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Assessment of land use land cover dynamics and its contributing factors in Adama district, central Ethiopia

Mamush Masha, Mengie Belayneh*, Gemechu Tedila

Department of Geography and Environmental Studies, Mettu University, Mettu, Ethiopia

*Corresponding author E-mail: mengie1980@yahoo.com

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Abstract
Land use land cover change has resulted negative consequences for the quality of environment and life of rural livelihoods in Ethiopia in general and the study area in particular. The aim of this study was to investigate the spatial and temporal Land Use/Land Cover Changes and its contributing factors in Adama District, Oromia regional sate, central Ethiopia. The three periods of satellite imageries (Landsat 4-5TM 1990, Landsat7 ETM+ 2000 and Landsat 8 OLI/TIRS 2020) were used to detect the changes. By using simple random sampling technique, 240 respondents were selected, and questionnaires, interviews and field observations were used to collect the data. The collected data were analyzed by using ArcGIS 10.5; ERDAS imagine 2015, SPSS version 23 and excels 2010 software. The determinants variables of land use land cover changes were assessed using multiple regression model. The results showed that there was continuous expansion of cultivated land and settlement area, which increased by the rate of 935.3 and 797.1 hectares per year respectively during the study period of 1990 to 2020. On the other hand, water bodies, forest and shrub land reduced with rate of (-112.03), (-870.2), (-759) hectares per year respectively. This indicates that an increased deforestation together with poor land management practices has accelerated land cover changes. Rapid urbanization, settlement expansion and population growth, expansion of agricultural land, need for fuel wood and construction materials are the main driving forces to the land use /cover dynamics in the district. This suggest that there is a need to protect the fragile environment by implementing sustainable land management practice through integrated participatory approach. Besides, long and short term training need to be arranged for all farmers/stakeholders toward land use land cover changes of the district.

Keywords
Adama District, Contributing factors, Land use land cover changes, GIS and RS

Introduction

Land is a vital natural resource, both for the survival and prosperity of humanity, and for the maintenance of all terrestrial ecosystems (Gelagay and Minale, 2016; Masha et al., 2021). It is an important bridge to achieve the UNs sustainable development goals linked with food, water, climate, and health; as a result, high pressure on this resource is to be expected (Keesstra, et al., 2016; Keesstra, et al., 2018). Nevertheless, Land use/cover changes (LULC) become the main components of the global change of the environment and depict the impact of human activities on the natural environment (Zhao et al., 2017; Masha et al., 2021). Society's demand for land resources and the espansion of technological, managerial, and institutional capacity have significantly altered the vegetation, soil, and topographic features of the environment on a global scale (Mohamed, et al, 2018, Gebrelibanos and Assen, 2015; Zerihun et al., 2018). Land Use Land Cover (LULC) change is an endless process taking place on the earth surface starting from ancient time (Shiferaw and Singh, 2011). The change is mainly attributed from natural and human causes, and the complex interaction of economic, social, and environmental factors (Haregeweyn et al. 2017, Belayneh et al., 2019). However, anthropogenic processes make it worsen exponentially over time (Kertész, 2009). Humans are among the main destructive agents of the natural environment, which continuously modify and change the landscape and land cover (Gashaw et al., 2017; Ayala et al., 2018; Rimal et al., 2019; Haregeweyn etal. 2017, Belayneh et al., 2019). Different human induced causes that drive the LULC change have been identified, including cropland expansion, infra-structural expansion, and greater demand for natural resources (construction, fire-wood, sources of income (Belayneh et al., 2020; Belay and Mengistu, 2019). Also, the fast growing population in conjunction with other processes and associated consequences further exacerbated the problem and exerts negative influence on land cover changes (Shiferaw and Singh, 2011; Molla et al., 2018; Haregeweyn et al., 2017; Belayneh et al., 2019). In Ethiopia, population growth leads further to unnecessary natural resource exploitation such as forest clearing both for farming and settlement purposes, short fallow periods, and land fragmentation which has a direct adverse effect on agricultural output (Garedew, 2010; Muluneh and Arnalds 2011; Gashaw et al., 2017; Haregeweyn et al., 2017; Belayneh et al., 2020). LULC change has negative consequences for both quality of environment and life change the availability of different biophysical resources including soil, vegetation, water, animal feed and others (Molla, 2015; Sisay et al., 2016; Bewuket and Abebe, 2013; Belayneh et al., 2020). It causes a significant effect on hydrology, land degradation, climate change, biodiversity, increa- sed soil erosion, reduction of biological diversity, hydrological changes, and a modification of local climatic conditions and impacts on ecosystem services (Bewket and Abebe, 2013; Shiferaw and Singh, 2011; Hishe et al., 2020, Belayneh et al., 2020; York et al., 2011). Similar to that of most of the highlands of Ethiopia, significant land cover changes have occurred in the highlands of Oromia regional states, particularly, in the study district (Adama) since the last decade (Alemu, 2015). This change was primarily due to anthropogenic activities like urbanization, industrialization, land degradation in connection with the population increase, which forced people to clear forest for cultivation and other activities (Newton et al., 2014). Cognizant of this fact, a lot of efforts and investment has been made by the government; development partners (NGOs), and communities to manage land resources sustainably since 1990 (Bewuket, 2007). Despite continuous efforts and the growing policy interest on the land management in different regions of the country; land use land cover changes/forest degradation continued as a problem to be tackled as part of the government's efforts at ensuring livelihood security and sustainability (Bewuket, 2009; Belayneh et al, 2020; Haregeweyn et al., 2017). Many factors are contributing to land use land cover changes, which are biophysical, socioeconomic, political, technological, cultural and institutional; but site specific identification and analysis of the determinants and drivers of spatiotemporal changes in the study area has received little attention. Besides, unlike the previous studies which focused on descriptive statistics for the analysis of contributing factors of LULC change, the current study used multiple linear regression model, which are important to know the relative contribution each independent variables. Moreover, at present, sustainable land management strategies are increasingly became major areas of scientific concerns and, hence, the effective identification, analysis, planning and implementation require a detailed understanding of the extent, risks and spatial distribution of the problem (Bewuket, 2009).

