

Research Paper

Land Use/ land cover dynamics in the Central Rift Valley Region of Ethiopia: The Case of Arsi Negele District

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ABSTRACT

The aim of this research paper was to assess the spatial and temporal Land Use/Land Cover Changes (LU/LCC) in Hada Boso and Gallena Kello Peasant Associations (PAs) in Arsi Negele District. Due to rapid population growth, agricultural expansion, and other environmental fluctuations degradation of natural resources, loss of biodiversity, and environmental deterioration are the most visible socio-economic and environmental problem in the study area. Satellite imagery, Ground Control Point (GCPs) data and household level socioeconomic survey were used to produce land cover maps and explaining the historical trends of the study area. ERDAS imagine and ArcGIS software was used to accomplish the analysis. The analysis result showed that in 1973 most of the study area had been covered by dense acacia woodland and shrub/bush land. In the period between 1973 to 1986 cultivated, grazing/grass land and bare/open land showed an incremental changes by 8.98, 33.9, and 36.5 ha respectively. While, shrub/bush land and acacia woodland decreased by 6.17 and 73.21 ha, respectively. Between 1986 and 2010 cultivated land, acacia woodland and shrub/bush land increased by 15.38, 4.63, and 38.52 ha. However, bare/open land, and grazing/grass land showed a decreasing trend 19.23 and 39.3 ha, respectively. Furthermore, the trend and magnitude of LU/LCC in the year between 1973 to 2010 acacia woodland decreased by 22.72 ha, and grazing/grass land by 13.58 ha, but in the same year difference shrub/bush land increased by 22.82 ha and cultivated land 13.14 ha. On the other hand, the socio-economic survey result revealed that, the above figures which showed that acacia woodland and shrub/bush land decreased, but cultivated land, barren/open land and grazing/grass land increased in the derg regime. But, the present government, give emphasis for natural resource conservation activity, the spatial coverage of shrub/bush land, acacia woodland has increased. Expansion of agricultural land, population growth and the associated demand for land were the major driving forces for the observed LU/LCC changes in the study area. Therefore, loss of biodiversity, soil degradation, and environmental deterioration are largely the results of LU/LCC. Hence, land resources management practices, utilization of alternative energy sources and family planning education are some of the appropriate interventions to reduce this dramatic change.

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Key words: Remote sensing, GIS, LU/LCC, accuracy, Landsat, imagery.

INTRODUCTION

Land is the major natural resource on which economic, social, infrastructure and other human activities are undertaken. 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). LU/LCC and its impacts on terrestrial ecosystems including forestry, agriculture, and biodiversity have been identified as high priority issues at global, national, and regional levels (Fu et al., 2000). LU/LCC can also affect biodiversity, biogeochemical cycles, soil fertility, hydrological cycles, energy balance, land productivity, and the sustainability of environmental service provision (Lambin, 1997; Geist and Lambin, 2002). Apart from these, it may directly have serious impacts on future food security (Brown and Pearce, 1995). This means LU/LCC affects both environmental quality and the quality of life, which are the two aspects that affect human wellbeing. Hence, LU/LCC is central issue that requires investigation to sustainable development (Lambin, 1997) and represents a vibrant and dynamic area of research.

Therefore, LU/LC dynamics is a result of complex interactions between several biophysical and socio-economic conditions, which may occur at various temporal and spatial scales (Reid et al., 2000). This kind of information is required in many aspects of land use planning and policy development, as a prerequisite for monitoring, modeling and environmental change, and as a basis for land use statistics at all levels. This study was conducted in two peasant associations (PA's) located in the central Rift Valley region of Ethiopian, which is a dry land area. The livelihood of the community is based on agriculture and mixed farming system which is exposed to rapid deforestation. The area has a reasonable agricultural potential, which is reflected in the diversity of crops and animal resources. Remote sensing image processing, GPS reading and field observation were employed in this study. Remote sensing image processing and classification is an appropriate method for the identification of LU/LC changes in the past, and present to provide information on the causes and drivers of changes. GCP's and field observation gives accurate information on the current LU/LC, however information on changes in LU/LC may also dependent on the knowledge and memory of those giving the information. The general objective of this study is to analyze the rate, pattern, causes, and socio-economic and environmental implications of LU/LC dynamics using GIS and Remote Sensing techniques in Arsi Negele District.

MATERIALS AND METHODS

Description of the study area

The study was conducted from September to June 2011 time period. The study was undertaken in the lowland part

of Central Refit Valley region of Arsi-Negele district located between 7°09'-7°41'N and 38°25'-38°54'E, and found in 210 km south of Addis Ababa along the road to "Shashemene - Hawasa".

According to National Metrological Services Agency (NMSA) (2010) at Arsi Negele station shows that the mean annual minimum and maximum temperatures of 6.8°C and 27.2°C respectively, while rainfall varies between 250-750 mm per annum. Coniferous forests of podocarpus species, woodland and broadleaf forests prevail in the district. At mid-altitude tropical dry evergreen montane forest dominates. The overall farming system is strongly oriented towards grain production dependent on the use of oxen for land preparation (ORS, 2004).

Methods of data collection

The main objective 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 forms. The systematic study of land use/ land cover dynamics requires good and adequate data to assess the changes clearly. In order to achieve the objective of the study both primary and secondary sources of data were used.

Primary data collection

The primary data sources were generated by the researcher in order to measure the independent variables. Data were collected through structured questionnaire, field observation, and key informants interview. 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 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.

Household survey data: To support the data obtained from remote sensing images, household level data were collected through semi-structured questionnaires. This survey focused on information about demographic characteristics of the households, household asset (land, land size), and individual level land use system, perceptions

Table 1. Amount and coverage of land use/ land cover classes in the study area in 1973, 1986, and 2010.

No	Land use/ land cover classes	1973		1986		2010	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
1	Bare Land	72.5	1.1	547.0	8.4	85.4	1.3
2	Grazing/ Grass land	956.5	14.7	1397.2	21.5	454.0	7.0
3	Cultivated land	1324.0	20.4	1440.8	22.2	1810.0	27.8
4	Shrub/Bush land	1801.2	27.7	1721.0	26.5	2645.4	40.7
5	Acacia Woodland	2345.8	36.1	1394.1	21.4	1505.3	23.2
	Total	6,500	100	6,500	100	6,500	100

on trends of land cover, impact of land use/ land cover in the study area.

Secondary data

Different secondary sources of data were used to drive the required information for this study. Some of the major sources include; metrological data, satellite images (MSS, TM and ETM⁺ which is obtained from EMA).

RESULTS AND DISCUSSION

Trend and patterns of LU/ LCC in the study $A = \pi r^2$

As discussed ealier, the information obtained from key informant, interpretation of remotely sensed imagery and field observation are the main points to classify the LU/LC classes in the study area. Hence, the total coverage or size of the area was estimated to be about 6,500 ha or 65 km². This is own estimate using the boundary map of the study area. Determining the trend and the rate of land cover conversions are necessary for the development plan in order to establish rational land use policy (Solaimani et al, 2010). The statistical value of LU/LC distribution of the study area in the year 1973 1986 and 2010 was derived from land sat image and is presented as follows.

Table 1 represents the value of each LU/LC classes for each study year respectively. As it is indicated in the table, a significant amount of land in the study area of a specific year (1973) is covered by dense acacia woodland (2345.8 ha or 36.1%), shrub/bush land (1801.2 ha or 27.7%), followed by cultivated land (it covers 1324 ha or 20.4% out of the total area). The rest 956.5 ha or (14.7%) and 72.5 ha (or 1.1%) is covered with grazing/grass land and bare land respectively. The coverage of acacia woodland and shrub/bush land was larger than other land cover classes, while grazing/grass land and bare land cover smaller area. Because, during this time there were low pressure of population and small agricultural activities and relatively the environmental condition was also safe and undisturbed.

