GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(Published By: Global Institute for Research & Education)
www.gifre.org

POPULATION DYNAMICS AND LAND USE/LAND COVER CHANGES IN DERA DISTRICT, ETHIOPIA

Temesgen Gashaw[1], Amare Bantider[2] & Abraham Mahari[3]
[1&3]Department of Natural Resource Management, Adigrat University, Adigrat, Ethiopia
[2]Department of Geography and Environmental Studies, Dilla University, Dilla, Ethiopia

Abstract

This study was conducted to quantify the effect of population dynamics on land use/land cover (LU/LC) changes in Dera District, Ethiopia. Population data (1984, 1994 and 2007) and remote sensing data (Landsat 5 TM of 1985 and Landsat 7 ETM$^+$ imagery 2011) were used. Global positioning system and topographical maps of scale 1:50,000 for ground verification; field observations and focus group discussions; ERDAS Imagine 9.1 and ArcGIS 9.2 software for satellite image processing and data analysis were used. The result indicated an increased of population by 73% from 1985 to 2011. Cultivated land and degraded lands were also increased by 25.79% and 398% at the expense of forest land, shrub land and grazing lands. Thus, population dynamics is one of the major driving forces for the LU/LU changes in the study area.

***Key words**: population dynamics, LU/LC change.*

1. Introduction

The population of Ethiopia was increased from 20 million in 1950 (Paulos, 2001) to 73.9 million in 2007 (CSA, 2007). The annual growth rates were also increased between 1950-1960 and 1994-2007 which was 1.65% and 2.5% respectively. Thus, if the population of the country continues to increase, it may put pressure on the environment (Meyer and Turner, 1992).

Being a tropical country, land use dynamics including forest cover change is one of the major environmental problems in Ethiopia. In relation to this, recent studies showed that LU/LC 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 (Amsalu et al., 2006; Gessesse and Kleman, 2007).

In Ethiopia, different studies were conducted on LU/LC changes. From the studies rapid population growth is one of the repeatedly mentioned factors (Paulos, 2001; Belay, 2002; Abate, 2011). In line with the above studies, studies conducted at longer time scales showed LU/LC change had and still has tremendously been influenced by both the increase and decrease of a given population (Lambin et al., 2003). However, research on quantification of population dynamics on LU/LC change is very much limited. Therefore, this study attempts to quantify the effects of population dynamics on the observed LU/LC changes.

2. Materials and Methods

2.1 Study area

This study was conducted in Dera district, Ethiopia which is located between 12° 92' - 13° 12' N latitude and 34° 40' - 35° 80' E longitude and elevation from 1798 m to 2118 m above sea level. Topographically, the area exhibited plateau at the upper limit to plain in the lower limit. The average annual rainfall and temperature is 1250 mm and 19 °C respectively. Agriculture is the major economic activity which is characterized by rain-fed and predominantly subsistence nature. Both crops and livestock productions are equally important at Dega and Woinadega agro-ecological zones of the study area. The main soil types of the study area are Nitosols, Vertisols, Gleysols, Luvisols and Cambisols. The dominant vegetation type includes: *Eucalyptus* species, *Croton macrostachyus*, *Juniperus procera*, *Cordia africana* and *Ficus vasta*.

2.2 Data collection

This study mainly used population and remote sensing data. However, field observation, and focus group discussion with farming households (HHs) were also conducted to obtain additional information. For LU/LC change analysis, multi-temporal satellite imagery was used. GPS and topographical maps of scale 1:50,000 were used for ground verification. For population data analysis, population data of 1984 (CSA, 1984), 1994 (CSA, 1994), and 2007 (CSA, 2007) were used. To meet population data with LU/LC data, population data of 1984 and 2007 were projected to 1985 and 2011 respectively by calculating growth rate as stated by Woldeamlak (2002): $r = 1/n \ln(Pt/Po)$

Where: r = growth rate, n = the number of year, pt = the present population number, Po = the initial population number

Table 1: Types of remote sensing data used

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

2.3 Image Classification Methods

Image preprocessing including band ratio, radiometric correction (haze reduction), Tasseled Cap and post classification comparisons were performed to correct the surface features reflectance characteristics. Then, the LU/LC maps were produced from Landsat 5 TM of 1985 and Landsat7 ETM$^+$ of 2011. Image classification was performed using hybrid classification method involving both unsupervised and supervised techniques (Lillesand and Kiefer, 2000). Using signature editor of unsupervised classes, supervised categorization of image pixels were made on the basis of their pixel by pixel spectral reflectance and spatial relationships of pixels with pixels surrounding them through geo-linking techniques. Among different classification algorithms, maximum likelihood was used for supervised classification by taken 60 ground control points for six major LU/LC class categories (10 ground control points for each LU/LC class).

Table 2: Description of Land use and land cover classes

Land use/Land cover 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.
Grass land	Areas of land where small grasses are the predominant natural vegetation usually used for grazing.
Water body	Areas covered by manmade small dams, seasonal water bodies and permanent water bodies.
Degraded land	Are parts of the land surface which is mainly covered by bare soil and exposed rocks.