Therefore, the study is important to understand dynamics, identify the determi-nants/drivers and to be able to predict how they will affect human society, both today and tomorrow (Bewuket, 2002). Moreover, LULC analysis has become an important tool to generate evidence for decision-makers, spatial planners, local communities, or actors who are operating within a given landscape to formulate appro- priate policies and strategies, generate data for spatial planning, and develop detailed land use plans as well as understand agents of change (Zerihun et al., 2016).

In this regard, The geographical information system (GIS) and remote sensing (RS) technologies have

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made possible to assess and analyze LULC change in less time, at low cost and with better accuracy (Dimobe et al., 2015; Nigro et al., 2016; Ayalew et al., 2017).

Therefore, area-specific information on LULC dynamics is essential for land-use planning through appropriate resource management and maximizing sustainable productivity of agricultural and non-agricultural land, on both local and regional levels (Daniel, 2008). Thus, this study can provide useful information for conservation decision-making in the Adama district of Oromia regional state by identifying disparities, trends and contributing factor for the LULC in the years of 1990, 2000 and 2020.

Materials and Methods

Study area description

Adama district is found in east Shoa Zone, Oromia regional state, central Ethiopia. The district lies between 8°21´N to 8°42´ N latitude and 39°6´ E to 39°27´E longitude as show in Figure 1 below. It covers an area of 107296 hectares. The altitude ranges from 1341m to 2442 m.a.s.l. It has annual temperature and rainfall of 22.5°C and 809 mm (NMSA).

The altitude ranges from 1880 to 2681 meters above sea level. The slope gradient is dominated by gentle to steep slope, and the climax vegetation is tropical montane rainforest in nature. The area is well-known with various types of land uses such as forest, shrub land, cultivated, water body, and settlement.

The cropland is the dominant land use type in the study area followed by shrub woodlands, grasslands, forestlands, bare lands, and settlement. The most commonly cultivated crops are barley (*Hordeum vulgare*), wheat (*Triticum vulgare*), maize (*Zea mays*), teff (*Eragrostis tef*), horse bean *(Pisum sativum),* and chickpeas (*Cicer aritinum*). With regard to livestock, horses, mules, donkeys, goats, sheep, cattle and poultry are common. The area is densely populated, and due to its production potential and tropical climate, it is intensively cultivated and known by land fragmentation, land cover degradation and overgrazing. Small-scale subsistence mixed farming is the main livelihood source and comprises majority of the economic activity, which is predominantly dependent on the seasonal rain. However, some farmers who owned small sized land are engaged in off-farm and non-farm income-generating activities such as daily laboring, hand crafting and petty trading. Most of the land resources, particularly soils of the area have been degraded because of the interplay between some environmental and human factors such as relief, climate, population pressure and the resultant over-cultivation of the land, deforestation of vegetation, and overgrazing.

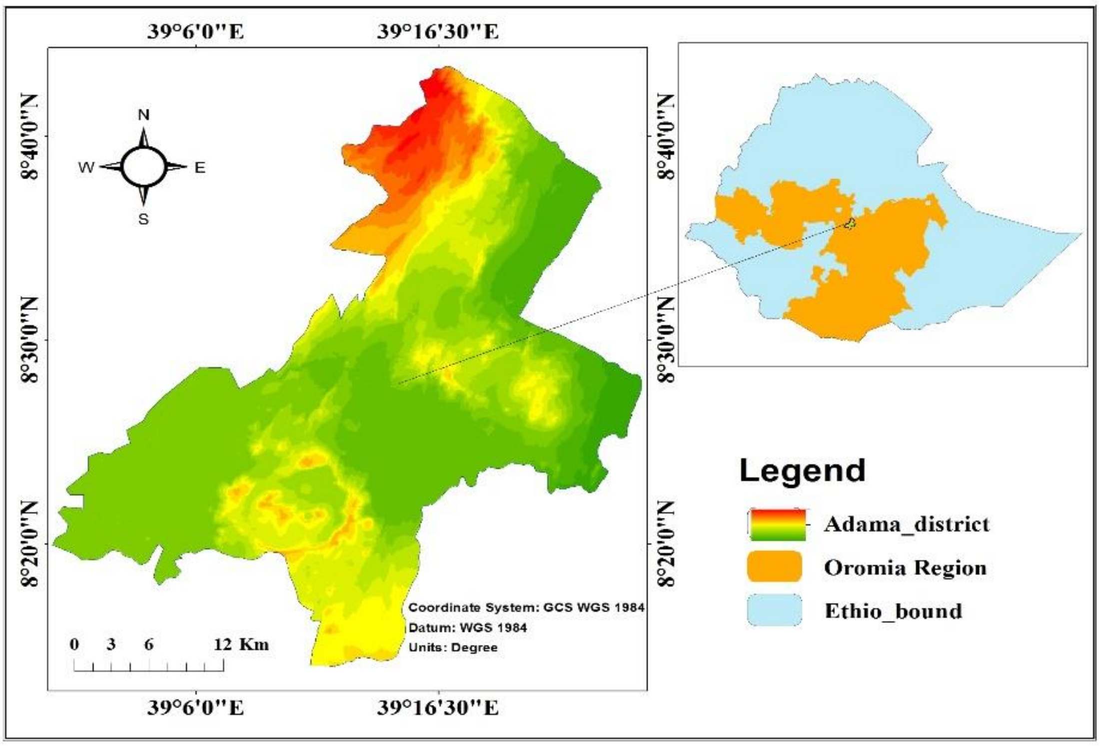

Figure 1
Location map of study área

Research design and approach

The research design has a significant role in facilitating the overall flow of the entire research, and provides a blueprint for studying research questions. This study used modeling and cross sectional survey study. The motive for employing survey design with modeling approach in the current study was that it is helpful to collect the data at a single point in time in which the pattern of association between variables are examined so as to detect the association of causal effects.

Data source and acquisition method

For the land use land cover analysis, the three satellite imaginers, such as Landsat 8 OLI-TIRS (Operational Land Imager), Landsat7 ETM+ (Enhancement thematic mapper) and Landsat4-5 TM (Thematic mapper) were used. The particulars of the spatial data used in this study were organized in (Table 1), and applied topographic map in scale of 1:50,000 and GPS for ground verification.

