Land Use/land cover Dynamics, its driving forces and impacts on ecosystem services in Jimma Rare District, North-Western Ethiopia

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Abstract

Land use/cover (LULC) change is one of the most important environmental phenomena that have affected the earths' systems and its ecosystem services. Hence, this study was conducted with the main objective of assessing LULC change, its drivers andimpactson ecosystem services in Jimma Rare district for the year 1974–2019. In order to understand the spatial and temporal changes of LULC and its drivers four satellite images for the year1974, 1991, 2005 and 2019 were obtained and respondent interviews, focus group discussions (FGD) and field observations were employed. Moreover, the ecosystem service value coefficients developed at a global level were used to assess the impacts of LULC on ecosystem service provision of the study area. The results of the study revealed that grass land and forest land decreased from 4518.87ha (13.09%) to 902.42ha (2.61%) and 3287.79ha (9.52%) to 2506.63ha (7.26%) from 1974-2019 respectively. Similarly, wetland declined from1182.08ha (3.42%) to 562.37ha (1.63%) in the stated period.The greatest expansion of cultivated land and settlement area occurred during the year 1974-1991. Agricultural expansion, deforestation, overgrazing and expansion of rural and urban settlement were among the major proximate causes. Likewise, the major underlying drivers of LULC dynamics include population increase, the presence of weak policy and institutions, poverty and lack of awareness were identified by respondents and focus group discussants. The total natural capital value reduced from 662.75 (million $/ha/yr) to 577.03 (million $/ha/yr) in the study period indicating the impacts of LULC on ecosystem services. From this study, it is possible to conclude that Jimma Rare District has experienced a significant change in LULC and ecosystem service values over the past 45 years. Hence, appropriate policy packages of land use are required to curb the negative impacts of such changes in the study district in the provision of the required services for sustainable development.

Keywords: Ecosystem service values; Land cover change; Proximate causes; Underlying causes

1 Introduction

Land is the major natural resource on which social, economic, infrastructure and other human activities are embarked and play a vital role in shaping the rural livelihoods ([1]. Land use changes modify land cover due to human interferences through settlement, cultivation, infrastructure, transportation, mining, manufacturing, fishing and recreation ([2]. Land use refers to the purposes for which humans make use to modify or convert the land and its resources [3, 4], whereas, land cover, designates the physical features of Earth's surface [5,6]. The understanding of the LULC relationship is associated with the causes and consequences of LULC change [7], hence the change in land cover guide to the change in land use **[3].**

LULC change elucidation and conceptualization contribute to intricate dynamics of land cover and is also significant for policy and planning actions [8-9]. The major factors causing land use changes are both natural and socioeconomic [10]. LULC is the most major form of worldwide environmental modification arising at spatial and temporal scales.

LULC change is a global occurrence which is as old as human activity [3] and caused primarily by anthropogenic factors but natural processes are also occurring at varying degrees through landscapes [11], having a significant impact on the environment [12]. LULC changes have become vital constituents of global environmental change and denote the impact of human activity [13], recently LULC change become a key research priority for national and international research programs investigating natural resources and environmental change (13-17]. LULC information is essential for policy making, business, and administrative purposes [18].

The convertinon of forest land to cropland, pasture, urban area, reservoirs, and other anthropogenic landscapes represents the form of human impact on the environment [19-20]. and in particular, agriculture covers roughly 40% of earth's land surface, and 85% has some level of anthropogenic influence [21]. For that reason, large-scale land cover change is largely a rural phenomenon, but many of its drivers can be traced to the consumption demands of the growth of the urban population [22]. Deforestation, wetland drainage, and grassland degradation have all amounted to a globally major adjustment of the land cover changes. Large scale environmental phenomena like land degradation and desertification, biodiversity loss, habitat destruction, and species transfer are consequences of land use by converting natural land cover [23].