Source: Adopted from Abate, 2011

2.4 Accuracy assessment

In this study, accuracy assessment was done for the recent satellite image (Landsat7 ETM$^+$ 2011) for which the ground truth data is likely corresponding. An overall accuracy was calculated by summing the number of pixels classified correctly and dividing by the number of pixels. Thus, an overall accuracy of 84% with a Kappa coefficient of 0.82 was achieved.

2.5 Data analyses

ERDAS Imagine 9.1 and ArcGIS 9.2 software were used for satellite image processing and LU/LC change analysis. The rate of change was calculated for each LU/LC following the formula stated by Abate (2011): 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

In the study area, both population number and population density were increased from 1984 to 2011 (Table 3) mainly due to natural increase. The population density in 2007 was 174 persons/km^2 which is much higher than the national population density of 67 persons/km^2. Such higher population density implies that there is a need for high food production, both for crop and livestock production, which may lead to LU/LC change. Thus, the increasing population density may continue in putting pressure on land resources although family planning is being under taken. Similar results have been reported by Hurni et al. (2005), who stated that population growth led to intensification of land use in the rainfed highlands, resulting in shortening and eventual abandonment of fallow periods, expansion of cultivation land into grazing land, and wherever forests existed, continued deforestation.

Table 3: Population number and population density of the study area

Year	Population No.	Population density per km^2
1984	7823	106
1994	9959	135
2007	12841	174
2011	13845	188

Table 4: Growth rate of the study area

Year	1984-1994	1994-2007	2007-2011
Annual growth rate	2.41	1.95	1.88
No. of people added each year	189	195	242

Cultivated and degraded land has been on the pace of increase while forest, shrub, and grazing lands have been under way for cultivation (Table 5) as population growth is one of the causes for LU/LC changes in the study area. This study was incongruent with Belay (2002), Amare et al. (2011), and Judith (2013), who stated that most LU/LC changes are attributable to human activities and development.

Table 5: LU/LC changes of the study area between 1985 and 2011

LU/LC class	1985		2011		Change in ha (1985-2011)	Rate of change in ha/year (1985-2011)	Percentage change (1985-2011)
	Area (ha)	%	Area (ha)	%			
Water body	38.79	0.53	35.64	0.48	-3.15	-0.12	-8.12%
Forest	706.41	9.6	310.14	4.22	-396.27	-15.24	-56.09%
Shrub	1408.32	19.14	464.4	6.31	-943.92	-36.3	-67.07%
Grass	1243.98	16.91	1196.46	16.26	-47.52	-1.83	-3.81%
Cultivated	3859.74	52.47	4855.23	66	+995.49	+38.29	+25.79%
Degraded	99.36	1.35	494.73	6.72	+395.37	+15.2	+398%
Total area	7356.6	100	7356.6	99.99			

The human population of the study area was increased from 8,012 in 1985 to 13,845 in 2011 which is increased by 73% while cultivated land was increased by 25.79%. On the other hand, forest, shrub and grazing land showed negative increment (Table 5). The greater percentage increase of population number over cultivated, forest, shrub and grazing lands showed that population growth is a major driving force for these changes in the study area. In this case, the high population growth increased demand for agricultural products and result the expansion of cultivated land at the expense of forest, shrub and grazing lands. Similarly, Gete and Hurni (2001), Messay (2011), Abate (2011) reported that increment of population number leads to the expansion of cultivated land and degraded lands.

