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Dynamics of land use, land cover change trend and its drivers in Jimma Geneti District, Western Ethiopia

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ABSTRACT

Information on Land Use and Land Cover (LULC) changes and the driving forces behind such modifications underpin a proper understanding of the dynamics of LULC changes. This study aimed to analyse the dynamics of LULC change trends and its driving factors in Jimma Geneti District (JGD) for the year 1973–2019. Five satellite images downloaded from USGS were used to analyze and assess the geospatial and temporal changes in LULC. In addition, in-depth household interviews, key informant interview, focus group discussions (FGD) and field observations were used to address the drivers of LULC changes. The result showed a decline in forest land from 8632.5 ha (20.9 %) in 1973–5647.23 ha (13.7 %) in 2019. The study further revealed that the total of forest land cleared between 1973 and 2019 was estimated to be 2985.27 ha (7.22 %). In other words, 34.6 % of the forest cover that existed in 1973 was lost. Similarly, wetlands declined from 9919.5 ha (24.0 %) in 1973–2000.24 ha (4.8 %) in 2019. Similarly, wetlands declined from 9919.5 ha (24.0 %) in 1973–2000.24 ha (4.8 %) in 2019. On the other hand, cultivated land has increased from 18617.0 ha (45.1 %) to 27708.1 ha (67.1 %). Similarly, the increment in settlement areas has elevated from 908.7 ha (2.2 %) to 4436.46 ha (10.7 %) during the same period. Agricultural expansion, cutting trees for various purposes (such as firewood, charcoal and construction material), overgrazing and the expansion of settlements, were identified as the major proximate causes of these changes. Moreover, the major underlying drivers of LULC changes include population growth, changes in policy and institutions, poverty and lack of awareness on the importance of natural resource conservation for sustainable livelihoods. From this study, it can be concluded that JGD has experienced a significant change in LULC over the past 46 years and were affected both positively and negatively. Hence, a wide range of policy packages are required for sustainable land management practices which take in to account synergies and trade-offs between the various land uses in the study area. The national and local governments should enforce sustainable land management approaches through integrating land use planning and management into all development programmes and projects.

1. Introduction

Land is an indispensable natural resource, which has enormous economic, social and biophysical uses. As a result, land use and land cover (LULC) are under a continuous changes mainly because of societal development and natural causes. LULC changes are fundamental processes on the earth's surface and have significant impacts on human society, climate, biodiversity, hydrological cycles, ecosystems, biogeochemical cycles and many other processes (Baldyga et al., 2008; Were et al., 2014; Lin et al., 2018). LULCinformation is also required for policy making, business and administrative purposes (Rwanga and Ndambuki, 2017).

Changes in land cover have become key components of global environmental change and represent impact of human activity (Zhao et al., 2017). Worldwide, LULC change is as old as human activity (Turner et al., 1993). However, the recent rate of change is different from earlier changes (Gebreslassie, 2014) because of major changes in societal development and population growth. The speed, degree, and intensity of LULC changes are now faster compared to the past (Lambin and Meyfroidt, 2011; Lin et al., 2018).In fact, as Lambin and Geist (2006), acknowledge, a dramatic increase in the rate of change has happened in the last few centuries.

Land use changes modify land cover due to human intrusions, such as cultivation, settlement, transportation, infrastructure, manufacture, recreation, mining and fishing. In contrast, land cover change converts land cover from one type to another and/or the modification of

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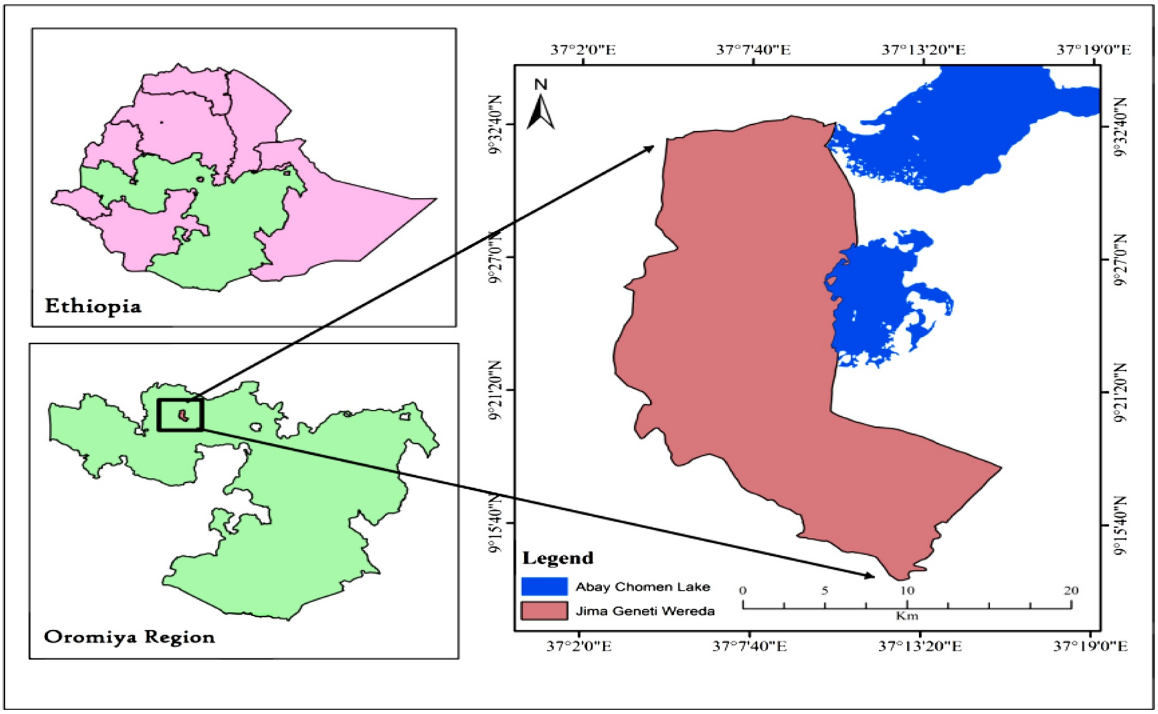

Fig. 1. Map of the study area.

conditions within a category (Pellikka et al., 2013). These dynamics alter the accessibility of various biophysical resources including water, vegetation, soil, animal feed and others.LULC changes exert detrimental and adverse influences, accelerated and driven by human actions, but also producing changes that impact humans (Agarwal, 2002).LULC change has numerous physical, ecological and socioeconomic consequences(Pellikka et al., 2013).