In addition, ecosystem services valuation has become a common practice in assessing the impacts of LULC changes on the flow of these services which affect the benefits human beings obtain from the ecosystem [24-26]. Ecosystem service studies have gained popularity due to the growing concern over environmental resource degradation by anthropogenic related activities and the recognition of the benefits that are obtained from nature in the form of ecosystem services which were not taken into account those benefits in production and consumption. Nowadays, production and the consumption sector of the economy is highly growing in response to population increase and changes in the consumption behavior of communities. These sectors of the economy are dependent on the well-functioning of ecosystems. Hence, studies on ecosystem service valuation are used to provide the trends in the changes of the values over spatial and temporal scales as well as to indicate any policy path to be taken.

In this study a benefit transfer method is used to assess the changes in ESVs in relation to change in LULC over spatial and temporal scales [27-28]. Benefit transfer is a mechanism of ecosystem service valuation based on the use of existing data in setting other than for what it was originally collected and such type of data are transferred to a new environmental condition with similar condition [27].

Studies on the effects of LULC on ESV is growing very rapidly in recent years due to the important of these values to human well-being across different parts of the world with significant proportions in developed countries [29] and in countries with economic transition [30, 31]. Yet few studies were conducted across African continent despite the importance of assessment of ecosystem service to which the majority of populations highly depend on primary products from environmental resources [32]. In Ethiopia, studies on ESVs started recently and very few studies were conducted despite the diversity of the Ethiopian landscape, its biodiversity and the dependency of communities on ecosystems for their livelihood [33]. To this end, this study was designed with the objectives of addressing the impacts of LULC change on ESVs in Jimma Rare District (JRD), North-western Ethiopia. Xie

Developing countries the likes of Ethiopia are highly depend on land as the most important natural resource, where their economy depends upon the agricultural sector. Development activities carried out in these countries use and alter the existing physical and biological land resources; often giving rise to changes in LULC. At times such modifications have been beneficial; while at other times they have had negative and adverse impacts on the environment and people's daily livelihoods [34].

Studies in different parts of Ethiopia showed that land under cultivation had increased significantly at the expense of shrubland, woodlands, and forestlands, especially on steep slopes, and in marginal areas [2,20, 35-38]. LULC change is a rising threat to the resilience of socio-ecological systems, since it is often connected with land degradation [39].
In Ethiopia, different studies reported several factors that are affecting LULC changes including population growth, firewood collection, overgrazing, policy and institutional factors, resettlement programs and increasing agricultural expansion [2, 20, 40-41], however, the main driving force identified as the major cause in LULC change is population growth which is also contributing to natural resource degradation [42].

In Oromia Regional State of Ethiopia, there have been some attempts made to study the LULC change [43-44, 20,24] in central highlands of Ethiopia, [42], Jimma zone; [41] and [45], in East Wollega as well as LULC impacts on ecosystem services [46 48]; however, there is a few studies made in Horo Gudru Wollega zone to assess LULC change, [49] and [50] in Fincha district, and [2] in Jimma Geneti district, which is a neighboring district to the current study area. Yet information on changes in LULC patterns and their drivers that were not addressed is limited in the study area. Similarly, the change in ecosystem services as a result of LULC change is not studied. Hence, this study is conducted to detect, quantify and map the LULC dynamics, and investigate the drivers of LULC changes as well as the impacts of changes on ecosystem services in Jimma Rare district.

2 Material and Methods

2.1 Description of the Study Area

Jimma Rare district is located in Western Oromia, HoroGuduruWollega Zone, Ethiopia (figure 1). The district is bounded by Choman Guduru district in the north, JimmaGeneti district in the west, Bakko-Tibe district in the South West, Cheliya district in South and Midakegni in the East.The district covers a total area of 34,518.53ha. It is geographically located at 09^{0}13'48.5"N and 037^{0}21'32.3''E at245km from Addis Ababa.

According to the Ethiopian Agro-ecological zone classification system, the district is classified as *Woina Dega* (subtropical) which covers 72% and the remaining 28% is *Dega* (tropical) [51]. The altitude of the district ranges from 1547 to 2846 m.a.s.l. Since, it is found in the highland and subtropical parts of Ethiopia, the district is suitable to grow various crops. The two agro-ecological zones practice mixed farming which involves crop cultivation and livestock production system. The district is endowed with different types of vegetation in response to the variation in soil, climate and human activities.