At the same time, the distribution, intensity, coverage, and duration of rain fall and temperature trend was regular.

In 1986, cultivated land, grazing/grass land and bare land occupied about 1440.8 ha or (22.22%), 1397.2 or (21.5%) and 547.0 or (8.4%), respectively. However, acacia woodland and shrub/bush land comprised of 1394.1 ha or (21.4%) and 1721.0 ha or (26.5%) respectively. This indicates that the cultivated land has increased by 1.8%, grazing/grass land by 6.8% and bare land by 7.3%. While acacia woodland and shrub/bush decreased by 14.7 and 1.2 % respectively. During this time, there was land redistribution for crop production, intensive agricultural expansion, and population growth. On the other hand, farmers were cutting trees illegally and expanding their agricultural activities in the area. The pattern of LU/LC distribution in 2010 also followed similar trends with that of 1986. Hence, as can be seen from Table 1, cultivated land was yet again the main land use class covering 1810 ha or 27.8% of the total area. Similarly, acacia woodland and shrub/bush land showed a big incremental change from the previous decades (21.4% to 23.2% and 26.5% to 40.7%) respectively from 1986 to 2010. Because a number of factors such as government attention to sustainable use of natural resources and environmental protection and people's awareness about the role of natural resource for their livelihood are the major reasons. On the other hand, grazing/grass and barren land showed a decreasing or negative trend, which is from 9% to 7.0% and from 6% to 1.3% respectively from 1986 to 2010. This means when the degraded area cover with trees, shrub/bush, and other vegetation, the coverage of open/barren land decreased and the area returned in to the previous land feature. Generally, as it can be seen from the graph (Figure 1) acacia woodland and shrub/bush land account for the largest amount in the 1973. This means during this period, it was highly likely that a portion of the land was unexploited and the human population was also relatively low in the study area. Furthermore, agricultural activities were practiced in small amount, because during this time the feudal families occupied the majority of the land holding system. While in 1986 the coverage of shrub/bush land still high, but as compared to the previous decade the amount is decreased, due to government land use policy, expansion of

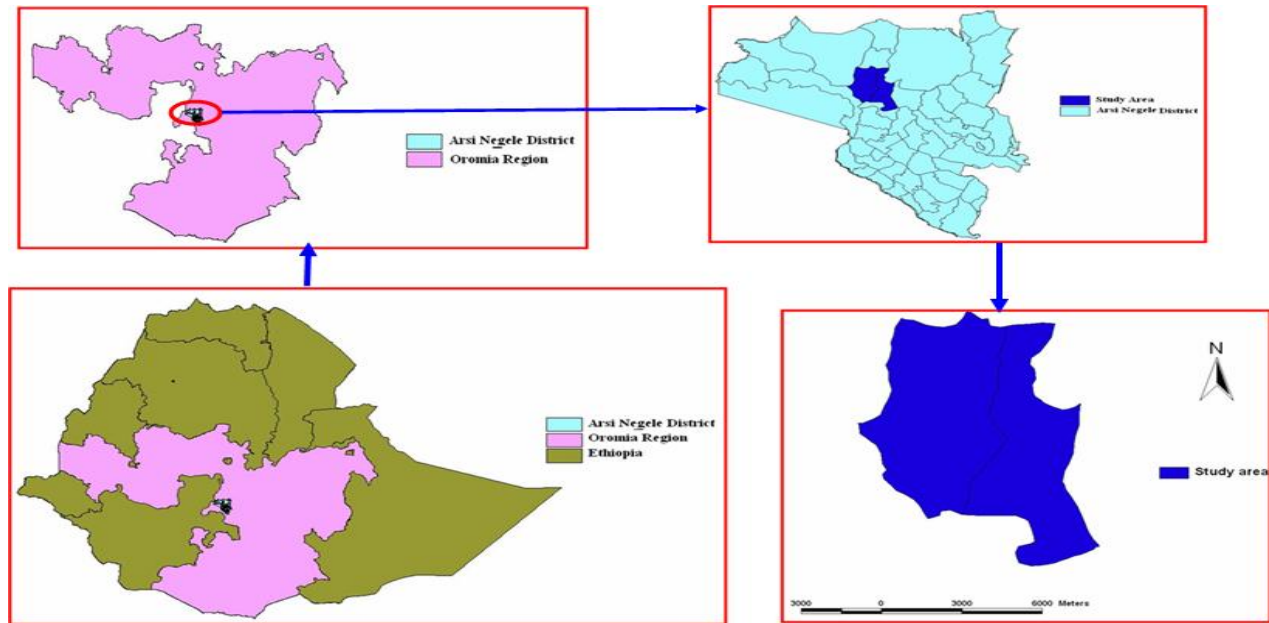


Figure 1. Location map of study area.

agricultural activity and population growth.

According to the witness of community elders (Gemedo Usho and Beriso Daka) and justification of Garedeu et al. (2009), the area in 1970's were covered by dense acacia-based grass land which is used as a home of different wild animals and support the livelihood of the community in various form. However, as can be seen from Figure 2 in 2010, cultivated land and shrub/bush land accounts the largest amount in this period the government gives more attention for degraded land rehabilitation activities, control illegal tree cutting and charcoal productions in the study area. Though, as a result of population growth the demand of farmland increased from time to time, therefore, the coverage of cultivated land increases. Figures 3 to 5 show the trend and patterns of LU/LC of the study area derived from Land-sat images of the respective period in the study area in 1973, 1986 and 2010. The trend of the change in all maps shows different patterns, it depending on the nature of land use type which covers in the area, population pressure, government's attention and people's awareness about environmental protection and conservation activities.

LU/LCC map and matrix result

LU/LCC in between 1973 and 1986

The information in Figure 6 was derived from the thematic image of LU/LC classes. The detection of LU/LCC is performed using ERDAS Imagine 8.7 software and GIS analyst model using classified images of the different years as inputs. To clearly understand the major change sources

and its destination, conversion matrix for each period is analyzed. Figure 6 illustrate the magnitude of LU/LC changes during 1973 to 1986 in hectares.

As indicated in the bar graph of Figure 7, bare, grazing and cultivated land showed an increasing trend, while shrub/bush land and acacia woodland showed decreasing trend. To explain briefly, in 1973, there were 2,345.8 and 1,801.2 ha of acacia woodland and shrub/bush land respectively. From this amount 951.7 and 80.2 ha of land respectively were converted into other land cover classes and the rest of others (bare, grazing and cultivated land) increased in the year 1986. Figure 8 confirmed that, the physical distribution of LU/LC in the years between 1973 and 1986, this map shows the matrix result of land use land cover change in the year between 1973- 1986. As can see from the map 58.5, 95.6, 372.2, 661.3 and 767.2 ha or totally 1954.8 ha of land were not changed in to other land cover type. However, 63045.2 ha of land were changed in to different land cover type in the 13-year duration. The change has adverse impact on the livelihood of the community as well as in the physical environment.

LU/LCC in between 1986 and 2010

In the year between 1986 and 2010 grassland and bare land shows a remarkable change in to other land cover classes. About 965.3 ha of grazing land was converted to shrub/bush land followed by the conversion of 294.8 and 124.9 ha of land in to acacia woodland and cultivated land respectively.