Apositive side of LULC change is agricultural land expansion, which increases food production for a rapidly growing population. Although, LULC change has social and economic benefits, it has also been reported to have an impact on spatial patterns of landscape properties by modifying ecosystems at local, regional and global levels (Allen et al., 2014; Muhati et al., 2018)

Furthermore, LULC changes cause negative impacts on stream water quality (Uriarte et al., 2011; Wankie, 2015; Yesuph et al., 2019), biogeochemical cycling and environmental health(Meshesha et al., 2014; Mwehia, 2015; Sewnet, 2015), forest condition (Ligdi et al., 2010; Rands et al., 2010; Siraj et al., 2018), forest carbon storage (Siraj, 2019), climate change (Bringezu et al., 2014), biodiversity conservation (Klenner et al., 2009) and the availability of ecosystem services (Lawler et al., 2014; Tolessa et al., 2017; WoldeYohannes et al., 2018; Woldeyohannes et al., 2020).

Generally, LULC changes are driven by natural factors and anthropogenic activities (Bennett and Saunders, 2010) causing the alteration of ecological process and the loss of native biodiversity across different ecosystems (Msofe et al., 2019). LULC is constantly changing in response to dynamic interaction between drivers of change and proximate causes (Lambin et al., 2003; Leh et al., 2013).

Since 1950, the world population has increased exponentially and this growth is producing major changes in LULC. In Ethiopia, population growth has been identified as the main driving force in LULC change and is contributing to natural resource degradation (Alemayehu et al., 2019). It is also considered as one of the major environmental challenge in Ethiopia(Gashaw et al., 2017; Berihun et al., 2019), where agricultural activity is considered to be the major economic sector in which 85 % of the population is engaged as a major source of income which, in fact, is makes it the backbone of the country's economy (Berihun et al., 2019).The reason for this is that land is dominantly used for mixed farming systems by smallholders (Tefera, 2011; Geremew, 2013), which in turn results in LULC changes in different parts of the country through devegetation(Gebrehiwot et al., 2014). Most of these changes happened due to the conversion of natural forest into agricultural land (Bewket, 2002; Daniel, 2008; Siraj et al., 2018).

As it is aforementioned above, land cover change is a widespread phenomenon and LULC change has increasingly become a key research priority for national and international research programs examining global natural resources and environmental change (Zhou et al., 2012; Du et al., 2014; Biru et al., 2015; Zhao et al., 2017; Siraj et al., 2018). Especially. LULC change caused by natural, as well as anthropogenic has a significant impact on the environment (Sharma et al., 2011). Information on existing LULC patterns and changes through time underpin better use and management of land resources (Yesuph et al., 2019).

Among several factors affecting LULC changes in Ethiopa, the three major factors include population growth, increasing agricultural investments and resettlement programmes (Negassa et al., 2020, Degife et al., 2018). In recent years, environmental changes, including LULC, have gained attention because of their impact on natural resources. There have been some attempts made to study the LULC in Oromia Regional State, Ethiopia, Dinka and Chaka, 2019; Siraj et al., 2018 & Desalegn et al. (2014a, 2014b) in central highlands of Ethiopia, Alemayehu et al., 2019, Jimma zone; Negassa et al., 2020 and Feyissa, 2015, in East Wollega. However there is a few study made in Horo Gudru Wollega zone (Tefera and Sterk, 2008 and Dibaba et al., 2020a, 2020b) in Fincha district, which is a neighbouring destrict to the current study area. Yet information on changes in LULC patterns is limited in the study area. This study is therefore, conducted to detect, quantify and map the LULC dynamics and to identify the drivers of LULC changes in Jimma Geneti district of Ethiopia.

Table 1
LULC classes and their thematic description in the study area.

LULC class	Description
Settlement area	Areas occupied by residential houses and other buildings
Bare Land	Exposed stone, sand and soil or area with no vegetation or dominated by rock-out crops, roads, eroded and degraded lands
Forest Land	Land with more than 0.5 ha, with a tree canopy cover of more than 10 %, which is not primarily under agricultural or other specific non-forest land use (FAO, 2000)
Cultivated land	Areas of land ploughed/prepared for growing crops by rain fed or irrigation, including fallow plots and degraded grazing land with very few scattered vegetation
Water Body	Areas of land covered with water (lakes and rivers)
Wet Land	Areas that is waterlogged or swampy during the wet season and relatively dry during the dry season. It also includegrazing land around the wetland.

2. Material and methods

2.1. Description of the study area

The study site, Jimma Geneti District(JGD) is located in HoroGuduruWollega Zone, Oromia Regional State, Ethiopia. The district covers a total area of 48,251 ha (482.51 sq.km) (Fig. 1). It is located 27 km from Shambu, the main town of the Zone and 273 km from the capital, Addis Ababa. According to Ethiopian agro-ecological zone classification, 60 % of the district is classified as Subtropical (Woina-Dega) and 40 % as Highland (Dega). The altitude of the district ranges from 1500 to 3200 m above sea level (JGDANRO, 2018). The mean annual temperature ranges between 13 °Cto 22 °C. The major rainy season ranges from April to September, with mean annual rainfall varying between 1600 − 2000 mm.

The major livelihood activity of the population in the district is mixed–farming (JGDANRO, 2018) with crop cultivation being the major agricultural activity, which is entirely rain-fed, with livestock rearing as a secondary activity. Pertaining to this, there are different types of land use observed in the study area (Table 1). In fact, the district can be characterized by various types of vegetation according to the variation in soil, climate and human activities. It is observed that there is a general trend that natural vegetation is degraded, even though there are some species of matured and naturally grown trees in some homesteads. The major indigenous woody species which survived in the district includes *Ficus vasta* Forssk., *Podocarpus falcatus* (Thunb.) Mirb., *Prunus africana* (Hook.f.)Kalkm., *Hagenia abyssinica (Bruce) J.F. Gmel.*, and *Croton macrostachyus*Hochst. exDelile. Other important exotic tree species, such as *Eucalyptus globules Labill*, *Eucalyptus camaldulesis* Dehnh., *Cupressus Lusitania Mill* are also found in the study area that are now replacing the demands of wood for various purposes.

The total population of Jimma Geneti district is 93,711, out of which 49.47 % (46,356) are male and 50.53 %(47,355) are female. The rural population size is 82,563 (88 %), indicating that only 12 % of the total population live in towns (JGDANRO, 2018). Hence, it may be inferred that the district is a densely populated area with 194 persons per sq.km.

