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LAND USE/LAND COVER DYNAMICS IN HULET WOGEDAMEA *KEBELE*, NORTHERN ETHIOPIA

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ABSTRACT

The objective of the study was to evaluate the land use/land cover dynamics of Hulet Wogedamea Kebele, Northern Ethiopia. Landsat 5 TM 1985 and Landsat 7 ETM+ 2011 were used for the study. Global positioning system and topographical maps of scale 1:50,000 for ground verification; field observations to take ground control points; 20 farming household's interview to get additional information; ERDAS Imagine 9.1 and ArcGIS 9.3 software for satellite image processing and data analysis were used. The collected data was analyzed mainly using quantitative method. However, results of farming household's interview were discussed in line with the quantitative data. The result reveled that there was an expansion of cultivated land and degraded land by 12.8 and 2.58 ha per year respectively from 1985 to 2011 at the expense of forest, shrub and grazing lands. Thus, proper cultivation of the land with appropriate implementation of soil fertility management measures and afforestation and reforestation activities are recommended.

Keywords: Land use, Land cover, Dynamics, Change analysis.

Contribution/ Originality

This paper is original and contributes for the existing literature in Northern Ethiopia by taking Hulet Wogedamea *Kebele*.

1. INTRODUCTION

Land use and land cover (LU/LC) change is a locally pervasive and globally significant ecological trend and has become an event of paramount importance to the study of global environmental change [1]. Chen [2] noted that the environmental impact associated with LU/LC is as large as that of climate change. LU/LC change contributes significantly to earth

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atmosphere interactions, forest fragmentation and biodiversity loss [3]. LU/LC dynamics including forest cover change is one of the major environmental problems in Ethiopia. In relation to this, recent studies showed that land cover change is brutal and there has been agricultural land size expansion at the expense of natural vegetation cover lands and marginal areas without any appropriate conservation measures [4-6]. LU/LC change studies have become one of the major issues for environmental change monitoring and natural resource management [3]. Effective utilization of Geographical Information Systems (GIS) and remote sensing (RS) facilitate LU/LC studies, change assessment and trend forecasting, rational land use planning, sustainable management of land and environmental production [7]. Thus, the main purpose of this study was to examine the overall LU/LC dynamics of the study area using GIS and remote sensing techniques.

2. MATERIALS AND METHODS

2.1. Study Area

This study was conducted in Hulet Wogedamea *Kebele*, Northern Ethiopia, which is located between the coordinates of 12° 84' - 12° 99' N latitude and 34° 80' - 35° 85' E longitude. Its altitude ranges from 2002- 2487m above sea level, and significant difference in altitude can be observed even in a short distance. The area is classified into *Dega* (Temperate) and *Woinadega* (Sub-tropical)agro-climatic zones which encompasses 35% and 65% of the area respectively. Agriculture is the major economic activity which is characterized by rain-fed and predominantly subsistence nature. The dominant vegetation type includes: *Eucalyptus* species, *Croton macrostachyus, Juniperus procera, Cordia africana* and *Ficus vasta.*

2.2. Data Collection

The study was conducted using Landsat 5 TM 1985 and Landsat 7 ETM^+ 2011. Global Positioning System (GPS) and topographical maps of scale 1:50,000 were used for ground verification (Table 1). Field observations to take ground control points and farming household's interview to get additional information were also conducted. Interview was conducted on randomly selected 20 farming households.

Table-1. Types of landsat and toposheet used in the study

Image	Path	Row	Sensor	Resolution or Scale	No of Bands	Date of acquisition	Source
Landsat5	169	52	TM	30 X 30	7	25/12/1985	GLCF
Landsat7	169	52	ETM +	30 X 30	8	12/1/2011	GLCF
Toposheet				1:50,000			EMA

2.3. Image Processing

Image classification was undertaken using hybrid classification method involving both unsupervised and supervised techniques. Among different classification algorithms, maximum

likelihood was used for supervised classification by taken 55 ground control points for five major LU/LC class categories (11 ground control points for each LU/LC class) (Figure 1). The major LU/LC types were identified with the help of visual interpretation elements and the different reflection characteristics of the features in the satellite images of 1985 and 2011. These include forest, shrub, grass, cultivated and degraded land. The classification legend was made based on spectral characteristics of the land cover types (Table 2).