Correspondingly, about 668.4 and 385.9 ha of shrub/bush land were converted in to cultivated, grazing

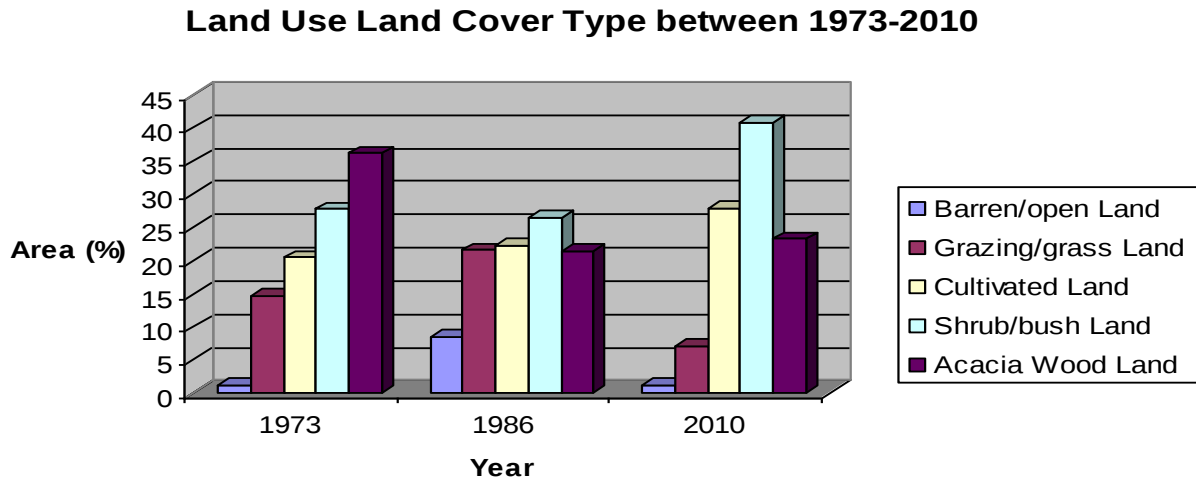


Figure 2. Major Land Use/ Land Cover Classes in 1973, 1986, and 2010.

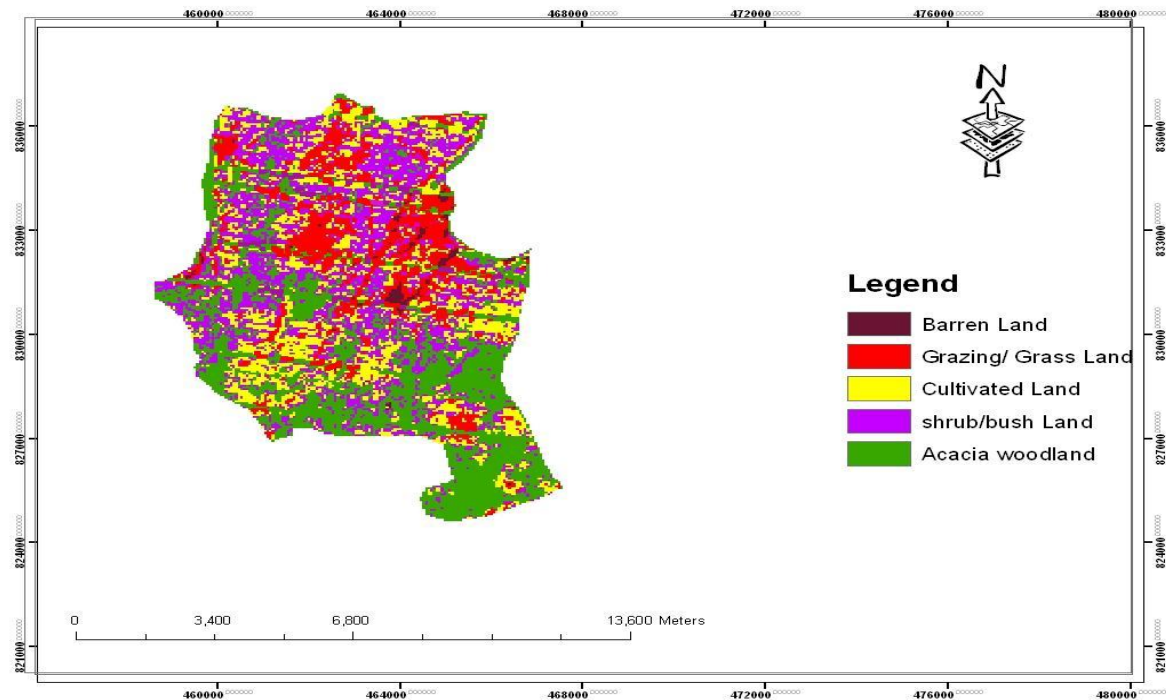


Figure 3. Classified land use/ land cover map of the study area in 1973.

and acacia woodlands respectively. Similarly, 299.8 and 446.2 ha of acacia woodland was also changed in to cultivated land shrub land.

In general, based on the matrix result concludes that 1787.2 ha of different cover of land were unchanged. Shrub/bush land, acacia woodland and cultivated land showed incremental changes with the total percentage of 39.91, 23.00 and 24.59% respectively. This improvement could be attributed to the implementation of conservation programs through coordinated efforts of development workers, other experts, and involvement of the community

at large. The percentage of bare land and grazing/grass land has shown a slight decrease to 7.36 and 14.5% respectively.

On the other hand, Figure 8 describes the overall increment and reduction of land use land cover in the year between 1986 and 2010 bare land and grazing/grass land reduce the amount of coverage, whereas the cultivated land, shrub/bush land and acacia woodland increased by 369.2, 924.4 and 111.2 ha.

Figure 9 illustrates the matrix result of land use land cover change in the year between 1986-2010. The result

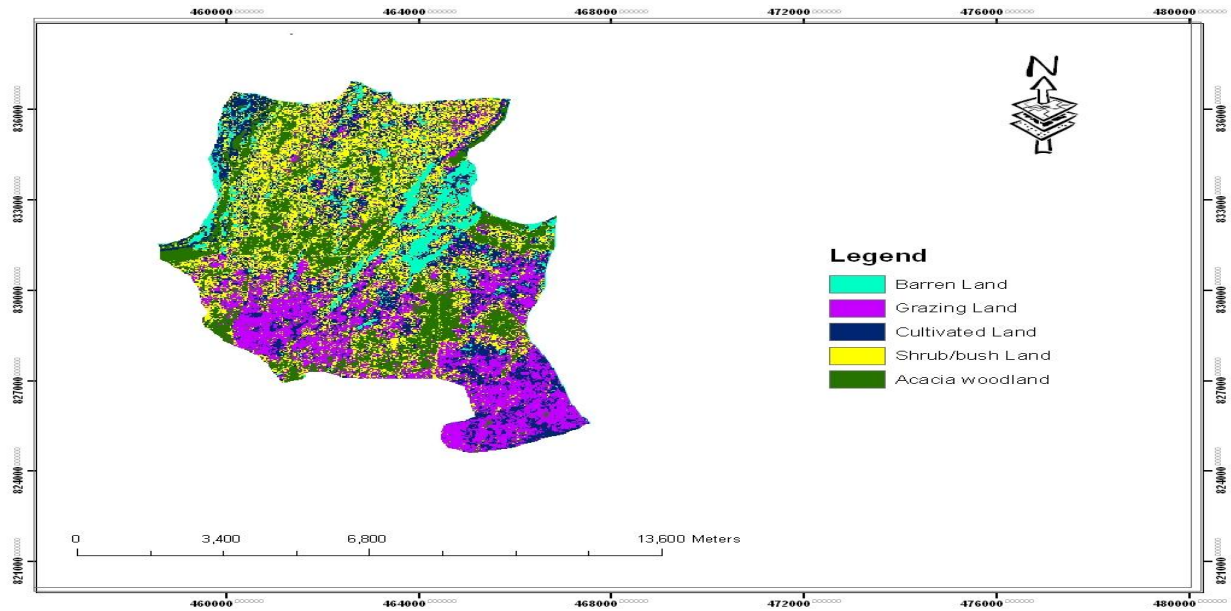


Figure 4. Classified land use/ land cover map of the study area in 1986.