Table 1. *Satellite image used for LU/C change analysis and their characteristics*

Satellite image	Sensor	path/row	Acquisition date	Resolution (m)	Source
Landsat8	OLI-TIRS	168/054	04/Feb/2020	30*30	USGS
Landsat7	ETM+	168/054	02/Feb/2000	30*30	USGS
Landsat 5	TM	168/054	02/March/1990	30*30	USGS

Satellite image pre-processing and classification

Before doing LU/C change detection image pre-processing like atmospheric correction or radiometric correction by using haze removal, image enhancement and then composite band were applied. Supervised image classification technique was used using maximum likelihood algorithm. Maximum likelihood was used for supervised classification by 600 ground control points for six major land use land cover class shows in (Table 2) below. This land use /cover types were identified with the help of visual clarification elements and the different reflection characteristics of the feature in the satellite images of 1990, 2000 and 2020.

Table 2. Description of LU/C categories considered in image classification

LU/C class	LU/C Description
Cultivated land	Areas used for rain fed crop production and dispersed rural settlements usually related with cultivated lands
Forest	Areas covered with dense vegetation, which include both Eucalyptus and coniferous trees.
Shrub land	Land covered by bushes, small tress and sometimes with scattered small trees mixed with grasses.
Settlement	Land area covered by urban and rural building area and were people's lives
Water bodies	Areas covered by Lake in the catchment permanently
Wetland	Areas that is waterlogged or swampy during the wet season and relatively dry during the dry season.

Sources of Survey data, and collection tool

The total population under study district consists of 2330 households. Hence Yamane's formula was used to determine and calculate the sample size; at 95 % confidences level and ±5 % of precision level, which is;

$$n = \frac{z^2 * p * q * N}{e^2(N-1) + z^2 * p * q} \quad [1]$$

$$\frac{(1.96)^2 * 0.11 * 0.89 * 2330}{(0.05)^2 * (2330 - 1) + (1.96)^2 * 0.5 * 0.5} = 240 \quad [2]$$

respondents were selected for the survey data through simple random sampling technique.

All the necessary primary data required for the study were collected from farm households by using a survey questionnaire with both open and close-ended questions, key informant interview (KII), focus group discussion (FGD), and field observation. Accordingly, the collected data was analyzed by using descriptive and inferential statistics. Multiple linear regression model was applied to analyze determinant factors affecting LULC changes of the area

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Method of Geospatial Data analysis

ArcGIS 10.5, ERDAS imagine 2015 and excel were employed for satellite image processing and LU/C change analysis. Therefore, the rate of change was calculated for each LU/C classes of study area as rate of change (ha/year) (Abate, 2011)

$$\text{Rate of change (ha/year)} = (A - B)/C \qquad [3]$$

where, A = Recent area of the land use and land cover in ha; B = Previous area of the land use and land cover in ha; C = Time interval between A and B in years.

Overall change matrix was built to understand or observe the magnitude of change between different land use land covers. In order to identify the major driving forces of LU/C changes and other nonvisual information that could not be extracted from the satellite images, through FGD, key informants from the local people were interviewed to receive further understandings on issues related to the major driving forces of LU/C changes of study area.

Accuracy assessment

Accuracy assessment was carried out to confirm to what degree the produced classification is well-matched with what reality exists on the ground (Congalton, 1991). It includes the production of references (samples) that evaluate the produced classification. These references were produced from Google Earth (by observing, digitizing and recording identifiable Coordinate points of features) and GPS points during field survey, which were independent of the ground truths used in the classification. Table Shows result of accuracy assessment recognized in three decades of classified images in Adama district. The accuracy assessment of land use land cover for the years 1990, 2000 and 2020 are recorded the overall classification accuracy of 90.00%, 91.33% and 88.35%, respectively. The ground truth data collected from the field were used as a reference for image classification. The total sampled ground truth data collected from the field were (300 reference data) stratified consistently to each LULC class. The reference data were used to examine the classification accuracy of the LULC images (Table 3).

Table 3. *Statistical Information of accuracy assessment for the years 1990, 2000 and 2020*

Class name	1990		2000		2020	
	Producers accuracy	Users accuracy	Producers accuracy	Users accuracy	Producers accuracy	Users accuracy
Settlement	82.82%	91.00%	100.00%	90.00%	93.75%	88.24%
Water Body	91.92%	91.91%	100.00%	90.91%	75.00%	100.00%
Wetland	93.31%	86.71%	93.86%	92.86%	89.47%	94.44%
Forest	90.00%	91.00%	91.00%	90.00%	66.67%	80.00%
Cultivated Land	86.71%	85.72%	76.00%	85.71%	90.91%	83.33%
Overall accuracy assessment	90.00%		91.33%		88.35%	
Overall classification accuracy	0.8615		0.8742		0.8764	

In this regard, the error matrix and kappa coefficient were used to evaluate the accuracy of the produced image and the consistency of the reference data. The overall Kappa statistics for 1990 is 0.8615, 2000 and 2020 Kappa values are 0.8742 and 0.8764, respectively.

Results and Discussions

Land use/cover change of the district

As the change detection analysis results revealed, cultivated land, forest land, wetland, grass land, rural settlement and others are the predominant LULC types identified during the entire study period (Fig, 2), which have been identified and discussed here under (Table 4). According to the quantitative evidence obtained from satellite images, which is indicated in the figures in Figure 3, 4, 5, and 6, the study area has undergone significant LULC change. In this regard, cultivated land increased with rate of 1115.3ha/year from 1990 to 2000 (Figure 7). But, from year of 2000 to 2020 the rate of change could