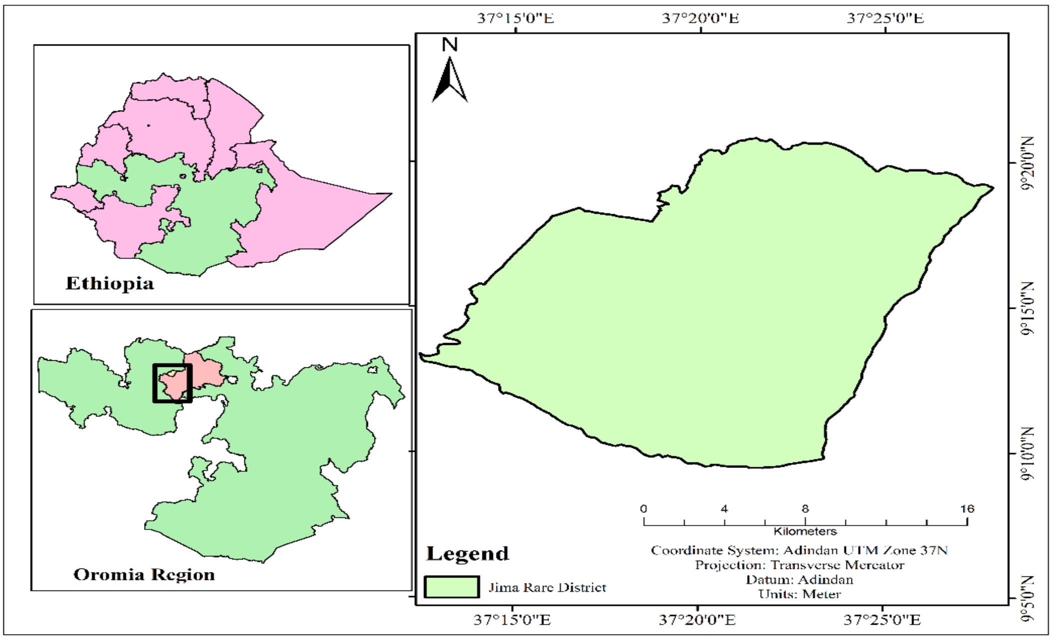

Figure 1: Map of the Study Area

Some of the major indigenous and exotic trees/shrub species in the district includes *Cordia africana*, *Ficus sur*, *Podocarpusfalcatus*, *Prunus africana*(Hook.f.) Kalkm), *Hagenia abyssinica* (Bruce) J.F. Gme l), *Croton macrostachyus*, *Eucalyptus globules*, *Eucalyptus camaldulesis*, *Cupressus lustanica*, *Grevillea robusta*.

The projected population of the district for the year 2019 was estimated to be 80,437 out of which 40,836 (50.8%) are male and 39,601 (49.2%) are female(CSA, 2007). This indicates that the population density in the study district is relatively high and small units of land are extensively cultivated by subsistence farmers. Of these total populations, 85.7% of them are living in rural area, and 14.3% lives in urban and their income depended on Agriculture. Jimma Rare district is one of the densely populated areas with 233 personssq^2/km^2 [51]. This created the problem of deforestation and intensive-cultivation including farming on sloppy land that aggravated deforestation.

2.2 Data Sources and Acquisition Method

To asses trends of LULC change four satellite images (table 1)were downloaded,during the dry season of the year, because the images were more likely to be cloud free and their spectral properties were less affected by the availability of moisture from USGS [52]. 250 GCPs were taken for training and for the different LULC types with the aid of Global Positioning System.

Table1: Satellite image, period, Path and Row, and resolution

No	Land Sat Satellite / Period	Path and Row / Resolution
1	Land Sat MSS / 1974	182/54 / Resampled to 30*30
2	Land Sat TM / 1991	169/54 / 30*30
3	Land Sat ETM+/2005	169/54 / 30*30
4	Land Sat OLT / 2019	169 / 54 / 30*30

Major LULC types were also identified by discussion with local community and development agents coupled with field observation and satellite images analysis. To understand the changes occurred within a period of time an approach of temporal analysis for change detection was carried out. The LULC change maps of Jimma Rare district for four reference years (1974, 1991, 2005 and 2019) and statistical summaries of the different LULC dynamics types were presented. LULC dynamics results were obtained through combined methods of remote sensing and GIS techniques from Land sat images. Potential land use and land cover type observed and identified in the study area was defined. In the study area there are four types of land use types (table2)