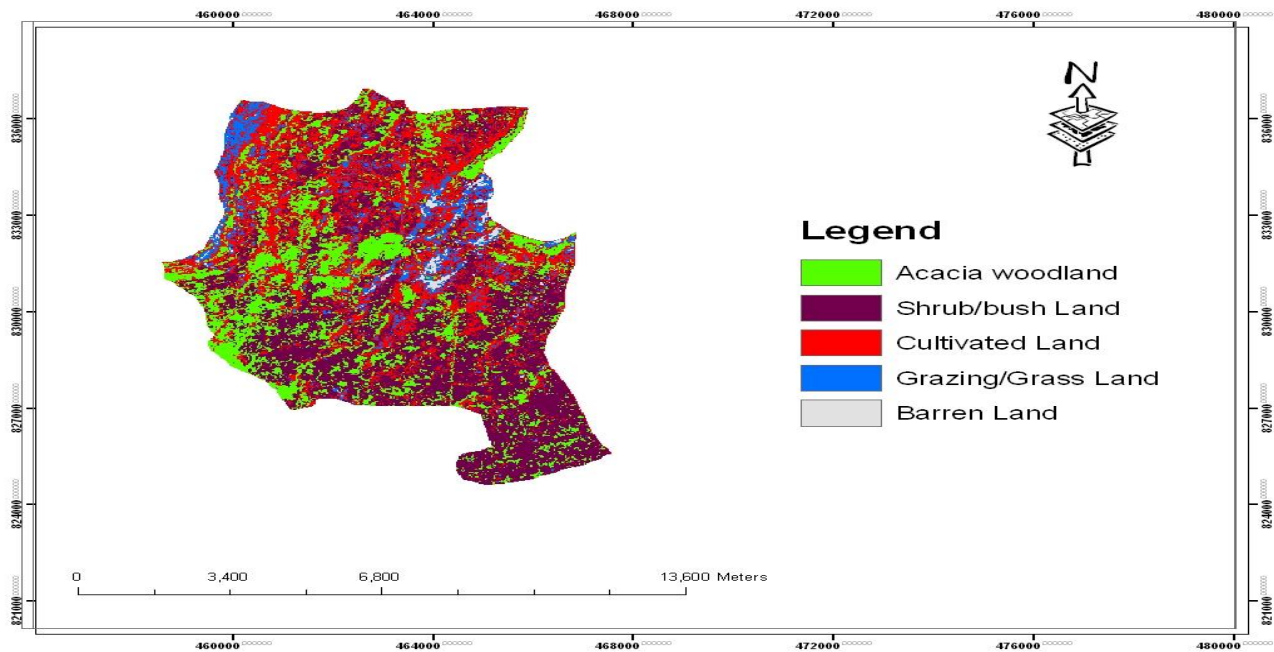


Figure 5. Classified land use/ land cover map of the study area in 2010.

depict 1797.2 ha of land area were not changed into other land cover type. However, totally 63202.8 ha of land were changed in to different land cover type in the 24-year duration. Thus, 1304.4 ha of various land use type were changed in to cultivated land, because of population growth. The change has adverse impact on the physical environment, degradation of natural resources, deforestation, soil erosion, soil fertility reduction,

biodiversity losses are the main results of land cove change in the study area. However, the existing government gives a great emphasis for environmental conservation and protection activities by participate the local community for sustainable use of natural resources in the area. Therefore, the degraded shrub/bush land and other vegetation cover becomes in a good situation. The local peoples were also understand the role of natural resources for their livelihood

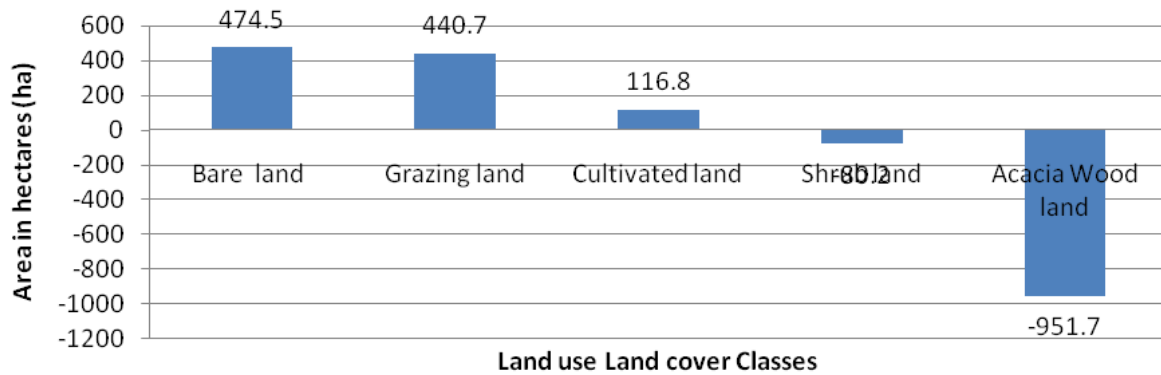


Figure 6. Magnitude of land use/ land cover changes during 1973-1986.

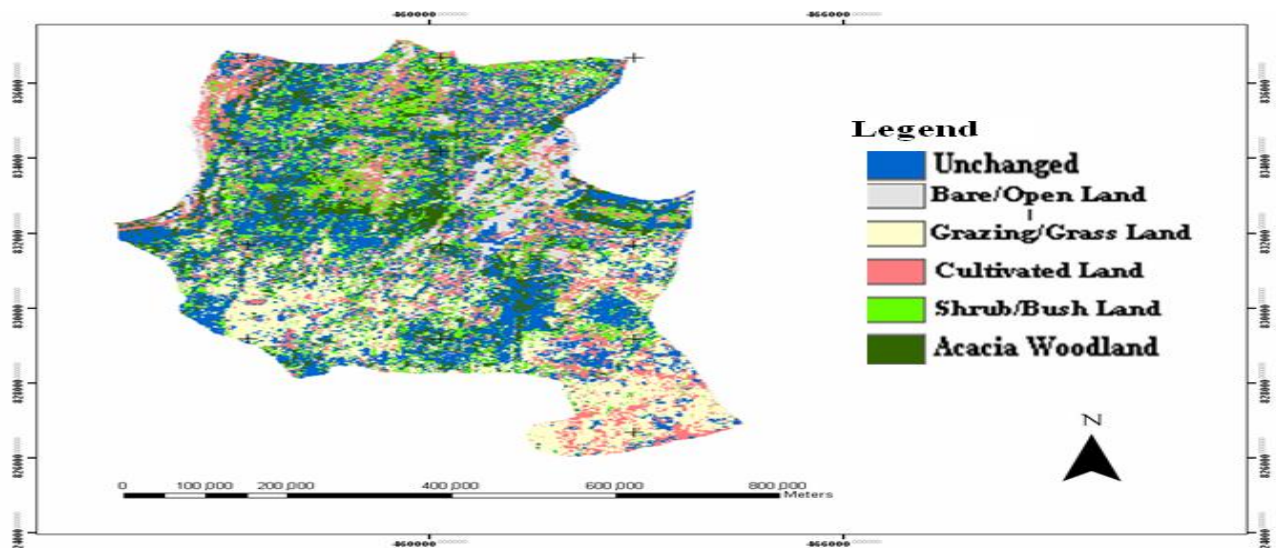


Figure 7. Land cover changes of the study area from 1973 to 1986.