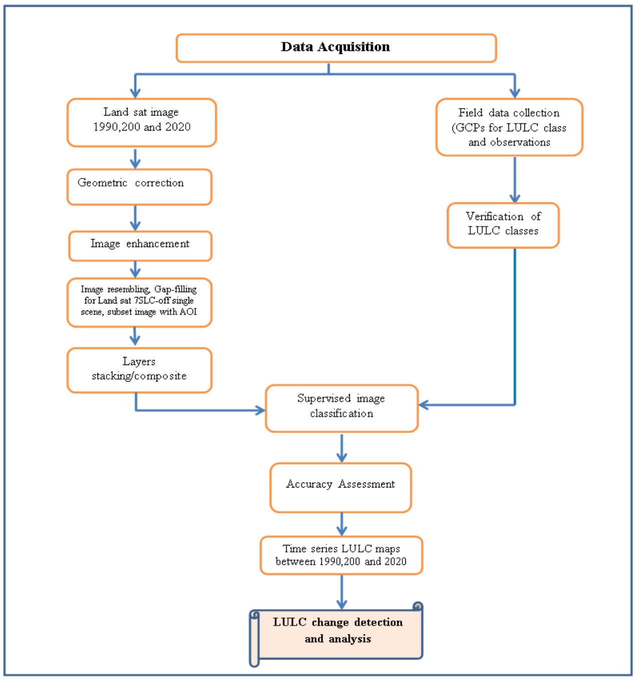

Figure 2. *Flow chart of LULC changes and analysis processes*

have decreased by (-180 ha/year) because of land use changes to other land cover classes. In the three decades (1990 to 2020), the cultivated land has increased with the rate of 935.3 ha/year. Which was due to various biophysical, socioeconomic, political, technological, cultural and institutional factors. Similarly, the shrubs, farmlands, and settlement were expanded while wetland, grassland and forest cover were reduced over the past 30 years in the study area. In this regard, the alarmingly increasing population pressure on the land resources has increased the demand for farmlands, settlements, fuel wood, and construction materials in different part of the district. This finding was similar with the finding of Abate (2011) that the fast growth of cultivated land up to 44% was due to the conversion of forest and shrub to agricultural land between 1972 and 2003 in Borena Woreda of South Wollo highlands, Ethiopia.

Table 4: LU/C change of the study district (1990, 2000 and 2020)

LU/C class	1990 Area (ha)	2000 Area (ha)	2020 Area (ha)	Rate of change hectare/year		
				1990-2000	2000-2020	1990-2020
water body	15185.1	14770.6	12950	-21	-91.03	-112.03
Settlement	2282.7	5054.9	18218	139	658.1	797.1
Shrub land	24976.7	13818.05	9804	-558	-201	-759
Forest	25972.9	12867.5	8580	-655.2	-215	-870.2
Wetland	5332.8	4931.2	5488	-20.08	28	7.92
Cultivated land	33545.7	55854.3	52256	1115.3	-180	935.3
Total	107296	107296	107296			

N.B. Positive symbol means increase while negative symbol means decrease in area.

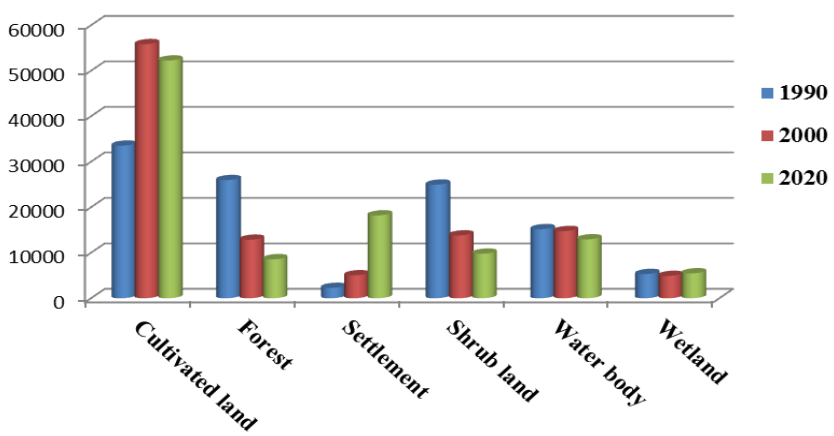

Figure 3
Overall comparison of LULC changes (Hectare) in Adama district between 1990, 2000, 2020

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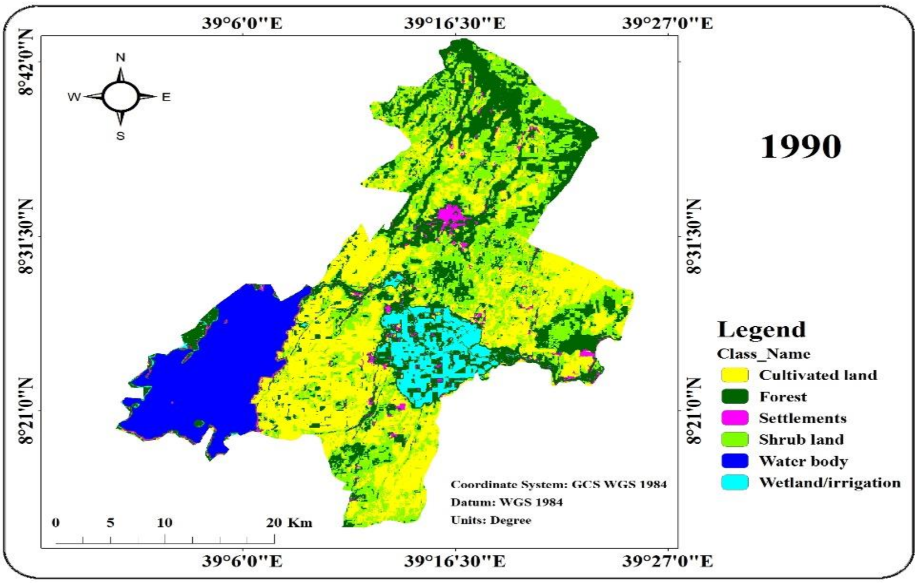