2.2. Data sources and acquisition method

2.2.1. Satellite data acquisition method

Globally, satellite images are playing a vital role in monitoring spatial and temporal landscape change (Siraj et al., 2018). To study trends of LULC dynamics, a total of five satellite images for the years 1973, 1987, 1995, 2010 and 2019 were downloaded from Earth Explorer (EE) Geospace of the United States Geological Survey (USGS). The images downloaded werefor the dry season of the year, due to maximum differentiation of land use elements, such as herbaceous plants, crops and ligneous plants at that period (Djiongo et al., 2019).Moreover, the images were more likely to be cloud free and their spectral properties were less affected by the availability of moisture. Furthermore, a ground truth exercise was carried out in JGDof different LULC types with the aid of global positioning systems (GPS).

2.2.2. Household survey

The data for the drivers of LULC change were collected from 134 household heads selected randomly to participate in in-depth interviews, key informants interview and focus group discussions (FGD). A three stage sampling technique was employed in selecting the district, administration and household respondents, by combining purposive and random sampling, while the household respondents were selected by systematic random sampling. Accordingly, out of 4531 households, 134 were selected (48 households from Gidami Dabsho, 32 from AdilekaTulu Chali Keble, and 54 from Damu Gembo Kebele). Moreover, participants as key informants and FGDs were selected purposively from each sampled (village). One FGD constituted of six to eight members from different social groups (youth, women and elders). Data collected from questioners were coded and categorized into a suitable data entry format using statistical package for social scientists (SPSS) window version 20.0 software and described by using frequency and percentage.

The sample size of the survey study was determined following Kothari (2004).

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

Where n = sample size

Z = 95 confidence limit (interval) under normal curve that is 1.96

P = 0.1(proportion of the population to be included in the sample that is 10 %)

q = none occurrence of event = 1 − 0.1 that is (0.9)

N = Total number of household = 4531

e = margin of error or degree of accuracy (accepted error term) (0.05)

Thus, $n = \frac{1.96^2 * 0.1 * 0.9 * 4531}{0.05^2(4531-1) + 1.96^2 * 0.1 * 0.9} = 134$

2.3. Image preparation and processing

As raw satellite images are affected by systematic and random errors and were, not directly utilized for feature identification and any applications. Therefore, some image corrections were carried out following the methods in the literature (Ayele, 2011). In particular, standard image processing techniques of extraction, layer stacking, radiometric correction, and geometric correction/georeferencing and change detection were performed on the five Landsat images. Further, the satellite images were orthorectified to Universal Transverse Mercator projection using datum WGS(World Geodetic System) 84 zone 37 N, and image were resampled from 57 * 57 cell size to 30 * 30 cell size.

As it has been repeatedly described, in image analysis, ground reference data play an important role to determine information classes, interpret decisions and assess accuracies of results (Thapa and Murayama, 2009). To this end, the data obtained from fieldwork were used for validating LULC interpretation from satellite images and for image classification and for qualitative description of the characteristics of each LULC class. The software ERDAS imagine 14.1 and Arc GIS 10.3

were employed for satellite image processing and LULC change analysis.

ERDAS Imagine Software was also used to perform classification and post classification comparison of change detection, which involves the application of multi-temporal datasets to analyze the changes between consecutive classification years. This is a process of sorting pixels into a finite number of individual classes or categories of data, based on their data file values (Rogan and Chen, 2004). Matrix analysis produces a thematic layer that contains a separate class for every coincidence of classes into two layers and the output is best described with a matrix diagram (ERDAS Field Guide, 1999). The classes of the two input layers represent the rows and columns of the matrix. The output classes were assigned according to the coincidence of any two input classes.

The reconnaissance survey, assisted by information collected from the FGD coupled with interpretation of remotely sensed satellite images was employed. Each satellite image was classified into different LULC classes, using supervised image classification coupled with the maximum likelihood classification algorithm. Ground truth data collection was carried out for collecting absolute location of different land use, for the use as training sites during classification and for accuracy assessment of the classified LULC map of 2019. A total of 180 ground control point (GCPs), 30 for each LULC type, were collected randomly from the study areas. The final images were converted to LULC maps. The temporal and spatial change observed between five classification intervals were statistics computed and presented in three different ways. These are the total LULC in ha, the percentage LULC changes and the rate of change between classification periods (Fig. 2).

3. Result and discussion

3.1. Accuracy assessment

The overall producer's accuracy assessment for the year 2019 was found to be 83 %, with 96 % for cultivated land and 94 % for settlement areas (Table 2).The user's accuracy, which is the percentage of correctly classified data from total classified data, shows 100 % for bare land and 95 % for cultivated land. The overall classification accuracy was 92.2 % with overall kappa statistics of 0.85 which means there is85 % in better agreement than by chance alone. In fact, according to Monserud (2002), the scientifically accepted result for kappa statistics was defined as poor, good and excellent when the kappa coefficient is less than 0.4, between 0.4 and 0.7 and greater than 0.75, respectively (Fig. 3). This proves that the classification was within the excellent range and was in complete agreement with reported values (Pontius, 2000).Therefore, the result of this study shows that there is strong agreement between the classification map and the ground reference information for the kappa coefficient that fall in excellent ranges for all the LULC.

3.2. LULC classes of the study area

Six major types of LULC were identified by using field data and satellite images of the years of 1973, 1987, 1995, 2010 and 2019.These

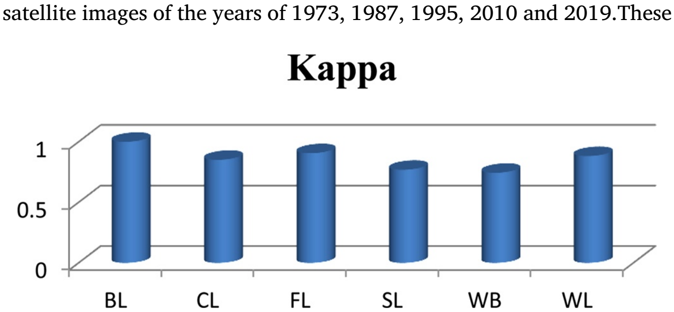

Fig. 2. Conditional kappa coefficient for each LULC changecategory (CL = Cultivation Land, BL = Bare Land and road, FL = Forest Land, SL = Rural Settlements, WB = Water Body and WL = Wet Land).

Table 2
The accuracy level of each land-cover category.

