production (figure 3).

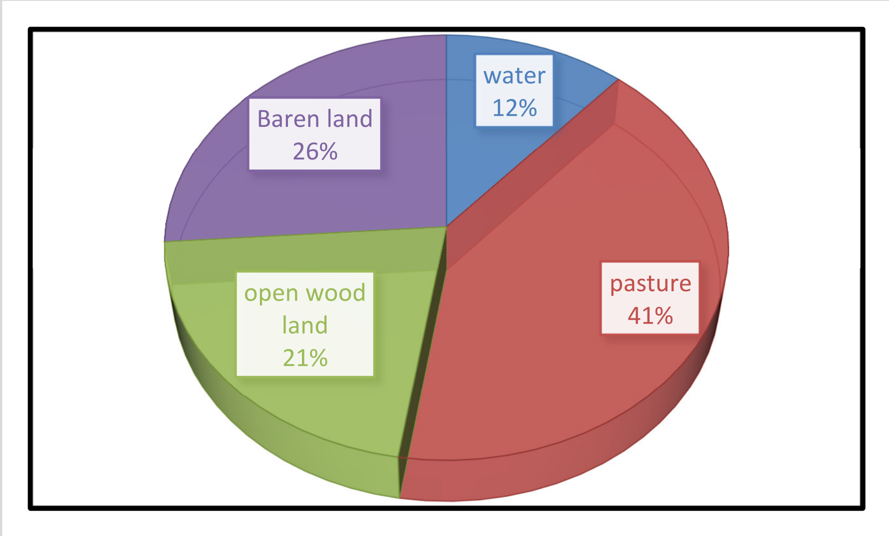

Figure 4 percentage distribution of LU/LC 2000

Figure 4 shows that, among the classified land cover classes in percentage distribution, pasture covers (41%) followed by barren land, open wood land and water with a percentage of 26%, 21% and 12% respectively.

4.2 Land use land cover of 2015

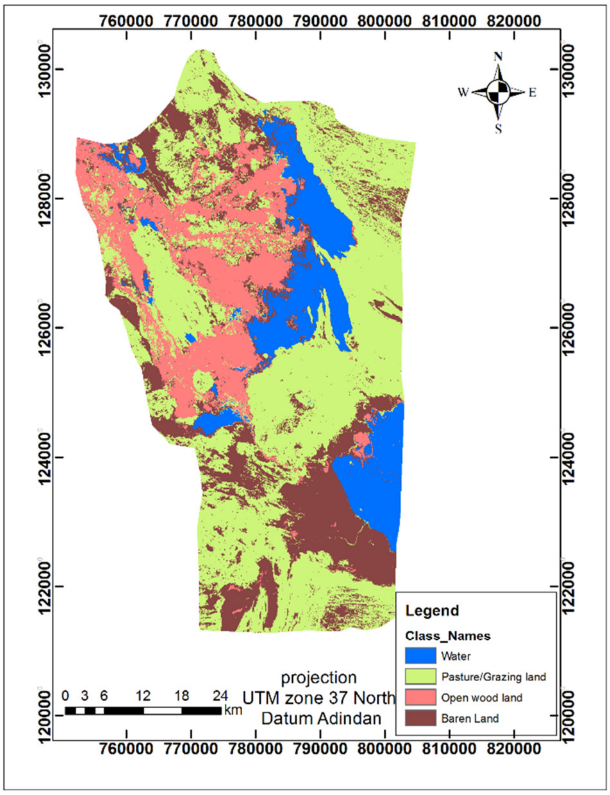

Figure 5 LULC map of the study area (2015)

Table 1 Area distribution of land use land cover in 2015

Class name	Area in hectare
Open wood land	55473.4
Water	41824
Barren land	75021.1
Pasture or grazing land	151712

Table 1 and figure 5 indicates that from the four major land use land cover the large area is covered by pasture or grazing land which comprise about 151712 hectare followed by barren land open wood land and water consisting of 75021.1, 55473.4 and 41824 hectares respectively.