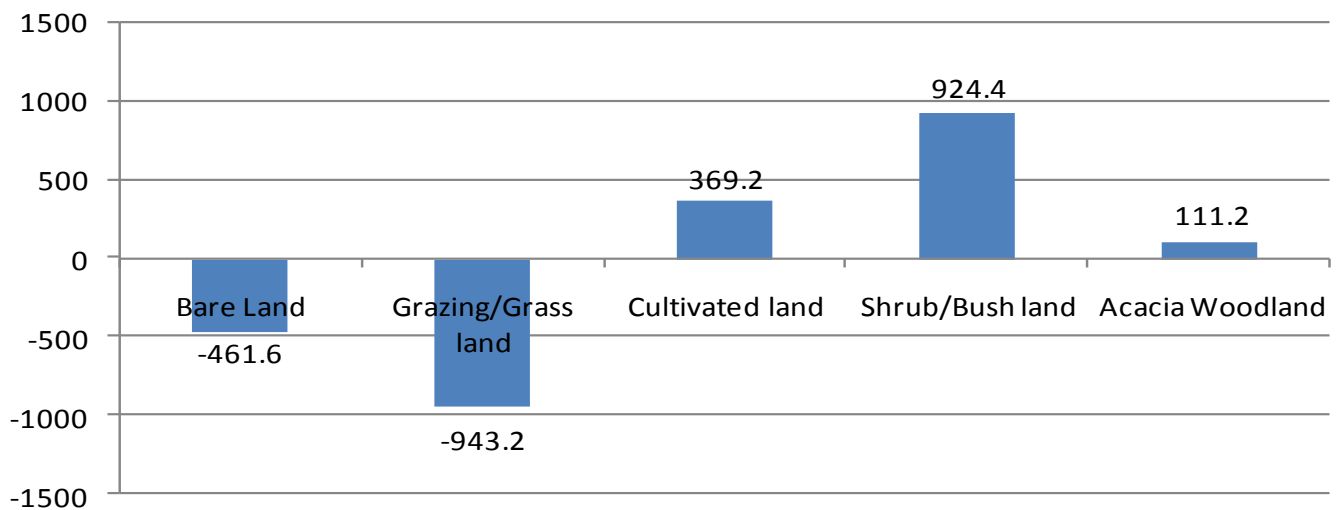


Figure 8: Magnitude of land use/ land cover changes during 1986-2010.

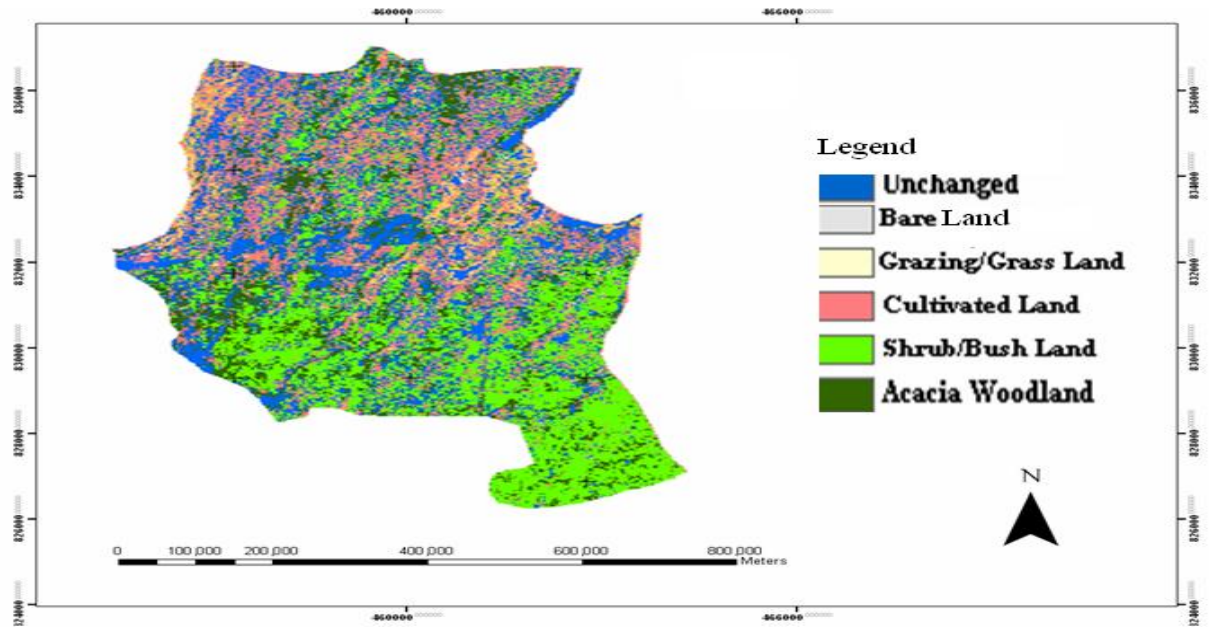


Figure 9. Land cover type of the study area from 1986-2010.

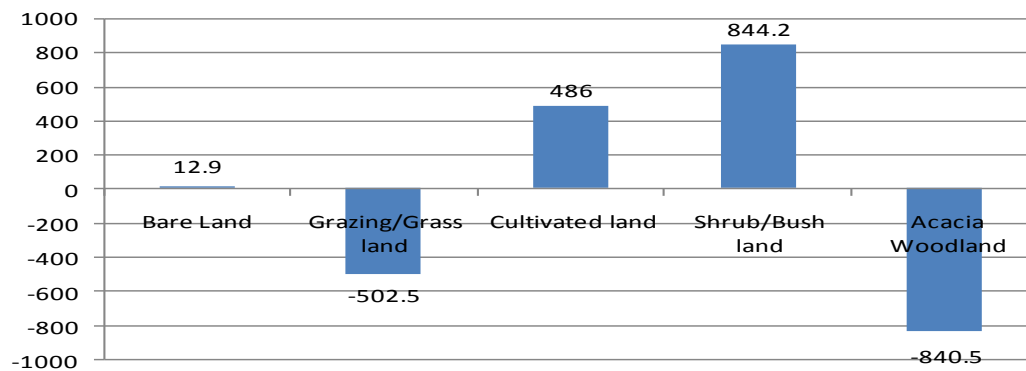


Figure 10. Magnitude of land use/land cover changes during 1973-2010.

the start an integrated conservation activity with local development agents and other voluntary organization. Figure 9 shows the coverage of LU/LC in the years between 1986 and 2010.

LU/ LCC between 1973 – 2010

In the period between 1973 to 2010, there was a dramatic decrease in the area of grazing/grass land which is about 348.1, 285.7 and 94.9 ha of land were converted into cultivated, shrub/bush and acacia woodland respectively. About 660.8 ha of Shrub/bush land in 1973 was directly converted into cultivated land in 2010. Cultivated land, shrub/bush land and to some extent, acacia woodland cover were showed that an incremental changes from 1986

to 2010. In recent year, the expansion of cultivated land has been limited by the emerging lack of suitable land.

Over the entire study period, the annual rate of the cropland area increased. While the rate of the woodland and shrub/bush land area declined and showed a fluctuating trend between the study years. In this year, the coverage of bare land has minimum but it is positive, however, grazing /grasses land and acacia wood land decreased by 502.5 and 840.5 ha of land respectively. As can see from Figure 10 cultivated land and shrub/bush land were show high coverage of land than other land cover type in the study area.