Class Name	2019 In ha	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
BL	551.34	2	2	2	67%	100 %
CL	27708.1	121	121	115	96 %	95 %
FL	5647.23	25	25	23	85 %	92 %
SA	4436.46	19	19	15	94%	79 %
WB	975.87	4	4	3	75 %	75 %
WL	2000.24	9	9	8	80%	89 %
Total	41319.2	180	180	166		

BL = Bare Land, CL = Cultivation Land, FL = Forest Land, SA = Settlement Area, WB = Water Body, WL = Wet Land.

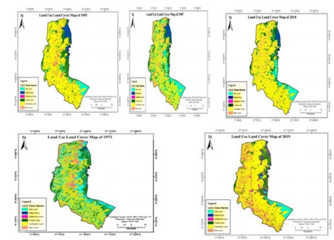

Fig. 3. Map of Land use and cover changes in JGD for the five study periods.

are forestland, cultivated land, settlement areas, water bodies, wetland and bare land. Descriptions of the different LULC categories are shown in Table 1.

To understand the changes occurring within a period of time, temporal analysis approach was carried out. Also, LULC dynamic results were obtained by using combined methods of remote sensing and GIS techniques from Landsat images of the aforementioned years. Statistical summaries of the different LULC dynamics are presented in Table 3. The nature and characteristics of LULC changes are discussed in subsequent sections.

3.2.1. Land Use Land Cover Dynamics from 1973 – 2019

3.2.1.1. Cultivated land (CL). As elsewhere in Ethiopia, the livelihoods of the majority of rural residents of JimmaGeneti District depend heavily on agriculture, crop cultivation being the major one. Consequently, as can be witnessed in Table 3, land that has been used for cultivation is significantly high. Land covered by this category includes areas of land ploughed for growing crops using rainfall or irrigation, which constituted 45.1 % of the total area in 1973. It also covered a significant share in the subsequent years of 1987, 1995, 2010 and2019. That means the land under cultivation increased progressively through the years 1973–2019 at the rate of 197.63ha/year (Table 4).

The highest increment in the percentage of cultivated land (and hence diminishing of wetland and forestland) has been observed between the years of 1987 and 1995, which can be attributed to the spike in small-scale farming (Table 5). The fact that the small-scale farming is carried out by resource-poor farmers can be considered instrumental in exacerbating the depletion of the wetland as well as the forest land.

It is worth mentioning that this finding is in line with prior studies that reported 44 % growth in agriculture and 36.4 % agricultural land increment, respectively, by Shiferaw and Singh (2011) and Siraj et al. (2018). Apparently, in subsistence agriculture, where the use of modern agricultural input is limited or does not exist, increasing yields are achieved by bringing more plots of lands under cultivation and this is exactly what was clearly observed in the study area. It is reported elsewhere that this type of agriculture is inherently ineffective, and therefore, needs larger areas to meet the needs of rural households. For example, earlier studies made in Ethiopia by Emiru and Taye(2012) and Gebre (2003), indicated that much of agricultural expansions targeted

Table 3
LULC changes in hectare and percentagefor the study area 1973 to 2019.

Class name	1973		1987		1995		2010		2019		gain/loss	gain/loss
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	ha	%
BL	2872.1	7	1932.59	4.7	1565.41	3.8	669.3	1.6	551.34	1.3	−2321	−5.7
CL	18,617	45.1	20932.5	51	26715.8	65	26944.8	65	27708.1	67	9091.1	22
FL	8632.5	20.9	6799.35	17	6488.64	16	6169.5	15	5647.23	14	−2985	−7.2
SA	908.7	2.2	951.57	2.3	1622.79	3.9	2554.9	6.2	4436.46	11	3527.8	8.5
WB	369.3	0.9	1306.23	3.2	2181.69	5.3	1368.3	3.3	975.87	2.4	606.57	1.5
WL	9919.5	24	9396.99	23	2744.91	6.6	3612.5	8.7	2000.24	4.8	−7919	−19.2
Total	**41319.2**	100	**41319.2**	100	**41319.2**	100	41,319	100	41,319	100		

marginal and ecologically fragile environments such as forests, wetlands and steep slopes.

Generally, intensive agriculture without proper management and practice has been observed as a common problem of the study area.

3.2.1.2. Bare land (BL). Bare lands have also been transformed into another land use types. In the study area under consideration, it was found that the bare land proportion has shown significant declines over the span of years. Indeed, the data obtained shows a decline of the bare land proportion from 2872.1 ha (7%) in 1973, to 551.34 ha (1.3 %) in 2019 and a progressive decline between the stated years (Table 3).

Computed from the collected data, it can be seen that the bare land has been converted to other land use types at the rate of 50.45ha/year during the study periods of 1973 − 2019 (Table 5).A total of 2320.76 ha bare land was converted to cultivated land or settlement areas between 1973 and 2019 (Table 3), which was attributed mainly to population growth and shortage of arable land in the study area. This result is contrary to the study conducted by Daniel (2008), which indicated an increase in bare land by 24.8 ha/year in the upper Dijo River Catchment, Silte Zone, Southern Ethiopia, Tolessa et al. (2017) from 0 in 973 to (739.08 %) in 2015 and Siraj et al. (2018) by 5.23 ha/yr during the study periods of 1973–2015 both in the central high lands of Ethiopia

3.2.1.3. Forestland (FL). Forestland is one of the major land use classes in the study area, covering about 8632.5 ha (20.9 %) of the total area in 1973 (Table 3). However, it has declined rapidly during the years studied. The land cover share of the forest was 6799.35 ha (16.5 %), 6488.64 ha (15.7 %), 6169.5 ha (14.9 %) and 5647.23 ha (13.7 %) in 1987, 1995, 2010 and 2019, respectively (Table 3). Evidently, these figures clearly indicate that forest cover of the study area has shown a gradual decline between the years of 1973–2019 at the rate of 64.9 ha/year (Table 4). This is in line with studies of Siraj et al. (2018); Alemu et al. (2015), and Assen and Nigussie (2009), which also witnessed changes in the majority of available forest lands to other land use types in Ethiopia

3.2.1.4. Settlement areas (SA). Similar to cultivated land, settlements have also expanded during the study years. The proportion of land under settlement during the different years constitute 908.7 ha (2.2 %), 951.57 ha (2.3 %), 1622.79 ha (3.9 %), 2554.9 ha (6.2 %) and 4436.46 ha (10.7 %) in 1973, 1987, 1995, 2010, and 2019 respectively. A total of 3527.76 ha of land have been converted to settlements between 1973 and 2019 (Table3). This continuous shift of forest land into cultivated and settlement land may be attributed to the rapidly growing demands for plots of lands for cultivations and settlements which, in turn, were directly related to the continuous growth of population in the district.

