The objective of this research paper was to assess the spatial and temporal Land Use/Land Cover Changes (LU/LCC) in Arsi Negele District. Rapid population growth, agricultural expansion, environmental fluctuations, degradation of natural resource and loss of biodiversity are the most visible socio-economic and environmental problem in the study area. Satellite imagery, ground control point 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 land. Between 1973 to 1986, cultivated grass and bare land increased by 8.98, 33.9, and 36.5 ha respectively. While, shrub and acacia woodland decreased by 6.17 and 73.21 ha, respectively. Between 1986 and 2010, cultivated acacia woodland and land increased by 15.38, 4.63, and 38.52 ha. However, bare and grass land decreased by 19.23 and 39.3 ha, respectively. Furthermore, the trend and magnitude of LU/LCC between 1973 to 2010 acacia woodland and land decreased by 22.72 and 13.58 ha, but shrub land and cultivated land increased by 22.82 and 13.14 ha. Socio-economic survey result revealed that acacia woodland and shrub land decreased, but cultivated land and grass land increased in the derg regime. However, currently, natural resource conservation activity has got a great emphasis, thus spatial coverage of 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.

Key words: Remote sensing, GIS, land use/land cover changes (LU/LCC), accuracy, landsat, imagery.
including forestry, agriculture, and biodiversity have been identified as high priority issues at global, national, and regional levels (Fu et al., 2000; Zeleke et al., 2001). LU/LC 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 et al., 1995). This means LU/LC affects both environmental quality and the quality of life, which are the two aspects that affect human wellbeing. Hence, LU/LCC is a central issue that requires investigation to sustainable development (Lambin, 1997) and represents a vibrant and dynamic area of research. LU/LC dynamics is also 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 be 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 Rift Valley region of Arsi Negele district. Since this area has immense and visible natural resources degradation (land degradation, deforestation and soil erosion), environmental deterioration, poor livelihoods communities living standards, seasonal variation, occurrence of unusual long rainy and dry season. The area is located between 7°09’ to 7°41’N and 38°25’ to 38°54’E at an altitude of 1600 m.a.s.l and found in 210 km south of Addis Ababa (Figure 1).

According to National Metrological Services Agency (NMSA) (2010) at Arsi Negele station shows that the mean annual minimum and maximum temperatures of 6.8 and 27.2°C respectively, while rainfall varies between 250 to 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 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, interviews were carried out on 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 older 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 on trends of land cover and 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; metrolological data, satellite images (MSS, TM and ETM which are obtained from Ethiopia Map Agency (EMA)).

RESULTS AND DISCUSSION

Trend and patterns of LU/LCC in the study area

As previously discussed, the information obtained from key informant, interpretation of remotely sensed imagery and field observations 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 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 shows the value of each LU/LC classes for each study year respectively. As indicated in Table 1, 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 (which 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 due to the fact that 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 rainfall 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 due to 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 as 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 to the previous land feature. Acacia woodland and shrub/bush land account for the largest amount in 1973 (Figure 2). This means during this period, it was highly likely that a portion of the land was unexploited and human population was also relatively low in the study area.
Table 1. Amount and coverage of Land Use/ Land Cover classes in the study area in 1973, 1986, and 2010.

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Land Use/ Land Cover classes</th>
<th>1973</th>
<th>1986</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>Area (%)</td>
<td>Area (ha)</td>
<td>Area (%)</td>
</tr>
<tr>
<td>1</td>
<td>Bare Land</td>
<td>72.5</td>
<td>1.1</td>
<td>547.0</td>
</tr>
<tr>
<td>2</td>
<td>Grazing/ Grass land</td>
<td>956.5</td>
<td>14.7</td>
<td>1397.2</td>
</tr>
<tr>
<td>3</td>
<td>Cultivated land</td>
<td>1324.0</td>
<td>20.4</td>
<td>1440.8</td>
</tr>
<tr>
<td>4</td>
<td>Shrub/Bush land</td>
<td>1801.2</td>
<td>27.7</td>
<td>1721.0</td>
</tr>
<tr>
<td>5</td>
<td>Acacia Woodland</td>
<td>2345.8</td>
<td>36.1</td>
<td>1394.1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6,500</td>
<td>100</td>
<td>6,500</td>
</tr>
</tbody>
</table>

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 was still high, as compared to the previous decade the amount is decreased, due to government land use policy, expansion of agricultural activity and population growth.

It is evident from community elders and justification of Garedew et al. (2009) that 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 the graph in 2010, cultivated land and shrub/bush land accounts for the largest amount in this period as 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; hence, 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, depending on the nature of land use type which covers 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 following table information was derived from the thematic image of LU/LC classes. The detection of LU/LC 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. The following illustrate the
Figure 3. Classified Land Use/Land Cover map of the study area in 1973.