Figure 4
LULC classes of Adama district in 1990

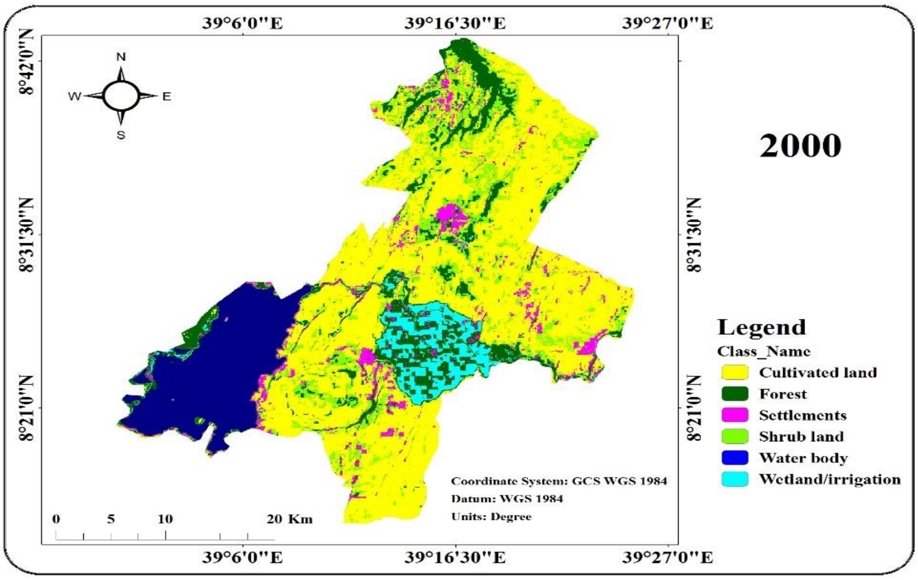

Figure 5
LULC classes of Adama district in 2000

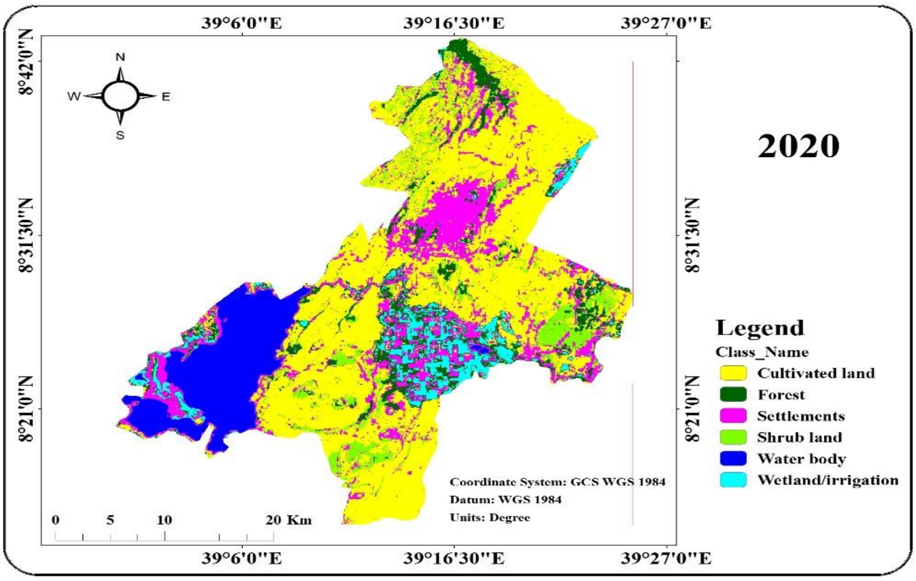

Figure 6
LULC classes of Adama district in 2020

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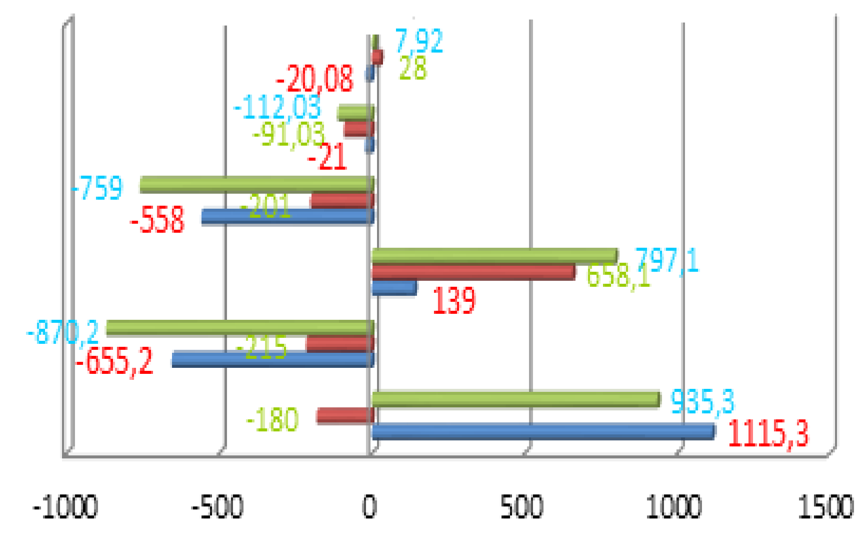
On the other hand, the area of shrub land and forest could have decreased with rate of -558ha/yr and -655.2ha/year respectively from year of 1990 to 2020 (Table 5). This indicates that population pressure on the land resources increased the demand for farmlands, and settlements, which in turn had negative consequences for the existing shrub and forest in the area. These suggest that population growth is a major driving force for the land use land cover change of the district. This result was in agreement with the study of Abate et al. (2014) in his study as it indicated that the reduction of forest land with rate of 120ha/year from year of 1973 and 2003 in Banja district, Amhara region, was due to population pressure coupled with other associated factors. On contrary, some studies conducted in the degraded parts of northern Ethiopia, revealed changes related with increments and improvement of vegetation cover due to plantation undertaken in hillsides in the period since the 1980s. Similar study of Amare et al. (2011) in Eastern Escarpment of Wello, Ethiopia and Munro et al. (2008) in Tigray highlands disclosed that vegetation cover improved since the 1980s owing to land rehabilitation efforts of the community supported by the government and multilateral donor agencies. More importantly, in the current study, water body decreased with rate of (-21) and (- 91.03) ha/year from year of 1990 to 2000 and 2020 respectively, which was due to alarmingly increasing population pressure coupled with other associated factors. This result is consistent with the study of Alemu et al. (2015) who stated the reduction of water bodies from 444.5 ha to 198.9 ha within a period of 25 years (from 1985 to 2010) because of sedimentation. The same study of Hassen et al. (2015) has indicated the decreased Lake surface areas, which was reduced by 3.7ha/year b/n 1957 and 2007 in lake Hayq Ethiopia drainage basin.