Table 2: LULC Class Description

Class Name	**LULC Description**
Forest Land (FL)	Land covered with dense trees which include evergreen Forest land, mixed forest and plantation forests.
Grass Land (GL)	The land around the wet land where cattle feed on it whether summer or winter seasons / throughout the year.
Settlement Area (SA)	Areas occupied by urban and rural residential houses and other buildings
Wetland (WL)	Areas that are waterlogged and swampy during the wet season and relatively dry during the dry season

2.3 Image Processing and Data Analysis

The pre-processing of satellite images before the change detection phenomenon is very vital in order to create a more direct association between the acquired data and the biophysical phenomena [53]. Image pre-processing involves management and analysis of digital images which may be affected by systematic and random errors and was not be directly utilized for features identification and any applications and it needed some correction [54]. Therefore, standard image processing techniques of extraction, layer stacking, radiometric correction, and geometric correction/geo referencing and change detection were performed on the images for the four reference periods.

In image interpretation, ground reference data play an important role to determine information classes, interpreting decisions, and assessing accuracies of the results [55].The data obtained from the field was used for validating LULC change interpretation from the satellite image, for image classification, and for qualitative description of the characteristics of each LULC type. The software ERDAS visualize 14.1 and Arc GIS 10.4 are employed for satellite image processing and LULC change analysis including mapping tools.

In order to clearly identify the type and size of LULC change as well as to acquire a general understanding of the land pattern in the study area from the multi-spectral and temporal satellite images, a reconnaissance survey was carried out in March 2020. A field survey assisted by information collected from the FGD was conducted to reveal the history of land use land cover in the classification periods which was later coupled with the interpretation of remotely sensed satellite images. Ground truth data collection was carried out for collecting fixed locations of different LULC and used them as guidance sites during classification and for accuracy assessment of the classified LULC change map of the 2019 classification year. A total 250 of GCPs were collected randomly from the study area taking into consideration area proportion for different LULC change types. LULC change statistics are computed using the following methods (equ. 1 & 2).

LULC Change in hectare is calculated by:

Total LULC change = Area Final Year - Area Initial Year ………………………... (1)

Where, Area is extent of each LULC type. Positive values suggest an increase whereas the negative values imply a decrease in extent.

Percentage LULC changes calculated using the following equation:

$$\textbf{Percentage of LULC change} = \frac{\text{Area Final Year} - \text{Area Initial Year} * 100}{\text{AreaInitialYear}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(2)}$$

Where, Area is extent of each LULC type. Positive values suggest an increase whereas negative values imply a decrease in extent.

Rate of LULC: computed using the following simple formula (equ.3)

$$\mathbf{r} = \frac{(\mathbf{Q1-Q2})}{\mathbf{t}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(3)}$$

Where, r, Q2, Q1 and t indicates rate of change, recent year LULC in ha, initial year LULC in ha and interval year between initial and recent year correspondingly.

2.4 Accuracy Assessment

Accuracy assessment is essential for individual classification, if the classification data is to be useful in change detection [56]. The accuracy assessment measures what numbers of ground truth pixels were classified properly. Accuracy assessment was very important for understanding the classification results and employing these results for decision-making [57].

In this study, the classification accuracy for the recent LULC maps was carried out using GCPs from field observations as the major sources of reference data and set of reference points. These GCPs were collected in the dry season to remove any sort of incongruity in vegetation reflectance behavior. Producer accuracy gives how well a certain area can be classified. The result of an accuracy assessment delivers an overall accuracy of the map based on an average of the accuracies for each class in the map [58]. The following equation indicates how accuracy assessments are carried out (Equ. 4, 5, 6 & 7)

$$\text{Overall Accuracy} = \frac{\text{Total number of correctly classified pixels (diagonal)}}{\text{Total number of reference pixel}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

$$\text{User Accuracy} = \frac{\text{Number of correctly classified pixels in each category}}{\text{Total number of classified pixel in that category (raw total)}} * 100 \ldots\ldots\ldots\ldots\ldots .5$$

$$\text{Producer Accuracy} = \frac{\text{Number of correctly classified pixels in each category}}{\text{Total number of classified pixels in that category (column total)}} * 100 \ldots\ldots\ldots\ldots\ldots 6$$

$$\text{Kappa coefficient (T)} = \frac{(\text{Total sample} \times \text{Total corrected sample})\text{-}\sum (\text{Column} \times \text{Row total})}{\text{Total sample2} - \sum (\text{Column} \times \text{Row total})} * 100 \ldots\ldots .7$$