4.3 Comparison of LU/LC changes between the two images (2000 vs 2015)

Table 2 Area distribution of land use land cover both in 2000 and 2015

Class name	Area in hectare	
	Year 2000	Year 2015
Open wood land	55473.4	69317.7
Water	41824	37098.3
Barren land	75021.1	84622.7
Pasture or grazing land	151712	132995

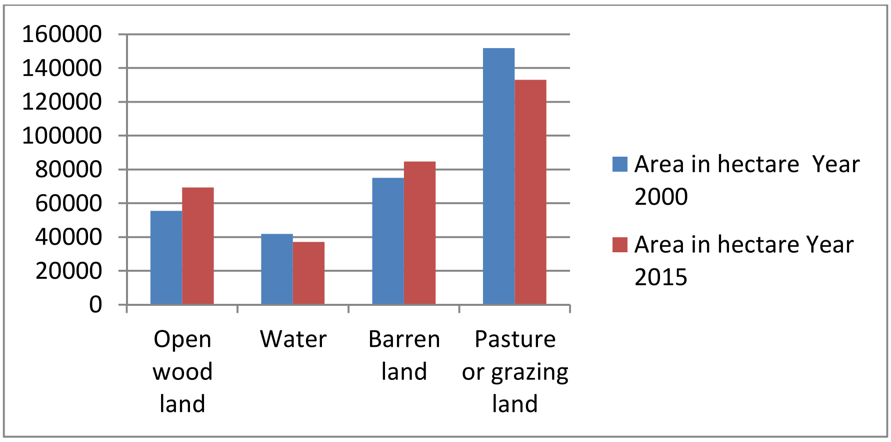

Figure 6 LULC change between 2000 and 2015

From the above figure (figure 6) we can understand that barren and open wood land increased at the expense of pasture and water. Office of agriculture and environment protection suggested that the reason why barren land increase from the previous year was due to the removal of Juliflora from the area. The government decided to remove and implementation more or less under the way because the species become in danger in biodiversity diversification. Water resource in the area become decrease and decrease from year to year.

5. Conclusion

The LU/LC map of the area had been developed from the satellite images following the different principles and procedures of image analysis**.** This indicates that the paper was prepared using GIS and remote sensing techniques. Four major land cover classes were discriminated based on spectral characteristics of Landsat MSS, image**.** Pasture or gazing land was covered a large area of proportion followed by barren land open wood land and water. This shows that the area has a potential for grazing for livestock production. From the four major land use land cover the large area is covered by pasture or grazing land which comprise about 151712 hectare followed by barren land open wood land and water consisting of 75021.1, 55473.4 and 41824 hectares respectively. Barren and open wood land increased at the expense of pasture and water. This is because the removal of Juliflora from the area becomes barren land increase in size from the previous year. Shortage of water becomes serious and serious from year to year. Climate had their own impact on shortage of water and decline of vegetation in the area.

References

Chen Liding and Fu Bojie (1996). The impact of human activities on Yellow River Delta, Acta ecological sinica ,1986, 16(4) , pp.337-344.

Lemlem S. (2003). Biodiversity potentials and threats to the southern Rift Valley lakes of Ethiopia, Wetlands of Ethiopia, IUCN, The World Conservation Union.

Sonneveld, B. G. J. S. (2002). Land Under pressure: The Impact of Water Erosion on Food Production in Ethiopia. Shaker Publishing. Netherlands.

Tsegaye Birkneh (2007). Assessment Of Land Degradation Using GIS Based Model And Remote Sensing In Bishan Guracha- Adilo Subcatchments, Southern Ethiopia, Msc Thesis, Addis Ababa University, Addis Ababa.

Zelalem Amdie (2007). Land Use/ Land Cover Dynamics and Vegetation Vulnerability Analysis: a Case Study of Arsi Negele Wereda, Msc Thesis (unpublished). Addis Ababa, University, Addis Ababa.