In this regard, it is also worth indicating that the results of this study are similar to a number other previous studies undertaken in different parts of Ethiopia. For instance, Belayneh et al. (2018) in the north-western highlands, Siraj et al. (2018) and Tolessa et al. (2017) in central highlands of Ethiopia reported similar findings. Sewnet (2016), in Infraz watershed and Bewket (2002) in Chemoga watershed, both in north-western Ethiopia, Desalegn et al. (2014a, 2014b) in Wetabecha Minjaro peasant association, came up with quite similar conclusions. All of these reports asserted that there have been expansions in settlement areas and agricultural lands in their study. The expansion of settlement area to other lands is possibly due to population growth.

Table 5
LULC change in Percentage 1973-2019.

Class Name	LULC in Percentage change(1973 − 2019)				
	1973 − 1987	1987 − 1995	1995 − 2010	2010 − 2019	1973 − 2019
BL	−2.3	−0.9	−2.2	−0.3	−5.7
CL	5.6	14	0.5	1.9	22
FL	−4.4	−0.8	−0.8	−1.3	−7.3
SA	0.1	1.6	2.3	4.6	8.6
WB	2.3	2.1	−2	−0.9	1.5
WL	−1.3	−16.1	2.1	−3.9	−19.2

3.2.1.5. Wetland (WL). The result of the study further revealed a continuous decline in the overall area of wetland with the average rate of 172.6 ha/year from year of 1973–2019. As can be seen in Table 5, the total loss of 19.2 % of wetland area was witnessed during the study period. In addition, based on data obtained from the Landsat image analysis, cultivated lands encroached upon wetland which also include grazing land around the area. Data from focus group discussion, key informant interview and field observation also confirmed that the

Table 4
Rate of change ha/year in the study area.

Class Name	Rate of change in ha/year				
	1973 − 1987	1987 − 1995	1995 − 2010	2010 − 2019	1973 − 2019
Bare Land	−67.11	−45.9	−59.74	−13.11	−50.45
Cultivated Land	165.39	722.91	15.27	84.81	197.63
Forestland	−130.94	−38.84	−21.28	−58.03	−64.9
Settlement Area	3.06	83.90	62.14	209.06	76.69
Water Body	66.92	109.43	−54.23	−43.6	13.19
Wet Land	−37.32	−831.51	57.84	−179.14	−172.16

changes in wetlands have possibly occurred due to agricultural runoff from farmlands and resulted in the reduction of wetland cover in the study district. This study is in line with Belayneh et al., 2018, which also reported a drastic reduction and complete drying up of wetlands in Fagita Lekoma District in Ethiopia

3.2.1.6. Water body (WB). The size of water body increased from 0.9 % in 1973 to 3.2 % in 1987 and further increased to 5.4 % in 1995(Table 3). However, the size of the water body declined by 2.9 % between the years 1995 (5.3 %) to 2019 (2.4 %). The main reason for the increase in the water body in the study area was attributed to the construction of Fincha hydroelectric power dam in 1973 which, in fact, caused major land use changes in the watershed by inundating grazing lands, swamps, forest and agricultural lands.

The result of this study is in agreement with the study of Tefera and Sterk (2008), which reported a total loss of 18 km^2 of cropland due to the creation of the hydropower dam in the watershed area. The backwater flow has reduced the area of good potential farmland. Another study made by Dibaba et al., 2020a, 2020b, reported that the construction of the Fincha Dam in 1973, Amerti Reservoir in 1987 and Neshe Dam in 2012 displacedthe community from their farmland and made the community landless, especially in upper highland parts of the catchment.

Most croplands were situated in relatively flat areas in 1957, however, these areas were affected by the construction of the Fincha dam in 1973 (Tefera and Sterk, 2008), Amerti Reservoir in 1987 and Neshe dam in 2012 (Dibaba et al., 2020a, 2020b).

BL-bare land, CL-cultivated land, FL-forestland, SA-settlement area, WB-water body, WL-wetland.

The result indicated a series of LULC changes over the last 46 years (1973–2019). In this regard, the trend shows a tendency towards more plots of lands being shifted to be used for cultivation and settlement. At the same time, the water body becomes more important. On the contrary, the coverages of bare-lands and wetlands have declined in size as they have been converted to cultivation and settlement areas. This is inline with the findings of Fisseha et al. (2011), and Shiferaw and Singh (2011), which similarly reported significant increments of agricultural lands at the expense of other land uses (Fig. 4).

3.3. LULC change matrix

An important aspect of change detection is to determine what is really changing and to which LULC type, i.e., which land use class is changing to other types of land use class (Agidew and Singh, 2017). This process involves a pixel to pixel comparison of the study year images through overlay analysis (Singh and Singh, 2015). The LULC change matrix depicts the direction of change and the land use type that has not changed (Table 6). Accordingly, from 1973 to 2019, 2069.82 ha (72 %) of bare land was converted to cultivated land and 693 ha (24.15 %) to settlement areas. On the other hand, within the same period, 54.9 % of wetland, representing 5445.92 ha, was converted to cultivated land and 2842 ha (28.65 %) to forestland. This indicates a rapid expansion of cultivated and forestland at the expense of wetland (Fig. 5 and 6). As shown in Table 6, 330.59 ha of water body was converted to agricultural land (Table 6).

In this study, though some areas gained from other LULC classes, shrinkage was also observed in forest cover and bare land over the entire study period. The largest area of change matrix was observed from wetland to cultivated land, as compared to other land uses. The dominant contributors to the decline of forest cover were the conversions of forest land to cultivated land 3608.44 ha (41.8 %), wetlands 965.52 ha (11.18 %) and settlement areas 717.72 ha (8.3 %) as shown in (Table 6). These could possibly be attributed to unsustainable utilisation of forests for agricultural expansion, deforestation and illegal logging of forest products. These were intensified largely due to population pressure during the last decade as is stated under the drivers of LULC change (Fig. 7).

While some parts of the original cultivated land was were lost to other LULC classes, such as settlement area, 1983.87 ha(10.66 %) and it has also expanded, mainly due to area gains from wetlands,5445.92 ha (54.9 %), forest land, 3608.44 ha (41.8 %) and bare land, 2069.82 ha (72 %), as shown in (Table 6). This is largely due to the encroachment of cultivated land into wetland and original natural forest cover, as a result of population pressure.