Figure 4. Classified Land Use/Land Cover Map of the study area in 1986.
As indicated in the bar graph of Figure 6, 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 that of others (bare, grazing and cultivated land) increased in the year 1986. Figure 7 confirmed 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 and 1986. As can be seen from the map, 58.5, 95.6, 372.2, 661.3 and 767.2 ha or a total of 1954.8 ha of land were not changed to other land cover type.

However, 63045.2 ha of land were changed 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 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 to acacia woodland and cultivated land respectively.

Correspondingly, about 668.4 and 385.9 ha of shrub/bush land were converted to cultivated, grazing and acacia woodlands respectively. Similarly, 299.8 and 446.2 ha of acacia woodland was also changed to cultivated land shrub land.

In general, based on the matrix result, it was concluded 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 map result of land use/land cover change in the year between 1986 and 2010. The result depicts 1797.2 ha of land area were not changed to other land cover type. However, a total of 63202.8 ha of land were changed to different land cover type in the 24-year duration. Thus, 1304.4 ha of various land use type were changed to cultivated land, because of population growth. The change has adverse impact on the physical environment as degradation of natural resources, deforestation, soil erosion, soil fertility reduction, biodiversity losses are the main results of land cover change in the study area. However, the existing government greatly emphasizes on environmental conservation and protection activities by including the local community for sustainable use of natural resources in the area.

Therefore, the degraded shrub/bush land and other vegetation cover becomes a good situation. The local peoples were also helped to understand the role of natural resources for their livelihood and to start an integrated conservation activity with local development agents and other voluntary organizations. The following map (Figure 9) showed the coverage of LU/LC in the years between 1986 and 2010.

Figure 9. Land Cover type of the study area from 1986 to 2010.

**LU/LCC between 1973 and 2010**

In the time period between 1973 and 2010, a dramatic decrease in the area of grazing/grass land which is about 348.1, 285.7 and 94.9 ha of land was noticed; lands were converted into cultivated, shrub/bush and acacia woodland respectively. About 660.8 ha of Shrub/bush land in 1973 was directly converted to cultivated land in 2010. Cultivated land, shrub/bush land and to some extent, acacia woodland cover were shown to have 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 be seen from Figure 10, cultivated land and shrub/bush land show high coverage of land than other land cover types 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 followed by cultivated land in the period from 1973 to 1986. However, the cumulative results of 1986 to 2010 showed 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 again covered 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 2 shows a total 1877.4 ha of land area were not changed to other land cover types. However, a total 63122.6 ha of land were changed to different land cover type in the 24-year duration.

The coverage of shrub/bush land shows greatest
change compared to the others. The main reason for the improvement of shrub/bush land in the study area was the government who gives more attention to the conservation and protection of environmental conservation activities. The following map (Figure 11) showed 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 to calculate 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 years 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 on 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 occupying 1801 ha (27.7%) and 1324 ha (20.4%), respectively. The share of bare land and grassland relatively covers 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 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 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 1394.1 ha or (21.4%) and 1721 ha or (26.5%), respectively.

In this period, the annual rate of shrub/bush land, cultivated land and bare land were 22.82, 13.14, and 0.35 ha of land cover respectively. The other major change during this period is reduction of the size of acacia woodland by -22.72 ha, followed by grazing land that account for -13.58 ha. The negative result was due to increment of population pressure as a result of the need for more cropland.

### Accuracy Assessment

According to Anderson et al. (1976), the recommended standard of accuracy in the identification of LU/LC mapping from the remote sensor data should be 85 to 90%. On the other hand, Kappa coefficient is important information in accuracy assessment. The overall accuracy and
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 underlying causes of LU/LC dynamics

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 of 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 2, cultivated land accounts for 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 change is related to agricultural activities of 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 households interviewed in the area, all of them responded that their agricultural plot has been expanded significantly in the past 10 to 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 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 were 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. Figure 14 revealed that 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 demand of 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. Relation of population growth to the cultivated land showed 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 486 ha 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 conversion of land to agriculture or other land uses (Abbas et al., 2009).

As can be seen from Table 3, in the year 1973, amount of production in common crop type was very high without the use of any fertilizers. Similarly, in 1986, the farmers used fertilizers like (dap and urea) to enhance their production and productivities but the production declined. According to the two kebeles information in 2010, in all common crop type the production declined 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
Table 3. Types of crop and inputs used.

<table>
<thead>
<tr>
<th>Type of crops</th>
<th>1973&lt;sup&gt;a&lt;/sup&gt;</th>
<th>1986&lt;sup&gt;a&lt;/sup&gt;</th>
<th>2010&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inputs used</td>
<td>Production (ha/q)</td>
<td>Inputs used</td>
</tr>
<tr>
<td>Teff</td>
<td>no</td>
<td>6 - 15</td>
<td>Dap</td>
</tr>
<tr>
<td>Wheat</td>
<td>no</td>
<td>10 - 15</td>
<td>no</td>
</tr>
<tr>
<td>Barely</td>
<td>no</td>
<td>8 - 14</td>
<td>no</td>
</tr>
<tr>
<td>Faba Bean</td>
<td>no</td>
<td>4 - 8</td>
<td>no</td>
</tr>
</tbody>
</table>

Data sources: <sup>a</sup>Arsi Negele District Agricultural Office and <sup>b</sup>PA’s Office (2011).