Generally, the LU/LC types in the three decades gradually changed with differing rates depending on the existing socio-economic, political, and environmental situation. Acacia woodland and shrub/bush land covered more area

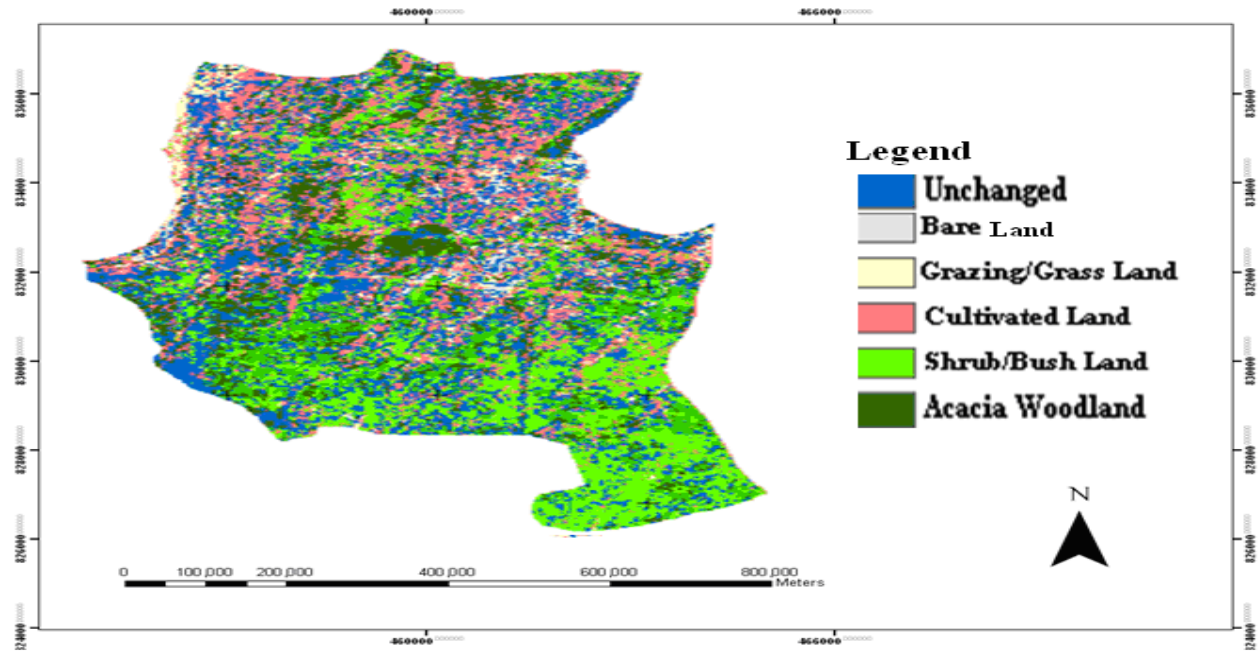


Figure 11. Land cover changes of the study area from 1973-2010.

followed by cultivated land in the period from 1973 to 1986. However, the cumulative results of (1986 and 2010) showed the coverage of shrub/bush and cultivated land increased followed by acacia woodland; while bare land and grazing land decreased.

In the years from 1973 to 2010, shrub/bush and cultivated land covered again larger area. At the same time, the coverage of cultivated land has also increased due to population growth.

Figure 11 illustrates the matrix result of LU/LCC in the year between 1973 and 2010. The matrix table shows totally 1877.4 ha of land area were not changed in to other land cover type. However, totally 63122.6 ha of land were changed in to different land cover type in the 24-year duration. In this year, the coverage of shrub/bush land shows a greatest changed rather than others. The main reasons for the improvement of shrub/bush land in the study area were the government gives more attention for the conservation and protection of environmental conservation activities. The following map showed the coverage of LU/LC in the years between 1973 and 2010.

Annual Rate and trends of LU/LCC

In this study 13, 24 and 37-year gap satellite image were used and calculate the annual rate of land use/ land cover change of the study area from 1973 to 1986, 1986 to 2010, and 1973 to 2010. According to Zubair (2006), the annual rate of LU/LC change of the two year were calculated by

dividing observed change, by its duration or year gaps between two study periods and is expressed as hectares per year. Observed changes were also calculated by subtracting the recent year data from the previous year data.

As shown in Table 2, the land use/land cover analysis of the study area based on the satellite image confirmed that the largest amount of 2346 ha (36.1%) of land was covered by dense acacia woodland followed by shrub/bush land and cultivated land that occupying 1801ha (27.7%) and 1324 ha (20.4%) respectively. The share of bare land and grassland were relatively cover small area 72.5 ha (1.1%) and 956.5 ha (14.7%) of land respectively in the year 1973. The annual rate of change in 1973 to 1986 was very high in acacia woodland and shrub land and showed a negative results, -73.21, and -6.17 respectively. While, cultivated land 8.98 ha, grazing land 33.9 ha and bare land 36.5 ha of land were changed in to other different land covers.

In 1986 cultivated land, grazing/grass land and bare land cover were the largest area about 1440.8 ha (22.22%), 1397.2 (21.5%) and 547.0 (8.4%), respectively. However, acacia woodland and shrub/bush land covered of 1394.1 ha or (21.4%) and 1721.0 ha or (26.5%) respectively. In this period the annual rate of shrub/bush land and cultivated land and acacia woodland were increased, which covers, 38.52, 15.38, and 4.63 ha. While grazing/grass and bare land covers were decreased by -39.3 and -19.23ha of land respectively.

According to the information obtained from the interviews with key informants the cause of increase

Table 2. Trend and magnitude of land use/ land cover dynamics during 1973-1986, 1986-2010, and 1973-2010.

Land use/ land cover classes	Amount of land cover in						Observed change			Annual rate of changes in (ha/year)		
	1973		1986		2010		1973 - 1986	1986 - 2010	1973 - 2010			
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (ha)	Area (ha)	1973 - 1986	1986 - 2010	1973 - 2010
Bare Land	72.5	1.1	547	8.4	85.4	1.3	474.5	-461.6	12.9	36.5	-19.23	0.35
Grazing land	956.5	14.7	1397	21.5	454	7	440.7	-943.2	-502.5	33.9	-39.3	-13.58
Cultivated land	1324	20.4	1441	22.2	1810	27.8	116.8	369.2	486	8.98	15.38	13.14
Shrub land	1801	27.7	1721	26.5	2645	40.7	-80.2	924.4	844.2	-6.17	38.52	22.82
Acacia Woodland	2346	36.1	1394	21.4	1505	23.2	-951.7	111.2	-840.5	-73.21	4.63	-22.72
Total	6,500	100	6,500	100	6,500	100						

Table 3. Types of crop and inputs used.

Type of Crops	1973 ^a		1986 ^a		2010 ^b	
	Inputs Used	Production (ha/q)	Inputs Used	Production (ha/q)	Inputs Used	Production (ha/q)
Teff	no	6 -15	Dap	6 - 14.5	Dap and Urea	3 - 9.5
Wheat	no	10 - 15	no	7 -12	Dap	5 - 8
Barely	no	8 -14	no	6 - 8	Dap	5 - 7.5
Faba Bean	no	4 - 8	no	2.5 - 6	no	2.5 - 4.5

Data sources: ^a Arsi Negele District Agricultural Office and ^b PA's office (2011).

agricultural land was mainly due to population growth this expose to the expansion of cultivated land into marginal and communal lands. Similarly, between 1973 to 2010 acacia woodland and shrub/bush land cover the highest parts which is 2645 ha (40.7%) and 1505 ha (23.2%) respectively, followed by cultivated land 1810 ha (27.8%). while, the rest bare land and grass land accounts 454 ha (7%) and 85.4 ha (1.3%) respectively. The annual rate of shrub/bush land, cultivated land and bare land were 22.82, 13.14, 0.35 ha of land cover respectively. The other major changed during this period is reduction of the size of acacia woodland by -22.72 followed by grazing land that account-13.58 ha. The reason for such negative result was due to the increment of population pressure as a result the need of more cropland.

Accuracy assessment

According to Anderson et al. (1976), the recommended standard of accuracy in the identification of LU/LCC mapping from the remote sensor data should be 85 - 90%. On the other hand, Kappa coefficient is important information in accuracy assessment. The overall accuracy and a Kappa analysis were used to perform a classification

accuracy assessment based on error matrix analysis. Therefore, overall classification accuracy for the five classes was established as 92% with kappa coefficient or statistics of 0.8978%.