2.5. Proximate and underlying driving forces of LULC change

Through social survey, local community views about LULC change trends and priorities were evaluated. A total of 178 respondents were randomly selected from the district. Nine Key informant interviews (KII) and three focus group discussions (FGD) were conducted. Household interviews, KII and FGD questions were constructed with both open-ended and closed ended questions. The questions addressed issues related to proximate and underlying causes of LULC change.

2.6. Ecosystem service valuation

The outputs from LULC analysis and global data sets developed for different biomes were used to assess the trends in ecosystem service values of the study district and period. The global ecosystem service valuation database (ESVD) was developed using over 1300 data points from 267 case studies on the monetary values of ecosystem services across all biomes to reduce uncertainties of the previous studies [59-60]. The recently updated global ESVD (Table 3) and the value transfer valuation method were used to estimate the changes in ESVs in response to LULC changes in the study area.

The selection of most representative biomes used as a proxy for each LULC class is summarized in Table 3. The equation described by [24, 26] was used to estimate ESVs from each LULC class and the total ESVs of the entire district. In addition, the values of the individual ecosystem services (i.e., provisioning, regulating, supporting and cultural ecosystem services) were estimated using the equation described. The updated coefficients given by [59] that were used in this study are shown in Table 3. The percent change of ESVs across different periods (1974–1991, 1991–2005, 2005–2019) was calculated using the equation described in [24, 26]

$$\mathbf{ESV}=\sum(\boldsymbol{A_K}\,\boldsymbol{XVC_k}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Where ESV is the estimated ecosystem service value, A_K is the area (ha) and VC_k the value coefficient (US $\$ha^{-1}yr^{-1}$) for LULC category k. The change in ecosystem service value was estimated by calculating the differences between the estimated values for each LULC category in 1974, 1991, 2005 and 2019.

In addition to estimating LULC change effects on the total value of ecosystem services, we also estimated the impacts of such changes on 16 individual ecosystem services(de Groot et al., 2020) in the study landscape (Table 4). The values of services provided by individual ecosystem were calculated using the following equation [24, 61].

$$\mathbf{ESV_f}=\sum(\boldsymbol{A_K}\,\boldsymbol{XVC_{fk}}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where ESV_f is the estimated ecosystem service value of function f, A_k is the area (ha) and VC_{fk} the value coefficient of function f (US \$ $ha^{-1}yr^{-1}$) for LULC category *k*.

$$Percentof\ VC\ change = \left(\frac{VC_{recent\ year} - VC_{previousyear}}{VC_{total}}\right) * 100 \quad \ldots\ldots\ldots\ldots\ldots \quad (10)$$

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2.7. Elasticity of ESV change in relation to LULC

$$CS_{t,i} = \frac{VC_{t,i} * A_{t,i}}{NCV_t} \quad (11)$$

Where, NCV is the total natural capital value (US$ year-1) of all ESs from all LULC classes at t year (US$ year-1), VC_t, i is the total value of ESs provided by the i LULC class at t year (US$ year-1) and A_t, i is the area coverage (ha) of the i LULC class at t year.