	Cultivated land	Forest	Settlement	Shrub land	Water body	Wetland
1990-2020	935,3	-870,2	797,1	-759	-112,03	7,92
2000-2020	-180	-215	658,1	-201	-91,03	28
1990-2000	1115,3	-655,2	139	-558	-21	-20,08

Figure 7
Rate of LULC change Ha/year of Adama district

Table 5. *LULC change matrix from 1990 to 2020*

	Land use class	2020						
		Cultivated land	Forest	Settlement	Shrub land	Water body	Wetland	Grand Total
1990	Cultivated land	2664.1	976.2	3788.8	1668.2	0.4	455.6	33535.7
	Forest	8377.5	4920.4	6332.3	4090.8	123	2109.3	25953.4
	Settlement	348.2	184.9	1553.5	60.2	3.1	130.7	2281
	Shrub land	16575.3	989.2	3274.2	3907.2	0.1	218.8	24965
	Water body	133.4	281	1380.4	11	12732.6	645	15183.6
	Wetland/ Irrigation	155.8	1223.6	1874.9	62	90.4	1924.2	5331.1
	Grand Total	52236.6	8575.5	18204.3	9799.6	12949.7	5483.9	107249.8

Contributing factors to Land use Land Cover Changes: outputs of multiple regression model analysis

In order to generate the parameter estimates on the land use land cover changes, the statistical package of social sciences (SPSS) version 23 was used. Accordingly, twelve variables expected to have relationship with the land use land cover changes in the area were designated and considered in the model (Table 6). To determine the problem of mullticollinearity or relationship between the independent (explanatory) variables, the variance inflation factor (VIF) for continuous variables and contingency coefficient for categorical variables were checked. In this regard, the tolerance value of all variables in the model (1-R^2) are between 0.1 and 0.75 and their VIF are also between 1 and 10, which showed the absence of mullticollinearity. Before proceeding to the interpretation of determinant factors, the fitting of the model and the variables used were checked by using goodness of fit-statistics. Among the variables considered, the 7 (seven variables) have showed statistically significant level at $p < 0.05$. The study findings showed that there exists a strong positive relationship (r=0.874) between the land use land cover changes and considered independent variables in the study. As stated on (Table 6) the goodness to fit (coefficient of determination or the R^2) is 0.776. This shows that 75.6% of the variance of soil gully expansion explained by independent variables. The rest 24.4 % was not explained by considered explanatory variables, but to be explained by other variables that were not considered in the study.

Population pressure. the rapid population growth is one of the major driver forces of LULC in the study area. The increase of population is positively and significantly correlated at 10 % level of significance (Table 6). The beta coefficient of this variable in the model was .028, which implies that as population increase by one-unit, the chance of change of land use land cover rate also increased by a factor of .028. The study suggested that in the study area, with increasing population of the area, there is proportional increase in the rate of land use land cover change. Similar reports by Belayneh et al. (2020) and Haregeweyn et al. (2015) reported that high population increment have resulted in very high rates of land use land cover changes. In addition, the study of (Hishe et al., 2020) indicated as the alarming increase in population escalated the rate of change of LUC because of the high demand for agricultural land, charcoal and wood making, conversion of land to cultivated land, and overgrazing. Based on qualitative survey results and personal field verification, the population of Adama district was 261,341, of which 58.60% were urban residents. In addition, based on the 2007 CSA report, the district has an approximate total population of 422,490; of which 64.82% of its population are still urban dwellers, which is higher than the average of an Eastern Showa zone of 32.1%. With an area of 107296 square kilometers, Adama district has an approximate population density of 419.3 persons per square kilometer, which is higher than the zonal average of 181.7. The study area is therefore considered to be the most densely populated district in East Shewa Zone. So, the population growth in the district where resulted lack of farming land and grazing land, forest degradation, and decrease in agricultural productivity, loss of biodiversity, drought and desertification fragmentation of natural habitat, soil erosion and climate

Rapid urbanization. The large scale rural-urban population migrations, illegal settlement in and around towns, and unplanned utilization of urban ecosystem have a great role to land use land cover changes. The model result indicates that the rapid urbanization of the area had positively influenced land use land cover changes at the level of 5% significance (Table 6). The beta coefficients for this variable implies that as the intensity of urbanization increases the probability of the land use land cover also increased by 0.095 (Table 6). As it is explained from the model, the marginal effect shows the likelihood of land use land cover change occur by 0.95%. This means that adding one unit of occurrences of urbanization can increase the chance of change of land use land cover by 0.95%. This is consistent with the previous studies in the highlands of Ethiopia (Wubalem 2012; Tsegaye and Mohammed 2015; Hassen et al. 2015; Gelagay and Minale 2018).

Expansion of agricultural land: which was also one of the main causes of land use /cover dynamics in the study area. In the study area, a rapid population growth coupled with cultivation of marginal land, improper land resources management and utilization are the major cause of the land use land cove changes. The beta coefficients for this variable implies that as population of community increases, the likelihood of land use land cover changes by the factor of 0. 148. From the analysis it is possible to suggest that the rapidly increasing population has significantly contributed for the change of land cove in the area. Similar study (Gashaw et al., 2017; (Hassen et al., 2015) reported that the existence of this LULC dynamic was attributed to socio-economic factors, namely population growth, agricultural expansion, poverty, land scarcity, and related land tenure policy factors.

Deforestation. Deforestation and LU/LCC are becoming locally common features wherever escala-ting human populations, because fuel wood de mands to exceed supplies in the study area. Fuel wood has been identified as one of the most signifi cant 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. Fire wood and charcoal, which is leading cause for deforestation next to agricultural expansion in the district. The beta coefficients for this variable implies that as the level of deforestation increases, the probability of changing land cover in the study area increased by a factor of 0.753, being other variables constant. Similar studies of (Aklilu et al., 2006; Fikir et al., 2009; Adimassu et al., 2015) indicated deforesting of forest as a main factor for the change of land cover.

Settlement. Settlement land has played a significant role in changing and modifying the landscape of the district. Expansion of land for the settlement and deforestation (cutting of trees) significantly aggravated land use land cover changes at less than 5% significant level, which implies that agriculturalists provoke land use land cove changes through cutting of trees for their settlement purposes. The increasing demand for making of home and using land cover as a source of food and income, as well as other associated socio-economic factors, have contributed to the persistent change of land cover in the area. The model result indicated that as settlement pattern of the district increase by one unit hectare, the rate of land use land cover change increases by a factor of 0.285 being the rest independent variables in the model constant (Table 6).

Lack of awareness. The model result indicates; the variable farmer's poor awareness had positively and significantly influenced the change of land use land cover at less than 5% ($P< 0.05$) probability level. The beta coefficients for this variable implies that as the level of farmers poor awareness increases, the probability of changing land cover in the study area increased by a factor of 0.519%, being other variables constant. From the model, the marginal effect shows the likelihood of changing of land cover minimized as the awareness of farmers increased by a factor of 0.5%. This means that adding one unit poor awareness can increase the chance of degrading forest cover by 0.5%. Similar studies conducted by (Bewuket, 2002; Belayneh et al., 2020; Degefu et al., 2021; Gashaw et al., 2017; Kleemann et al., 2017; Teshome, 2022) confirmed the level of awareness is an essential to minimize land cover changes of the given area.