Proximity and underline causes of LU/LC dynamics in the study areas

Proximate causes of LU/LC dynamics

To meet the demands of large population means the need for more food production, more water requirement, and more infrastructure development to sustain increasing pressure for maintaining quality of life (Chaudhary et al., 2008). Agricultural expansion is one the major proximate or direct causes of LU/LCC in the study area. The coverage of total cultivated land increased overtime. As indicated in Table 3, cultivated land accounts 1324.0 ha (20.4%), 1440.8 ha (22.2%) and 1810.0 ha (27.8%) in the year from 1973, 1986 and 2010 respectively. Over the years, researchers have identified agricultural expansion as a major or primary factor in almost all studies on LU/LCC and deforestation (IUCN, 2000). Hence, the major cause of acacia woodland, shrub/bush land and other vegetation

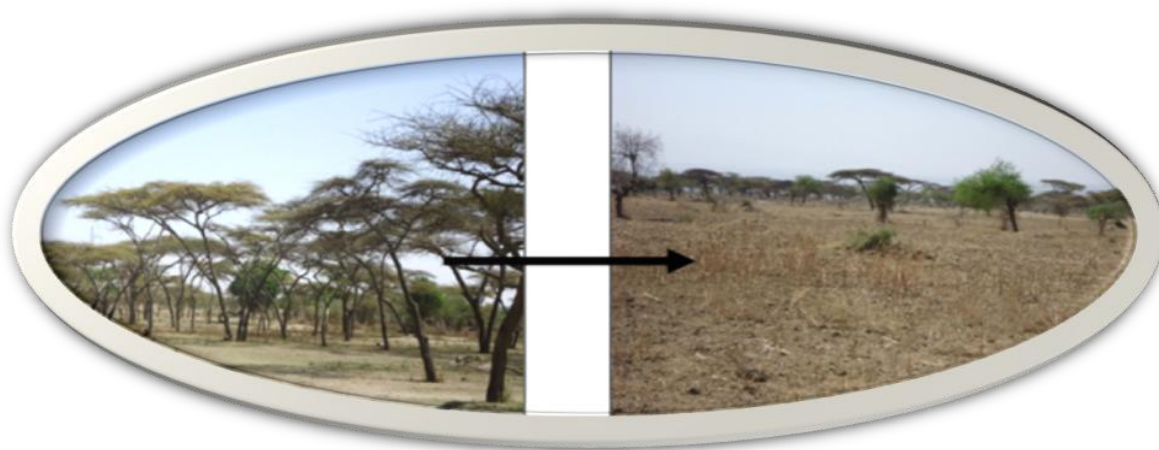


Figure 12. Acacia woodland converted in to cultivation land.

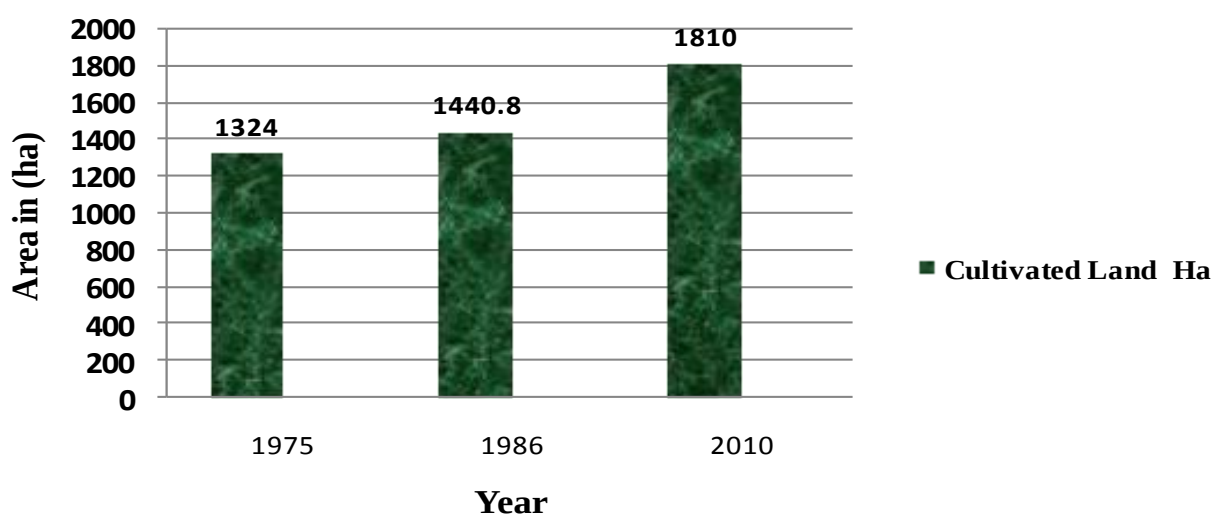


Figure 13. Trends of agricultural expansion in 1973, 1986, and 2010.

change is related to agricultural activities of in the study area.

Figure 12 shows expansion of agriculture at the expense of acacia woodland, shrub/bush, and other vegetation in the study area.

From 1973 to 2010, cultivation of agriculture was the driving force for 20.4 and 27.8% of the natural vegetation loss respectively. From the 10 households interviewed in the area, all of them responded that their agricultural plot has been expanded significantly in the past 10-20 years. The drive to expand has been largely set off by the need to fulfill household food demand. Figure 13 shows the

incremental change of agricultural land in the three periods.

Underlying cause of LU/LC dynamics

Population pressure is believed to be one of the underlying causes of the observed LU/LCC in the study area.

This study showed that there was rapid LU/LC change in the study sites, with cropland replacing woodland and wooded-grassland forests due to the population growth and its resulting expansion of agricultural land. Population

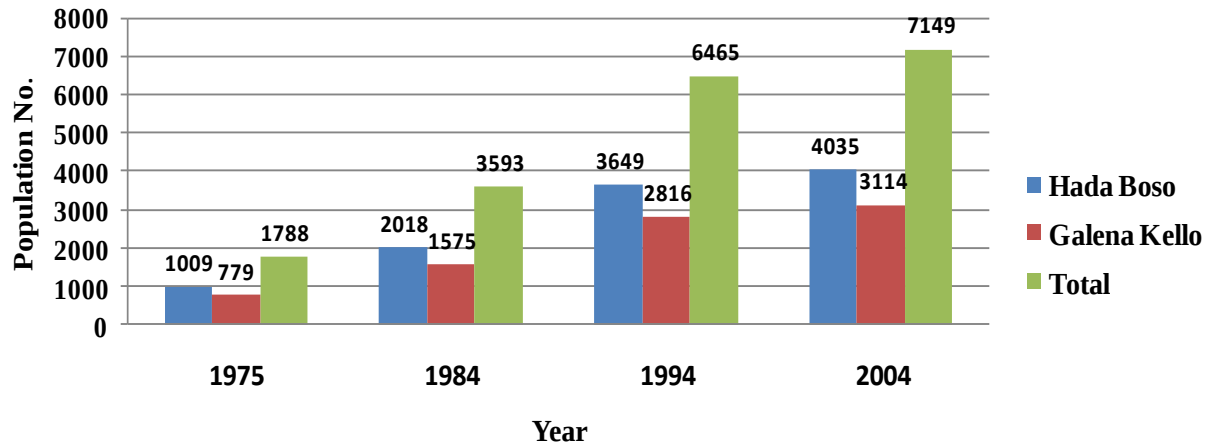


Figure 14. Estimated population in the year 1975, 1984, 1994, and 2004.

pressure has a negative effect on land because more shrubs and trees are cut for fuel and cultivation of the existing natural landscape. The present study found that a dramatic change in LU/LC happened over time, associated with rapid population growth. Among others, Pimentel et al. (1986), Abernathy (1993), and Mortimore (1993) have shown that population growth is a major driving force in land cover changes and that it contributes to resource degradation.

Data obtained from the study area showed that the rural population in the study area in 1973, 1986 and 2010 years was 1788, 3593 and 7149 respectively. However, for the area under study, data on rural population density were not available. People may supplement their income from agriculture with little or no off-farm employment. The population in the study area depends almost entirely on the land they cultivate. As shown in Figure 14, the population number in the year 1975, 1984, 1994, and 2004 was estimated to be; 1788, 3593, 5465 and 7149 respectively in the study sites.