Table 3 LULC categories, corresponding equivalent biomes and ESV coefficients

LULC category	Equivalent biome	Total ecosystem service value coefficient (2020 USD ha^{-1} yr^{-1})
Cultivated land	Cultivated areas	8026
Grass land	Grass land	1597
Forest land	Tropical forests	119,076
Settlement area	Urban green-blue	11,759
Wetland	Inland wetlands	48,647

Data obtained from [59]

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Table 4 Land uses and the corresponding individual Ecosystem service values (USD$million/ha/yr)

Individual Ecosystem services	Land uses				
	Cultivated land	Grass land	Forest land	Settlement area	Wetland
Food	510		602		6030
Water	604	313	47,869		1934
Raw materials	6	637	11,739		1682
Genetic resources			16		60
Medicinal resources			3		
Ornamental resources					
Air quality regulation	10	8	309	9416	34
Climate regulation	10	73	658	1722	150
Moderation of extreme events	993		108		13320
Regulation of water flows	17	43	442	620	3638
Waste treatment	40		12		2043
Erosion control	173		604		
Maintenance of soil fertility	34		42		
Pollination	1498		877		
Biological control	624		14		
Maintenance of life cycles of migratory species			19		1886
Maintenance of genetic diversity			7		3427
Aesthetic information	395				49
Opportunities for recreation &tourism	3101	92	52,789		2662
Inspiration for culture, art& design	16	284	5		114
Spiritual experience					1
Information for cognitive development		147			120
Existence & bequest values			2960		11,498

Total		**8,026**	**1,597**	**119,076**	**11,759**	**48,647**

Data obtained from [59]

3 Result and Discussion

3.1 Accuracy Assessment

Accurate information on LULC changes and the forces and processes behind them is essential for designing sound environmental policies and management [19]. The Producer's accuracy assessment was 96.77% for Cultivation land and 100% for Forest land (Table 5). While Users' accuracy was the percentage of correctly classified from total classified showed 94.49% for Cultivation land and 80% for Settlement area LULC types and the overall classification accuracy was 91.33%. The overall kappa statistics was 0.7041 there is 70.41 % better agreement than by chance alone (Table 5).

Acceptable classification result for the kappa statistics defined as poor when the kappa coefficient is less than 0.4; good when it was between 0.4 and 0.7 and it will be taken as admirable when the kappa coefficient is greater than 0.75 [62]. This finding showed strong agreement existed between the classification map and ground truth indicating kappa coefficient ranges of all the LULC change classes were very good (Table 5).

Table 5: The accuracy level and Conditional kappa coefficient of each LULC category

No	LULC Name	Area (ha)	GCP	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy	Kappa coefficient
1	CL	29313.9	127	124	127	120	96.77%	94.49%	0.682
2	GL	902.42	4	6	4	3	50.00%	75.00%	0.712
3	FL	2506.63	11	8	11	8	100.00%	72.73%	0.740
4	SA	1233.21	5	7	5	4	57.14%	80.00%	0.790
5	WL	562.37	3	5	3	2	40.00%	66.67%	0.655
Total		34518.53	150	150	150	137			

Overall Classification Accuracy =91.33% / Overall Kappa Statistics = 0.7041

CL: Cultivated Land, GL: Grass Land, FL: Forest Land, SA: Settlement Area, and WL: Wetland

3.2 Analysis of LULCChange from 1974–2019

During the study periods (1974 to 2019) two land use types namely, cultivation land (84.92 %) and settlement area (3.57 %) showed a significant increment (Table 6). In contrast, three land use types namely forest land reduced by 3287.79 ha (9.52%), grass land by 4518.78ha (13.09%) and wetland 1182.08ha (3.42%). The highest amount of grassland (2147.09 ha), forest land (776.21 ha) and wetland (325.19ha) lost during1974-1991 the period (Table 5). Especially the change in government in 1991 has exposed the grassland, forest land and wetland areas for expansion of cultivation land. This result is in line with report of [63] and [64], who reported a significant increase in agricultural land at the expense of forest lands. Speedy decline of the area under forest cover and increase in the area under agricultural land is also documented in the studies conducted in dry and semi-dry land parts of Ethiopia [2; 20, 24, 65-68]

Cultivation Land (CL): As reported by many studies the major part of rural communities of the district get their livelihoods from agricultural production. Mostly crop cultivation is a major economic activity and the dominating land use in the district. This study indicated that a huge amount of land has been brought under cultivation (Table 6 and Figure 2). The land covered by cultivation land included areas of land ploughed for growing rain fed or irrigated crops, it covered 72.42% of the total area of the study area in 1974. Similarly, the extent and its proportional share in the years 1991, 2005 and 2019 were recorded to be, 80.53 %, 82.02 % and 84.92 % respectively. CL has shown increasing trends from 1974 to 2019(Table 6 and Figure 2).