Table-2. Description of LU/LC classes (Adopted from Abate [8])

LU/LC classes	Description
Cultivated land	Areas allotted to rain fed and irrigated cultivation, including fallow plots, cultivated land mixed with some bushes, trees and the scattered rural settlements included within the cultivated fields.
Forest land	Areas covered by trees forming closed or nearly closed canopies; Forest; Plantation forest; Dense (50-80% crown cover).
Shrub land	Land covered by small trees, bushes, and shrubs, in some cases mixed with grasses; less dense than forests.
Grazing land	Areas of land where small grasses are the predominant natural vegetation usually used for grazing.
Degraded land	Are parts of the land surface which is mainly covered by bare soil and exposed rocks.

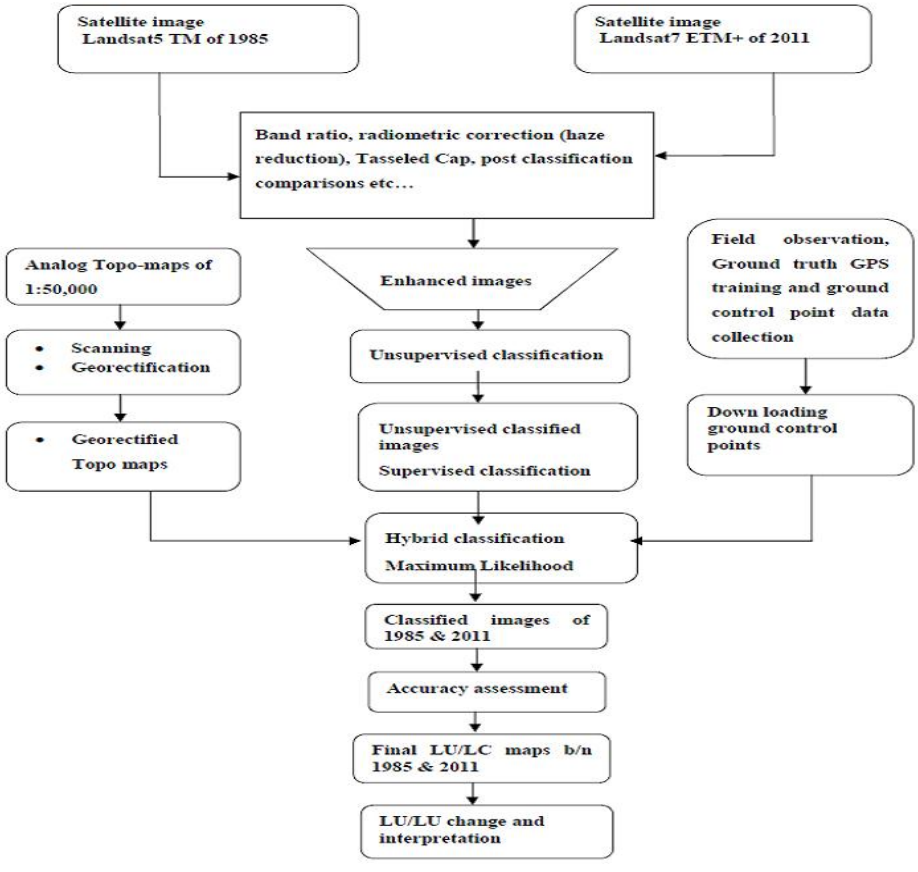

Figure-1. Flow chart of LU/LC classification (Adopted from Temesgen, et al. [6])

2.4. Accuracy Assessment

Accuracy assessment was done on the recent satellite image (Landsat7 ETM+ 2011) for which the ground control points are likely corresponding. Accordingly, an overall accuracy of 93.02% with a Kappa coefficient of 0.8083 was achieved.

2.5. Data Analysis

The rate of change was calculated for each LU/LC class [8] as Rate of change (ha/year) = (A-B)/C

Where: A = Recent area of LU/LC in ha, B = Previous area of LU/LC in ha, C = Time interval between A and B in years