3.4. Analysis of rate and patterns of LULC dynamics 1973–2019

During the 1973 – 2019 years periods, three land use types had shown an increasing trend; cultivated land (48.83 %), settlement areas

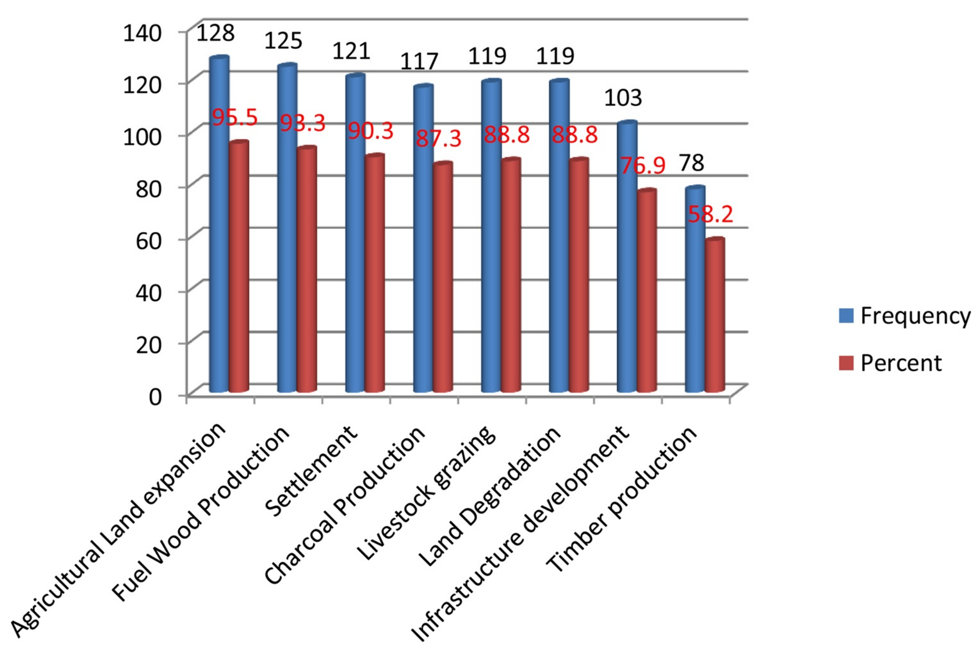

Fig. 4. Direct drivers of LULC dynamics in study area.

Table 6
LULC classes from 1973- 2019.

LULC classes	Changed to	1973 – 2019		LULC classes	Changed to	1973 – 2019	
		Ha	%			Ha	%
Bare land	Bare Land	98.03		Settlement Area	Bare Land	8.89	0.98
	Cultivated Land	2069.82	72		Cultivated Land	2.56	0.28
	Forest Land	0	0		Forest Land	15.75	1.7
	Settlement Area	693	24.15		Settlement Area	875.14	96.3
	Water Body	7.92	0.28		Water Body	6.39	0.7
	Wet Land	2.6			Wet Land	0	0
Cultivated land	Bare Land	324.9	1.75	Water Body	Bare Land	0.27	0.07
	Cultivated land	16250.77	82.3		Cultivated Land	330.59	89.5
	Forest Land	3.28	0.02		Forest Land	0	0
	Settlement Area	1983.87	10.66		Settlement Area	1.6	0.43
	Water Body	16.02	0.9		Water Body	380.20	9.73
	Wet Land	38.16	0.2		Wet Land	0.99	0.27
Forest land	Bare Land	25.56	0.29	Wet land	Bare Land	93.69	0.94
	Cultivated Land	3608.44	41.8		Cultivated Land	5445.92	54.9
	Forest Land	2785.81	32.27		Forest Land	2842	28.65
	Settlement Area	717.72	8.3		Settlement Area	164.36	1.66
	Water Body	529.52	6.13		Water Body	380.2	3.83
	Wet Land	965.55	11.18		Wet Land		

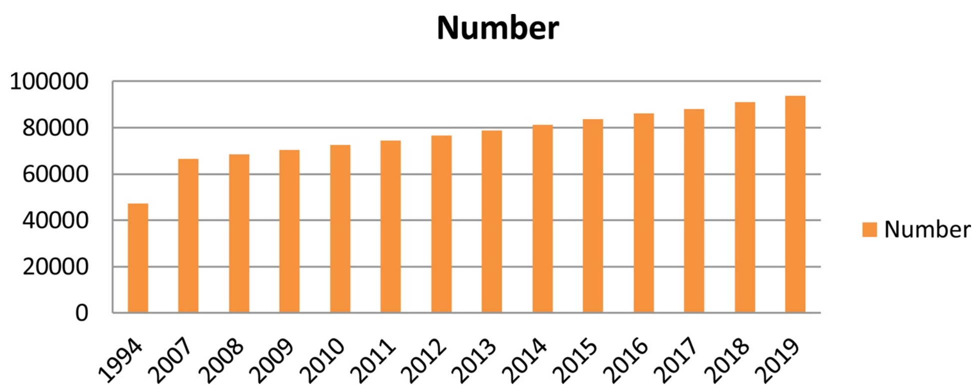

Fig. 5. Population growth in JimmaGeneti District from 1994-2019.

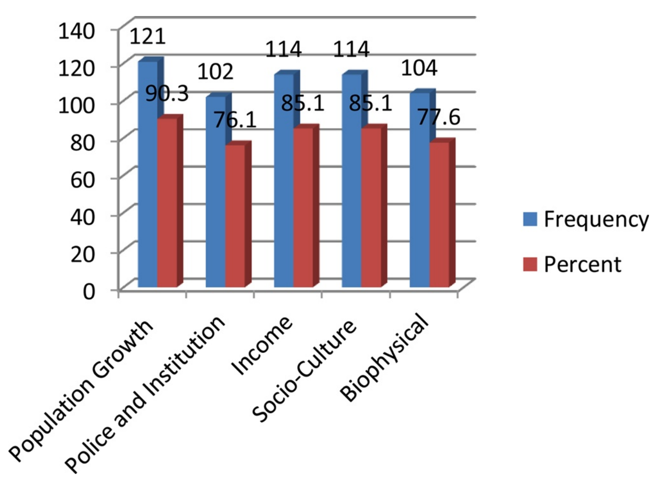

Fig. 6. Underlying Causes of LULC dynamics in the study district.

(38.8 %) and water bodies (164 %). During this period, forest land 2985.27ha (34.6 %), bare land 2320.76 ha (80.8 %) and wetland 7919.26 ha (395.9 %), was lost in the study area. Particularly, the highest amount of wetland coverage accounted for 6652.08ha has been lost during the period 1987–1995. Likewise, the forest ecosystem, which covered1833.15 ha also declined between 1973 – 1987 (Table 3). The change of government in 1991 exposed wetland areas to the expansion of cultivated land, as grazing lands are included in this type of land use. However, water bodies increased during the 1987–1995 period by 67 %, which was mainly attributed to the construction of Amerti Reservoir in 1987.