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Table 6. *Result of multiple linear regression Model analysis. Source: Survey study, 2022*

Independent variable	Coefficients						
	Unstandardized Coefficients		Standardized Coefficient			Co- linearity Statistics	
	B	SE	Beta	T	Sig.	Tolerance	VIF
Constant	17.127	13.201		7.20	0.002		
Population pressure	5.019	11.039	.028	-1.39	0.032	.626	1.596
Urbanization	6.139	9.075	.095	1.84	0.021	.525	1.904
Agric. land exp.	.991	7.508	.148	0.07	0.282	.497	2.019
Settlement	-.176	7.054	.285	-3.276	0.041	.700	1.428
Lack of awareness	427	1.129	.421	-4.317	0.021	.771	1.301
Over grazing	1.284	.152	.842	9.871	0.620	.989	1.011
Inappropriate L.use	3.341	.533	.484	5.564	0.016	.907	1.102
Deforestation	4.096	.174	.753	8.309	0.103	.898	1.113
Lumbering	-2.178	.478	.519	6.294	0.013	.746	1.340

Conclusion and Recommendations

This study investigated the spatial and temporal Land Use/Land Cover Changes and its contributing factors in Adama District, Oromia regional sate, central Ethiopia. The results revealed that shrub land, forest, water bodies, have decrease over a period of 30 year whereas cultivated land expanded during in this period. While wet lands and forest cover were contracted over the past 30 years in the study area. The main driving forces of land use /cover dynamics in the district were population pressure, expansion of agricultural land, need for fuel wood and construction materials and poor land management system. The results indicated the necessity of proper land use planning, otherwise the existing natural resources including forest and water bodies might be under the risk condition in the near future. This suggest that there is a need to protect the fragile environment by implementing sustainable land management practice through integrated participatory approach.

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References

ABATE S. (2011) Evaluating the land use and land cover dynamics in Borena Woreda of South Wollo Ethiopia. Journal of Sustainable Development in Africa, 139(1):94–101. ISSN: 1520-5509

ADMASU T. G. (2015) Urban land use dynamics, the nexus between land use pattern and its challenges: The case of Hawassa city, Southern Ethiopia. Land Use Policy, 45:159-175. https://doi.org/10.1016/J.LANDUSEPOL.2015.01.022

AMARE S. (2013) Retrospective analysis of land cover and use dynamics in Gilgel Abbay Watershed by using GIS and remote sensing techniques, Northwestern Ethiopia. International Journal of Geosciences, 4(7):1003–1008.. http://doi.org/10.4236/ijg.2013.47093

AKLILU Y., MOZURKEWICH M., PRENNI A., KREIDENWEIS S., ALFARRA M., ALLAN J., SHARMA, S. (2006). Hygroscopicity of particles at two rural, urban influenced sites during Pacific 2001: Comparison with estimates of water uptake from particle composition. Atmospheric Environment, 40(15):2650-2661. https://doi.org/10.1016/j.atmosenv.2005.11.063

ALEMU B, GAREDEW E, ESHETU Z, KASSA H. (2015) Land use and land cover changes and associated driving forces in north western lowlands of Ethiopia. International Research Journal, 5(1):28–44. https://doi.org/10.14303/irjas.2014.063

AYALA T. (2018) Resilience of soil properties to land-use change in a tropical dry forest ecosystem. Land Degradation & Development, 29(2):315-325. https://doi.org/10.1002/ldr.2686

BELAYNEH M., YIRGU T., TSEGAYE D. (2019) Potential soil erosion estimation and area prioritization for better conservation planning in Gumara watershed using RUSLE and GIS techniques. .Environmental Systems Research, 8(1):1-17. https://doi.org/10.1186/s40068-019-0149-x

BELAYNEH M., YIRGU T., TSEGAYE D. (2020) Current extent, temporal trends, and rates of gully erosion in the Gumara Watershed, Northwestern Ethiopia. Global Ecology and Conservation 24:e01255. https://doi.org/10.1016/j.gecco.2020.e01255.

BEWKET W. (2002) Land cover dynamics since the 1950s in Chemoga watershed, Blue Nile basin, Ethiopia. Mountain Research and Development 22(3):263-269, https://doi.org/10.1659/0276- 4741(2002)022.

BEWKET W., TEFERI E. (2007) Assessment of soil erosion hazard and prioritization for treatment at the watershed level: case study in the Chemoga watershed, Blue Nile basin, Ethiopia. Land Degradation and Development, 20(6):609-622. http,://dx.doi.org/10.1002/ldr.944

BEWKET W., ABEBE S. (2013) Land-use and land-cover change and its environmental implications in a tropical highland watershed, Ethiopia. International Journal of Environmental Studies, 70(1):126–139. https://doi.org/10.1080/00207233.2012.755765.

CONGALTON R.G., GREEN K. (2009) Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, 2 nd edition. CRC press.New York, USA. https://doi.org/10.1201/9781420055139

DANIEL A. (2008) Remote sensing and GIS based land use and land cover change detection in the upper Dijo river catchment, Silte Zone southern Ethiopia. Working paper on population and land use change in Central Ethiopia, nr.17, Acta GeographicaTrondheim.