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

<table>
<thead>
<tr>
<th>Peasant Association</th>
<th>Number</th>
<th>Number/hectare</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hada Boso</td>
<td>89</td>
<td>209</td>
<td>56</td>
</tr>
<tr>
<td>Gallena Kello</td>
<td>68</td>
<td>189</td>
<td>49</td>
</tr>
<tr>
<td>Total</td>
<td>157</td>
<td>398</td>
<td>105</td>
</tr>
</tbody>
</table>

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

Deforestation and LU/LCC are becoming locally common features wherever there are escalating human populations, because fuel wood demand tends to exceed supplies in the study area (Nejibe, 2008). In Arsi-Negele town, 87.3% of the populations are directly supporting their life by distillation of katikala and fuel wood has continued to provide all the energy 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 <i>Acacia tortilis</i>, <i>Acacia senegal</i>, <i>Acacia seyal</i> and <i>Balanite aegypticus</i>. 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 <i>A. etbaica</i> and <i>R. natalensis</i> which are 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 earns their income from the sale of firewood and charcoal.

The extent and type of LU/LCC directly affects 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 (Abbas et al., 2009). From the total respondent, 75% reported the interference of human beings in the study area as reason for alteration of the existing environment; this result can result in habitat loss, degradation of ecosystem services and livelihood support systems. As shown in Table 5, in the past two decades, there were many wild animals and different varieties of bird species in the study area, especially, in Abijata-Shalla and Langano lakes. However, most 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 (Mihiret, 2001).

In addition to different wild animal and bird species, there were different types of trees like <i>A. tortilis</i>, <i>A. senegal</i>, <i>A. seyal</i>, <i>B. aegptiaca</i>, <i>Ficus sycomorus</i>, and <i>Maytenus senegalensis</i> that are dominant tree species in the study area (EWNHS, 2009).

These species are nowadays rarely seen. According to the key informants or respondents in this study, before 15 or 20 years back there were various wild animals and dense acacia woodland in the study area. However, due
Figure 15. Illegal charcoal production in Arsi Negele District. Source: Arsi Negele District Department of Natural Resources Office (2011).

Table 5. Major types of wild animals and bird species.

<table>
<thead>
<tr>
<th>Wild Animals</th>
<th>Scientific name</th>
<th>Birds Species</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lion</td>
<td>Panthera leo</td>
<td>Great White Pelicans</td>
<td>Pelecanus onocrotalus</td>
</tr>
<tr>
<td>Tiger</td>
<td>Crocota crocota</td>
<td>Lesser Flamingoes</td>
<td>Phoeniconais minor</td>
</tr>
<tr>
<td>Hyena</td>
<td>Papio spp.</td>
<td>Greater Flamingoes</td>
<td>Phoenicopterus ruber</td>
</tr>
<tr>
<td>Baboons</td>
<td></td>
<td>Herons</td>
<td>Ardeola spp.</td>
</tr>
<tr>
<td>Greater kudu</td>
<td>Tragelaphus trepsiceros</td>
<td>Cormorants</td>
<td>Phalacrocorax spp.</td>
</tr>
<tr>
<td>Colobus monkey</td>
<td>Colobus gureza</td>
<td>Plovers</td>
<td>Vanellus spp.</td>
</tr>
<tr>
<td>Buffalo</td>
<td>Syncerus caffer</td>
<td>Black-winged stilt</td>
<td>Himantopus himantopus</td>
</tr>
<tr>
<td>Ape</td>
<td></td>
<td>Shovelers</td>
<td>Anas spp</td>
</tr>
<tr>
<td>Fox</td>
<td></td>
<td>little stint</td>
<td>Calidris minuta</td>
</tr>
</tbody>
</table>

to conversion of woodland into cultivated land, wild animals have been displaced. This means, land conversion is the greatest cause of migration of wild animals and destruction of tree species. Therefore, as noted in Table 5, some wild animals 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 led to 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 to marginal land lead to more severe land degradation. Agricultural land was increasing from 1324.0, 1440.8 and 1810.0 ha in 1973, 1986 and 2010. The amount of increase in cultivation land during the 1973 to 2010 periods was 1810 ha (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 declining soil fertility. It has also introduced very large impacts on surface and ground water quality and quantity, as well as 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 result in an unstable environment.

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REFERENCES


CONFLICT OF INTEREST

The authors have not declared any conflict of interests.