Regarding LULC change, agricultural land increased annually by 165.39 ha, 722.91 ha, 15.27 ha and 84.81 ha from 1973 – 1987; 1987 – 1995, 1995 – 2010 and 2010 – 2019 respectively (Table 4) and water body also increased during the study periods (1973 – 2019). However, during the periods between1995 – 2010 and 2010 – 2019, agricultural land declined annually by 54.23 ha and 43.6 ha respectively (Table 4). On the contrary, the annual rate of change for forest land, bare land and wetland area increased significantly, except for a wetland which showed increment once by 57.84 ha/year in the study period 1995 to2010. Generally, during the whole study period, 172.16 ha of wetland areas were annually converted into other land use During the study period, settlement areas, cultivated land and water bodies increased by 388.22 %, 48.83 % and 164.25 % respectively, from the original cover, while bare land and forestland decreased by 80.8 % and 34.6 % respectively (Table 3).

Within the 46 years of this study period, bare and forest lands have shown consistent reductions, whereas cultivated lands and forest lands increased at the expense of the aforementioned as well as a wetland, land use types. However, wetlands and water body has shown inconsistencies in changes of their coverages (Table 4 and 5).

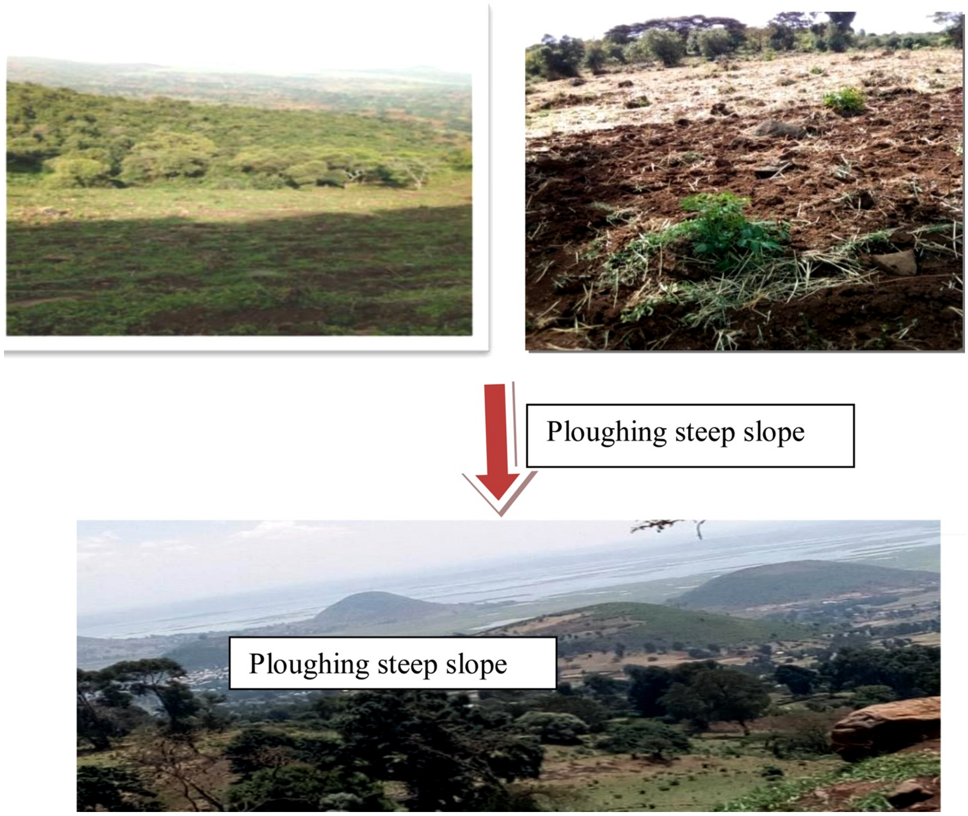

Plate 1. Deforestation and ploughing steep slope for expansion of agriculture in the study district.

3.5. *Drivers of LULC changes*

3.5.1. *Proximate drivers*

From data gathered from the respondents, a total of eight factors were identified as the major direct drivers of LULC dynamics in the study area (Fig. 5).Majority of respondents, (95.5 %) perceived expansion of land for crops cultivation as the main driver of LULC dynamics. This finding corroborates with the findings of deSherbinin et al. (2002) and Molla (2015), who reported the expansion of agricultural land as a major driver of LULC dynamics. Both studies revealed that there is a rapid conversion of forest covered area to agriculutral land.The Landsat image analysis of the study area further showed that out of the total 13225.43 ha of lands that underwent conversions, farmland constituted 68.5 %, indicating that agricultural expansion was an important proximate cause for LULC change in the study area (Plate 1).

The Majority of the respondents also identified firewood collection (93.3 %), house construction/settlement (90 %), land degradation (88.8 %), overgrazing (88.8 %,) and charcoal making (87.3) (Fig. 5), as important direct causes of LULC dynamics. Elders also confirmed this during FGDs. Mideksa (2009) reported similar results at Adaba-Dodola forest priority area, Ethiopia, where firewood and charcoal making was identified as the major causes of forest cover changes. Firewood collection and charcoal making were also found to be the main drivers of LULC in other African countries (Hosonuma et al., 2012) as well as in this study area (Plate 2).

Respondents also viewed overgrazing as an important driver of changes in the study area (Plate 3a & b). Cattle were allowed to graze on remaining crop stalks after harvest on croplands and on communal grazing lands. However, through FGDs and key informant interviews, it was found that existing grazingland is below the carrying capacity of livestock in the area, because of declining grazing land over time. The participants pointed out that cropland and settlement expansions were responsible for the reduction of grazing lands. Accordingly, there were farmers who let their animals forage in remaining forests which participants did not view as sustainable land management.

Cutting of *Cordia africana, Podocarpus falcatus* and *Juniperus procera* for timber trade was (58.2 % of respondents) registered as another prominent factor that threatened the forest cover of the study area. Rapid population growth resulted in huge demands for timber for construction purposes in the surrounding towns and villages, triggering illegal loggings from among communal forests. Through time, depletion of forests (a decline of forest areas) continued triggering the like of timber prices in towns (Plate 3). As acknowledged by the respondents, although the government has put strong regulations in place to prevent illegal logging, such activity is still continuing cutting down of trees for different purposes

Infrastructure developments, such as schools and roads, were also found to have contributed to the decline of grazing lands. Respondents (76.9 %) argued that the expansion of rural and urban settlements was the cause of LULC dynamics in the JGD. Previous studies (for example Geist and Lambin, 2002; Lambin et al., 2003; Geist et al., 2006), also highlight that better market and road infrastructure availability can be a driving force of LULC changes.