In subsistence agriculture, where agricultural input is meager, yield increases are achieved by bringing more land under cultivation. Subsistence agriculture is naturally unsuccessful therefore; huge areas of land are needed to meet the needs of rural households [44]. As earlier studies indicated, much of the agricultural land expansion targets marginal and ecologically fragile environments such as forests, wetlands, grassland and steep slopes when land suitable for cultivation is exhausted [20, 24, 69]. The expansion of cultivated land to steep land causes further land degradation. This is in line with the study of [20], who reported the expansion of agricultural land to the Chilimo forest and slope areas of the mountain areas in the Dendi district.

Table 6: LULC change classes in the Study Area from 1974-2019

Class Name	1974		1991		2005		2019	
	ha	%	ha	%	ha	%	ha	%
CL	24999.6	72.42	27799.2	80.53	28312.67	82.02	29313.9	84.92
GL	4518.87	13.09	2371.78	6.87	1524.69	4.42	902.42	2.61
FL	3287.79	9.52	2511.58	7.28	2334.06	6.76	2506.63	7.26
SA	530.19	1.54	979.08	2.84	1143.9	3.31	1233.21	3.57
WL	1182.08	3.42	856.89	2.48	1203.21	3.49	562.37	1.63
Total	34518.53	100	34518.53	100	34518.53	100	34518.53	100

Grass Land (GL): Grassland was transformed into other land use types. The proportion of grassland decreased from 4518.87ha (13.09%) in 1974 to 2371.78ha (6.87%) in 1991, 1524.69ha (4.42%) in 2005 to 902.42ha (2.61%) in 2019 (Table 6). About, 3616.45 ha of this land were converted to cultivation land and settlement area. This study is in agreement with some of the studies in Ethiopia where a significant change of grassland into cultivation land [2, 20, 24, 70]. All these studies reported in their respective found that local communities are converting grassland into cultivation land to satisfy the need of the ever growing population.

Forest Land (FL):FL was the largest LULC class, with the share of 3287.79 ha (9.52 %) of the total area of the study area in 1974 (Table 6). Forest cover has shown a rapid decrease during the entire study period. The land cover share of the forest declined to 2511.58ha (7.28%), 2334.06ha (6.76%) and 2506.63ha (7.26%) in 1991, 2005 and 2019 respectively. As elsewhere in Ethiopia, the forest cover of the study area showed a gradual decrease during the study periods (1974-2019). This has revealed that the majority of available forests have changed into other land use units.The rapid decline of area under forest cover and increase in area under agricultural land is also documented in studies conducted in other parts of Ethiopia [2, 24, 65-68].

Settlement Area (SA): Settlement area also expanded during the study periods.Theproportion of land under settlement constitute530.19ha (1.54%), 979.08ha (2.84%), 1143.9ha (3.31%) and 1233.21ha (3.57%) in 1974, 1991, 2005 and 2019 respectively. A total of 703.02ha of land have been converted to settlement between 1974 and 2019 (Table 6 and Figure 2).

Wetland (WL): Wet land also changed into other land use types. The proportion of wetland decreased from 1182.08ha (3.42%) in 1974, 856.89ha (2.48%) in 1991, 1203.21ha (3.49%) in

2005 and 562.37ha (1.63%) in 2019. About, 619.71 ha of this land were converted to cultivation land in study district which is similar with other findings elsewhere [63-64, 71].. Contrary to this finding [2] found the increment of wetland in their study area due to Fincha dam construction in the lower catchment.