3. RESULTS AND DISCUSSION

Forest, shrub and grazing lands were diminished with the average diminishing rate of 4.52, 5.28 and 5.09 ha per year respectively within 26 years (Table 3). Contrarily, cultivated and degraded land stretched extensively with the annual expansion rate of 12.28 and 2.58 ha per yearover the same period respectively. The expansion of forest land in 2011 image in the north and northwestern direction is due to the plantation of *Juniperus procera* during the Derg regime in 1989. In addition after 1989, there was an increasing expansion of *Eucalyptus* trees in different parts of the study area (Figure 2) for gaining better economic benefit. However, there is a general demolition of forest land during the study periods. This is due to the fast conversion of natural forest land into shrub and cultivated land. Similar with this finding, a study conducted by Belay [9], Amsalu, et al. [4], Gessesse and Kleman [5], Messay [10], Judith [11], Temesgen, et al. [6] and Temesgen and Tesfahun [12] indicated that there has been agricultural land size expansion at the expense of natural vegetation cover lands. Contrary to this finding, a study conducted by Tesfahun and Temesgen [13] in Southern Ethiopia revealed that annual cereal crop, mixed and woodland were declining. While, perennial crop land and settlement land were increasing.

Table-3. LU/LC dynamics (1985 and 2011)

LU/LC class	1985		2011		Change in ha b/n 1985-2011	Rate of change in ha/year b/n 1985-2011	Percentage change (1985-2011)
	Area (ha)	%	Area (ha)	%			
Forest	486.09	11.56	368.55	8.77	-117.54	-4.52	-24.18%
Shrub	563.67	13.41	427.05	10.16	-136.62	-5.25	-24.24%
Grass	547.92	13.03	415.62	9.89	-132.3	-5.09	-24.14%
Cultivated	2485.8	59.13	2805.12	66.73	+319.32	+12.28	+12.8%
Degraded	120.15	2.86	187.29	4.45	+67.14	+2.58	+55.9%
Total	4203.63	99.99	4203.63	100	4203.63		

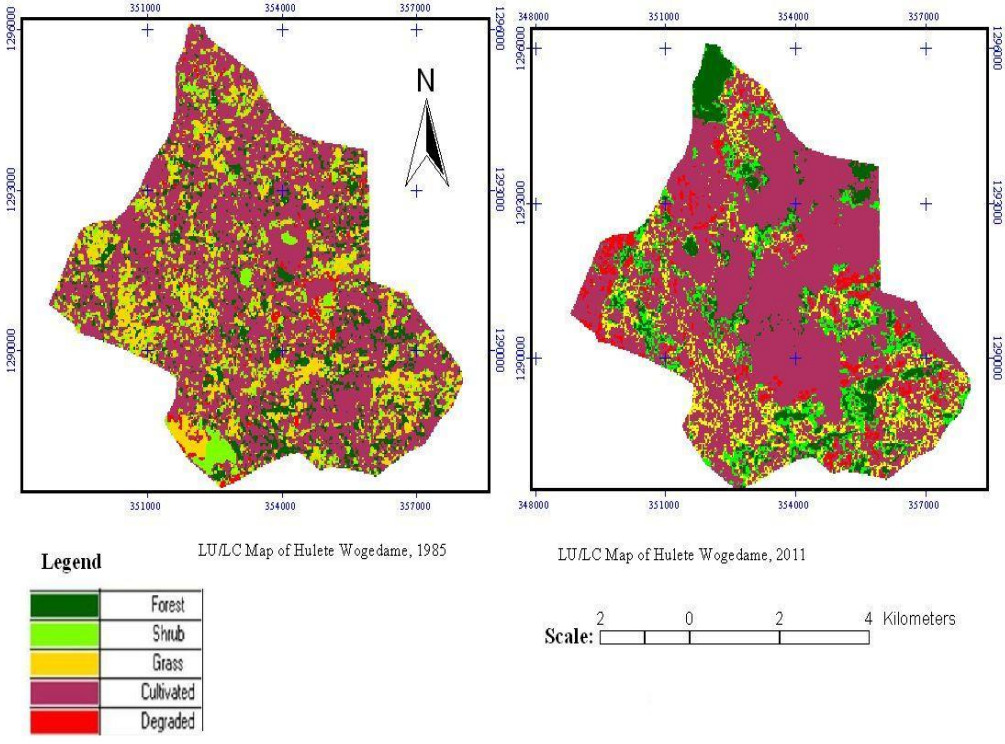

Figure-2. LU/LC map of 1985 and 2011

4. CONCLUSION

Analysis of LU/LC dynamics using GIS and remote sensing techniques portrayed that there was an expansion of cultivated and degraded land at the expense of forest, shrub and grazing land between 1985 and 2011. Thus, proper cultivation of the land with appropriate implementation of soil fertility management measures and afforestation and reforestation activities are recommended.

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