3.5.2. *Underlying causes of LULC dynamics*

Most respondents (90.3 %) confirmed that population growth is the most important underlying driver of LULC dynamics (Fig. 6). Similar findings (e.g. Tefera, 2011; Alemu et al., 2015; Gebrelibanos and Assen, 2015; Siraj et al., 2018) were also observed in different parts of Ethiopia.The findings of this study is in line with the studies of (Zeleke and Hurni, 2001; Bewket, 2002; Gashaw et al., 2017; Berihun et al., 2019) claiming human activities as the major drivers of LULC changes in Ethiopia.

The results of the FGDs are also in line with CSA reports showing increments in a total population of the study area. In 1994 the population of the study area was 47,199 (CSA, 2007). In 2019 it had increased to 93,711, with a population density of 194 person/km^2 (CSA,

Plate 2. Firewood extraction in study area.

2019) (Fig. 6). This implies that between 1994 and 2019 the number of people living in the study area had increased by about 46,512 with an annual rate of about 1329 people/year. Accordingly, land cover conditions of Ethiopia had also significantly transformed by the rapidly increasing population pressure and growing livestock population (Dejene, 2003; Hurni et al., 2005). The rapid population growth and the demand for agricultural land and biomass for fuel and construction resulted in forest and wetland encroachment for settlements, new agricultural land and firewood extraction.

Policy and institutional factors were found to be the underlying drivers of LULC dynamics accounting for about 76.1 % of respondents. According to the information obtained from FGDs, the villagization policy called“*Sefera*” where people were clustered into villages during the Derge regime, which means the resettlement policy contributed to the expansion of settlements and agriculture land. National and regional policies on land use and economic development, such as infrastructural expansion (e.g. roads, schools, markets etc.), attaining food self-sufficiency through investment in agriculture are other factors contributing to LULC change. Lack of proper land use plans is another policy related driver of forest and vegetation cover change. It is characterized by the encroachment of vegetated lands especially forest, grazing land and cultivation on steep slopes.

Information obtained from FGDs indicates that manifestations of weak law enforcement in the study area resulted in corruption and delays in decision-making by courts. Participants also said that change in land tenure systems was another policy-related driver of forest and vegetation cover change. During the Derge regime, large areas of forest and grazing land were converted to other land use types, due to change in the land policy from the previous government (Tefera, 2011). Distribution of land and resource among small-scale farmers following the 1975 ‘land to tiller policy’ which means the land and the resources were divided into pieces among peasants or smallholding farmers.

However, the current FDRE government considers the land as public property and land is, therefore, administered by the government (Crewett and Korf, 2008). The land use proclamations of the OromiaRegional State (Proclamation Number 130/2007), where the study area JGDis located stated that rural people have the right to use land indefinitely or to lease/rent land, and transfer the land into their relative. The land policy of the FDRE government looks better in comparison to that of the Derge regime (Tefera, 2011), as the land of farmers will not be distributed to others. In the study area, however, as it was discussed in the FGDs, farmers still lack confidence and feel that they have no right over their land. This further motivated rural households to encroach into vegetated lands for cropping, grazing and settlement causing deforestation and land degradation.

Poverty, unemployment, lack of off-farm jobs (especially among the landless and educated youth), and change in rural economic activities are the main economic causes of LULC dynamics in the study area. About 85.1 % of respondents and FGD participants stated that the major underlying economic factors behind the expansion of agricultural land are illegal logging, charcoal making and firewood extraction. Due to lack of off-farm employment opportunities, adults in the study area who remain are unemployed. This results in land fragmentation as land is shared within families and encroachment of forest areas in search of new land for cultivation and firewood take place. Hence, economically poor and landless households are engaged in logging in the form of charcoal and firewood to be able to provide for their families. World Commission on Environment and Development points out that people

Plate 3. a) Degraded communal grazing land over time.
b) Grazing land converted to settlement areas.

who are poor and hungry devastate their immediate environment in order to survive (Belay, 1995) and this clearly indicates the role played by poverty in environmental change.

Socio-cultural factors were found to be an important underlying driving force of LULC change by 85.1 % of respondents. Lack of awareness about the negative impacts of forest conversion, distribution of land and other resources are the socio-cultural causes for the expansion of agricultural lands at the expense of other LULC types, mainly wetland and forests.

The main limitationIt of this study include shortage of time and small finical support to collect ground truth for verification, gather information from respondents on drivers of LULC changes and interpretation and the difficult of classification of images due to similarity of spectral signature of features in mapping urban land use land cover changes

4. Conclusion and recommendation

This study has analyzed the dynamics of land use and land cover and explored the drivers over the past 46 years (1973 − 2019) in the study area. Analyses of LULC dynamics over four decades using GIS and remote sensing tools produced six types of LULC categories. Land use classes experienced prominent land cover dynamics during the study period. Quantitative spatio-temporal evidence produced through interpretations of satellite images showed that the study area has undergone significant LULC change since 1973.

The LULC types were affected both positively and negatively in the last 46 years. The pattern of the LULC change in different categories showed variation during the five periods considered (1973–1987, 1987–1995, 1995–2010, 2010–2019 and 1973–2019). In 1973, most of the study areas were covered by cultivated land, wetland and forestland, but in the last four decades cultivated land and settlement areas have shown remarkable expansions. On the other hand, the bare land area declined by 2320.76 ha (5.62 %) from its original size.

LULC dynamics in the study area were attributed to a combination of drivers (proximate and underlying causes), i.e. the proximate causes include agricultural expansion, particularly small scale farming, wood extraction for firewood and charcoal making, construction of infrastructure (for example schools, roads), overgrazing and expansion of rural and urban settlements, whereas population pressure, policy and institutions, poverty, lack of awareness and biophysical factors were claimed as major underlying drivers of LULC change.

Results of this study could help decision making bodies as it provides information that supports to take measures involving integrated land use planning and management and future developments.

Authors' statements

All authors share the contributions to this Manuscript. The fieldwork for data collection was carried out by Aleminsh Hailu. Data analysis and manuscript preparation, editions were carried out by all authors.

Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.105011.

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