The increasing number of rural population from time to time, needs more agricultural land because there is increase in their demands for food production. Farmers' lack of livelihood security has forced them to use the woodlands to cope with recurrent household shocks. As clearly pointed out by the World Commission on Environment and Development, "Those who are poor and hungry will often destroy their immediate environment in order to survive (Belay, 1995).

Fuel wood is another problem associated with population growth. The spatial and demographic growth of population has definitely had an impact on agricultural land and availability of fuel wood in the surrounding area. The relation of population growth to the cultivated land, the change was significant with the addition of only 116.8 ha of cultivated land between 1973 and 1986 and 369.2 ha between 1986 and 2010, and 486ha between 1973 and 2010 (Table 2).

Impact of LU/LC dynamics

Rain fed agricultural production system is the mainstay of farmers in the study area. According to the information obtained from the key informant, soil fertility and crop productivity declined from time to time. Land conversion is the greatest cause of extinction of terrestrial species, of particular concern is deforestation, where logging or burning is followed by the conversion of the land to agriculture or other land uses (Abbas et al., 2009).

As can be seen from Table 3 in the year 1973, the amount of production in common crop type was very high without the use of any fertilizers. Similarly, in 1986, the farmers used fertilizer like (dap and urea) to enhance their production and productivities but the production was decline. According to the two kebeles information in 2010 in all common crop type the production were decline, due to degradation of natural vegetation as a result loss of soil fertility. Farmers used input (like dap, urea, and locally prepared compost) to maximize the productivity of the soil.

Land use and land cover change play an important role in environmental change. The change constitutes loss of biodiversity, land degradation, climatic change (Ashenafi, 2008). As many farmers supposed that conversion of acacia woodland and shrub/bush land into other cover types can cause degradation of soil and land resources, increase run-off rate (soil erosion) and decline soil fertility. Hence, agricultural production decreased overtime. Excessive land degradation, along with other climatic factors such unpredictability and high intensity of rainfall could lead to reduced average crop yields.

Deforestation and LU/LCC are becoming locally common features wherever escalating human populations, because fuel wood demands to exceed supplies in the study area (Nejib, 2008). In Arsi-Negele town 87.3% of the populations are directly supported their life by distillation of katikala and fuel wood has been continue to provide all the energy

Table 4. Number, number per hectare and frequency of trees cut in each peasant associations.

Peasant association	Number	Number/hectare	Frequency (%)
Hada Boso	89	209	56
Gallena Kello	68	189	49
Total	157	398	105

**Figure 15.** Illegal charcoal production in Arsi Negele District. Source: Arsi Negele District Department of Natural Resources Office (2011).

required for distillation of it. The large volumes of fuel wood consumed for katikala distillation coupled with other factor is driving rapid deforestation and land cover change in the study area. Fuel wood has been identified as one of the most significant causes of acacia woodland and other vegetation decline in the study area. In the area, there are only four woody species, which are the most preferable for fuel wood and charcoal production. These were *Acacia tortillis* (*A. tortillis*), *Acacia senegal* (*A. senegal*), *Acacia seyal* (*A. seyal*) and *Balanite aegypticus* (*B. aegypticus*). These types of wood species were the most frequently mentioned and preferred fuel wood plants by consumers, as shown in Table 4.

The destruction of woodland resources has a complex implication on the status of the environment because vegetation cover and dead plant biomass are known to reduce soil erosion by intercepting and dissipating raindrops and wind energy. Having intercepted this rainfall, they facilitate the infiltration rate of water to the ground. Moreover, specific species like *A. etbaica* and *R. natalensis* which preferred by katikala distillers were extinct from the study site. Figure 15 shows illegal charcoal production in the study area.

The major purpose for cutting tree in the study area was for fuel wood sale at Arsi-Negele town due to high demand especially for katikala and charcoal production. Most of the poor farmers in the study area were earn their income

from the sale of firewood and charcoal.

The extent and type of LU/LCC directly affect wildlife habitat and thereby affect local and global biodiversity. Human alteration of landscape from natural vegetation (e.g. wilderness) to any other use typically result in habitat loss, degradation and fragmentation, all which can have devastating effect on biodiversity (IAbbas et al., 2009).

From the total respondent 75% were reported that the interference of human beings in the study area were alter the existing environment, this results can cause for habitat loss, degradation of ecosystem services and livelihood support systems. As shown in Table 5 in the past two decades, there were many wild animal and different varieties of bird's species in the study area, especially, in Abijata-Shalla and Langano lakes. However, most of wild animals and bird species were extinct due to the destruction of their habitats; these can in turn be causes for devastating effect on biodiversity (Ewnetu, 2001).

In addition to different wild animal and bird's species, there were different types of trees like *A. tortilis*, *A. senegal*, *A. seyal*, *Balanites aegyptiaca*, *Ficus sycomorus*, and *Maytenus senegalensis* are the dominant tree species in the study area (EWNHS, 2009).

These species are rare and nowadays seen few. According to the key informants or respondent reported that, before 15 or 20 years back there were various wild animals and dense acacia woodland in the study area. However, due to

Table 5. Major type of wild animal and bird species.

Wild Animals		Birds species	
Local name	Scientific name	Local name	Scientific name
Lion	<i>Panthera leo</i>	Great White Pelicans	<i>Pelecanus onocrotalus</i>
Tiger		Lesser Flamingoes	<i>Phoeniconaias minor</i>
Hyena	<i>Crocuta crocuta</i>	Greater Flamingoes	<i>Phoenicopterus ruber</i>
Baboons	<i>Papio spp.</i>	Hérons	<i>Ardeola spp.</i>
Greater kudu	<i>Tragelaphus strepsiceros</i>	Cormorants	<i>Phalacrocorax spp.</i>
Colobus monkey	<i>Colobus gureza</i>	Plovers	<i>Vanellus spp.</i>
Buffalo	<i>Syncerus caffer</i>	Black-winged stilt	<i>Himantopus himantopus</i>
Ape		Shovelers	<i>Anas spp</i>
Fox		little stint	<i>Calidris minuta</i>

conversion of woodland into cultivated land, wild animals have been displaced. This means, land conversion is the greatest cause of migration of wild animal and destruction of tree species. Therefore, as noted above table some wild animal species were extinct and endangered.

Conclusions

The pattern of LU/LCC in different categories shows variation during the three periods, 1973 to 1986, 1986 to 2010, and 1974 to 2010 within which that comparison had been made. In 1973 most of the study, area was covered by dense acacia woodland and shrub/bush lands (36.1 and 27.7%) respectively, followed by cultivated land (20.4%).

In the three decades, cultivated land was expanded by 844.2 ha at the expense of acacia woodland, shrub/bush land and bare/open land. The current population pressure has caused a high demand for additional land; as a result, shortage of cultivated land is the major problem for farmers in the study area.

Hence, the expansion of cultivated land and grassland in to marginal land lead to more sever land degradation. Agricultural land was increasing from 1324.0, 1440.8, and 1810.0ha in 1973, 1986, and 2010. The amount of increase in cultivation land during the 1973-2010 periods was 1810ha (27.8%).

Agricultural expansion is one the major proximate or direct causes of LU/LCC in the study area. This implies that population pressure is believed to be one of the major driving forces for the change of LU/LC in the study area. Hence, in the case of this analysis, the major driving force to changes in LU/LC is increased population change.

LU/LCC has a significant impact on degradation of soil and land resources, increase run-off rate (soil erosion) and decline soil fertility. It has also introduced very large impacts on surface and ground water quality and quantity, biological diversity. Overall, these changes affect the livelihoods of societies directly or indirectly. Destruction of

woodland and other vegetation cover to gain fuel wood and areas for cultivation can cause for instability environment.

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