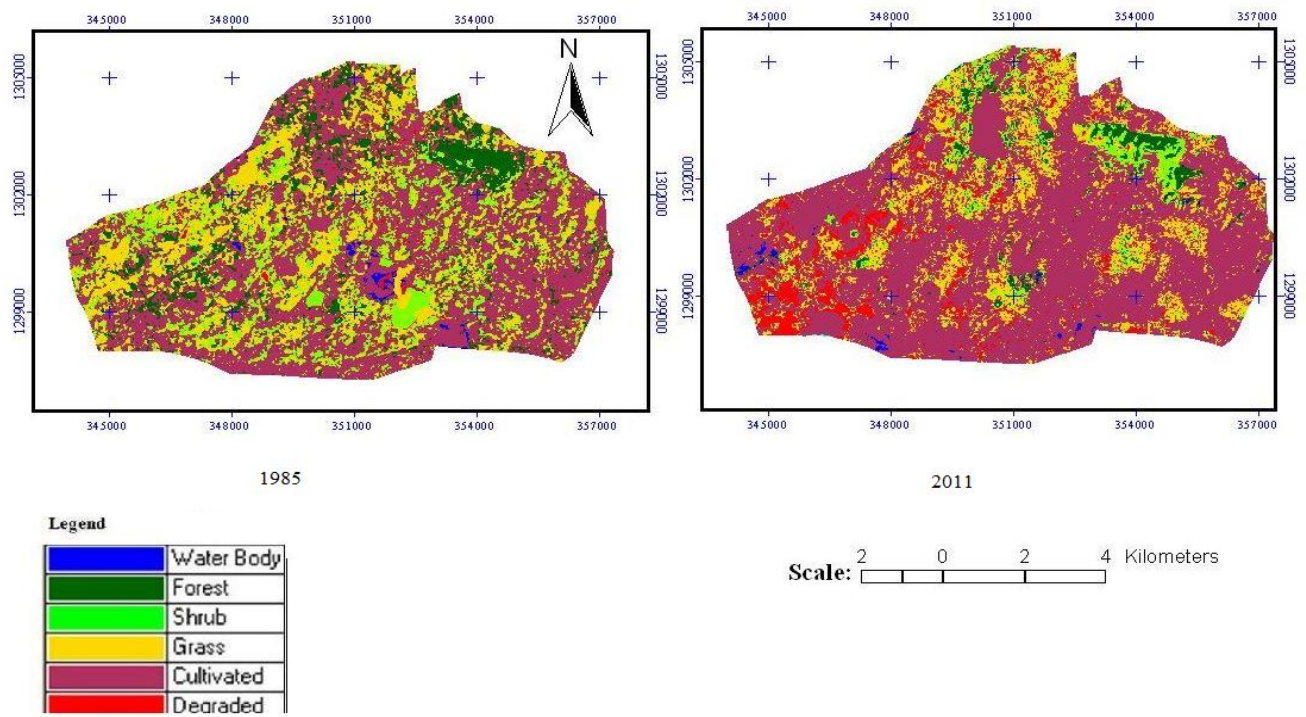

Figure 1: LU/LC Map of the study area in 1985 and 2011

4. Conclusions

Analysis of population dynamics and LU/LC change clearly indicates there is a considerable change in population size and LU/LC in the last 26 years. This implies population growth is one of the major driving forces for LU/LC changes in the study area. The increasing human population number with lack of supplementary income aggravated these change.

References

Abate, S. (2011). Evaluating the land use and land cover dynamics in Borena Woreda of South Wollo highlands, Ethiopia. *Journal of Sustainable Development in Africa*. 13(1): 87-105.

Amare, B., Hurni, H. and Gete, Z. (2011). Responses of rural households to the impacts of population and land use changes along the eastern escarpment of wello, Ethiopia. *Norwegian journal of Geography*. 65: 42-53.

Amsalu, A., Leo, S. and Jan de, G. (2006). Long-term dynamics in land resource use and the driving forces in Beressa watershed, highlands of Ethiopia. *Journal of Environmental management*. 83: 13-32.

Belay, T. (2002). Land-cover/land-use changes in the Derekolli catchment of the South Welo Zone of Amhara region, Ethiopia. *Michigan State University Press*.18 (1): 1-20.

CSA (1984). Summary and statistical report of 1984 population and housing censes. Federal Democratic Republic of Ethiopia Census Commission, Addis Abeba. Central Statistics Authority.

CSA (1994). Summary and statistical report of 1994 population and housing censes. Federal Democratic Republic of Ethiopia Census Commission, Addis Abeba. Central Statistics Authority.

CSA (2007). Summary and statistical report of 2007 population and housing censes. Federal Democratic Republic of Ethiopia Census Commission, Addis Abeba. Central Statistics Authority.

Gessesse, D. and Kleman, J. (2007). Pattern and Magnitude of Deforestation in the South Central Rift Valley Region of Ethiopia. *Mountain Research and Development*. 27: 62-168

Gete, Z. and Hurni, H. (2001). Implications of land use and land cover dynamics for mountain resource degradation in the Northwestern Ethiopian highlands. *Mountain Research and Development*. 21 (2): 184-191

Hurni, H., Kebede, T. and Gete, Z. (2005). The implications of changes in population, land use, and land management for surface runoff in the upper Nile Basin area of Ethiopia. *Mountain Research and Development*. 25(2): 147-154

Judith, MS. (2013). Land use and land cover changes and their implications for human-wildlife conflicts in the semi-arid rangelands of southern Kenya. *Journal of Geography and regional planning*. 6(5):193-199

Lambin, E., Geist, H. and Lepers, E. (2003). Dynamics of land use and land cover change in tropical regions. *Annu. Rev. Environ. Resour*. 28: 206-232

Lillesand, TM. and Kiefe, RW. (2000). Remote Sensing and Image Interpretation. 4th ed. John Wiley and Sons inc. New York.

Messay, M. (2011). Land-use/land-cover dynamics in Nonno district, Central Ethiopia. *Journal of Sustainable Development in Africa*. 13(1): 123-139

Meyer, W. and Turner, IIB. (1992). Human Population Growth and Global Land-Use/Cover Change. *Annual Review of Ecology and Systematics*. 23: 39-57

Paulos, D. (2001). Soil and water resources and degradation factors affecting their productivity in the Ethiopian Highland Agro-ecosystems. *Michigan State University Press*. 8(1): 1-18

Woldeamlak, B. (2002). Land cover dynamics since the 1950s in Chemoga Watershed, Blue Nile Basin, Ethiopia. *Mountain Research and Development*. 22 (3): 263–269