DEGEFU M. A., ARGAW M., FEYISA G. L., DEGEFA, S. (2021) Impact of landscape dynamics and intensities on the ecological land of major cities in Ethiopia. Environmental systems research, 10(1):1-19. https://doi.org/10.1186/s40068-021-00237-1

DIMOBE K., OUÉDRAOGO A., SOMA S., GOETZE D., POREMBSKI S., THIOMBIANO A. (2015) Identification of driving factors of land degradation and deforestation in the Wildlife Reserve of Bontioli (Burkina Faso, West Africa). Global Ecology and Conservation, 4:559-571. https://doi.org/10.1016/j.gecco.2015.10.006

GAREDEW E. (2010). Land-use and land-cover dynamics and rural livelihood perspectives, in the semi-arid areas of Central Rift Valley of Ethiopia Ph.D. Thesis. Swedish University of Agricultural Sciences, Umea, Sweden, 156 p. ISSN 2225-062X

GASHAW T., TULU T., ARGAW M. (2017) Erosion risk assessment for prioritization of conservation measures in Geleda watershed, Blue Nile basin, Ethiopia. Environmental Systems Research, 6(1):1-14. https://doi.org/10.1186/s40068-016-0078-x

GELAGAY H. S., MINALE A. S. (2016) Soil loss estimation using GIS and remote sensing techniques: a case of Koga watershed, Northwestern Ethiopia. International Soil and Water Conservation Research, 4:126–136. https://doi.org/10.1016/j.iswcr.2016.01.002

GEBRELIBANOS T., ASSEN, M. (2015) Land use/land cover dynamics and their driving forces in the Hirmi watershed and its adjacent agro-ecosystem, highlands of Northern Ethiopia. Journal of Land Use Science, 10(1):81-94. https://doi.org/10.1080/1747423X.2013.845614

HAREGEWEYN N., TSUNEKAWA A., POESEN J., TSUBO M., MESHESHA D. T., FENTA A. A., ADGO, E. (2017) Comprehensive assessment of soil erosion risk for better land use planning in river basins: Case study of the Upper Blue Nile River. Science of the Total Environment, 574:95-108. https://doi.org/10.1016/j.scitotenv.2016.09.019.

HASSEN M.Y., MOHAMMED A., ASSEFA M., TENA A. (2015) Detecting land use/land cover changes in the Lake Hayq (Ethiopia) drainage basin, 1957–2007. Lakes & Reservoirs Research & Management, 20(1):1-18. https://doi.org/10.1111/lre.12082

HISHE S., BEWKET W., NYSSEN J., LYIMO J. (2020) Analyzing past land use land cover change and CAMarkov-based future modelling in the Middle Suluh Valley, Northern Ethiopia. Geocarto International, 35(3):225-255. https://doi.org/10.1080/10106049.2018.1516241

KEESSTRA S., MOL G., LEEUW DE. (2018) Soil-related sustainable development goals: four concepts to make land degradation neutrality and restoration work. Land, 7(4):133. https://doi.org/10.3390/land7040133

KEESSTRA S., BOUMA J., WALLINGA G. (2016) Significance of soils and soil science towards realization of the united nations sustainable development goals. Soil, 2(2):111–128. https://doi.org/10.5194/soil-2-111-2016

KLEEMANN J., BAYSAL G., BULLEY H. N., FÜRST, C. (2017). Assessing driving forces of land use and land cover change by a mixed-method approach in north-eastern Ghana, West Africa. Journal ofEnvironmentalManagement,196:411-442. https://doi.org/10.1016/j.jenvman.2017.01.053.

MASHA M., YIRGU T., DEBELE M. (2021) Impact of soil and water conservation on greenness and soil loss in Damota Area, Southern Ethiopia. Applied and Environmental Soil Science, 2021-1-13. https://doi.org/10.1155/2021/9148138

MOHAMMED A. (2011) Land use/cover dynamics and its implications in the dried lake Alemaya watershed, eastern Ethiopia. Journal of Sustainable Development in Africa, 13(4):1–18. ISSN: 1520-5509

MOLLA T., SISHEBER, B. (2017) Estimating soil erosion risk and evaluating erosion control measures for soil conservation planning at Koga watershed in the highlands of Ethiopia. Solid Earth, 8(1):13-25. https://dx.doi.org/10.15413/ajes.2014.0105

MULUNEH A., ARNALDS O. (2011) Synthesis of research on land use and land cover dynamics in the Ethiopian highlands. Unpublished thesis. Hawassa University, Reykjavik, Iceland.

NEWTON K., DUGGER D. L., WICKLIFFE K. E., KAPOOR N., DE ALMAGRO M. C., VUCIC D., WEBSTER, J. (2014) Activity of protein kinase RIPK3 determines whether cells die by necroptosis or apoptosis. Science, 343(6177):1357-1360. https://10.1126/science.1249361

NIGRO A. (2016) Multi-season occupancy models identify biotic and abiotic factors influencing a recovering Arctic Peregrine Falcon Falco peregrinus tundrius population. Ibis, 158(1):61-74. https://doi.org/10.1111/ibi.12313

RIMAL M. (2019) Effects of land use and land cover change on ecosystem services in the Koshi River Basin, Eastern Nepal. Ecosystem Services, 38:100963. https://doi.org/10.1016/j.ecoser.2019.100963

SHIFERAW A., SINGH, K. (2011) Evaluating The Land Use And Land Cover Dynamics In Borena Woreda South Wollo Highlands, Ethiopia. Ethiopian Journal of Business and Economics, 2(1):1-15. ISSN: 2410-2393

TSEGAYE T., MOHAMED H. (2015) Land use and land cover change impacts on the regional climate of non-Amazonian South America: A review. Global and Planetary Change, 128:103-119. http://doi.org/10.1016/j.gloplacha.2015.02.009

TESHOME Y. (2022) Assessment of soil erosion hazard and contributing factors in the upper DombaWatershed, Heliyon, 14(10). https://doi.org/10.1016/j.heliyon.022.e09536

YORK A. M., SHRESTHA M., BOONE C. G., ZHANG S., HARRINGTON J. A., PREBYL T. J., NOLEN, B. (2011) Land fragmentation under rapid urbanization: A cross-site analysis of Southwestern cities. Urban Ecosystems,14(3):429-455. http://dx.doi.org/10.1 007/s11252-011-0157-8

WUBALEM T. (2012) The status of forestry development in Ethiopia: challenges and opportunities. National dialog on sustainable agricultural intensification in Ethiopia and its role on the climate resilient green economy initiative in Ethiopia July 23rd and 24th, 2012, ILRI Campus, Addis Ababa.

ZERIHUN M., MOHAMMEDYASIN M. S., SEWNET D., ADEM A. A., LAKEW, M. (2018) Assessment of soil erosion using RUSLE, GIS and remote sensing in NW Ethiopia. Geoderma Regional, 12: 83–90. https://doi.org/10.1016/j.geodrs.2018.01.002

ZHAO J., YANG Y., ZHAO Q., ZHAO Z. (2017) Effects of ecological restoration projects on changes in land cover: A case study on the Loess Plateau in China. Scientific Reports, 7:44496. https://doi.org/10.1038/srep44496