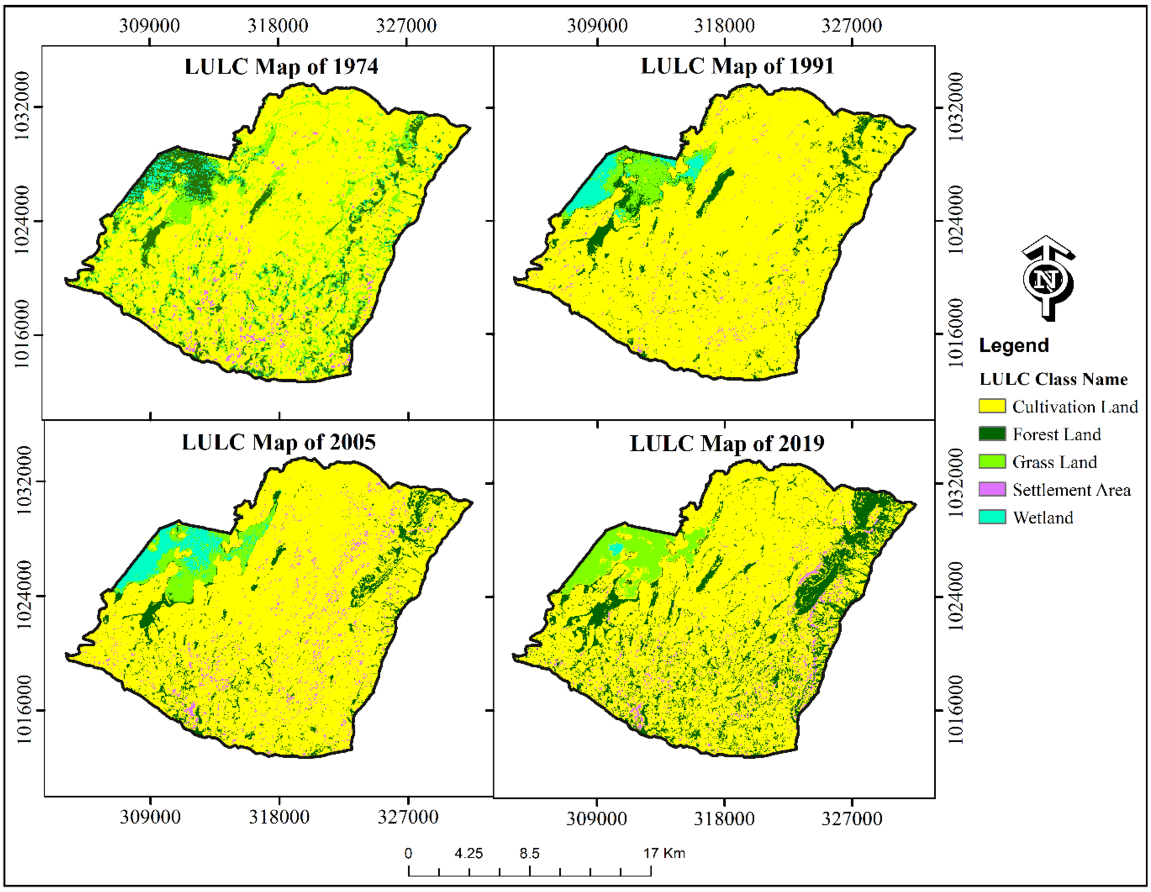

Figure 2: Land Use Land Cover Map of 1974, 1991, 2005 and 2019

Concerning therate of change of LULC, Table 7 indicated that cultivation land increased annually by 2799.6ha, 513.47ha and 1001.23ha during the period, 1974-1991, 1991-2005, and 2005-2019 respectively. Also, settlement area increased for the period of the study (1974-2019). Contrary, the annual rate of forest land, grass land and wetland area decreased. Generally, during the study period (1974-2019), grassland, forestland and wetland area converted into other land use types annually by1205.48ha, 206.57ha and 260.38ha on average respectively (Table7) and settlement area and cultivation land increased by 234.34ha and 1438.1ha respectively.

The decrease in forest cover and increase in agricultural land was also reported in studies conducted in dry and semi-dry land parts of Ethiopia [2;20; 24, 65-68].

Table 7: Rate of change ha/year in the study area

Class Name	**Rate of change in ha/year**			
	1974-1991	1991-2005	2005-2019	1974-2019
CL	2799.6	513.47	1001.23	4314.30
GL	-2147.09	-847.09	-622.27	-3616.45
FL	-776.21	-177.52	-172.57	-781.16
SA	448.89	164.82	89.31	703.02
WL	-325.19	346.32	-640.84	-619.71

3.3 Trends of change in Land Use Land Cover

The result of this study revealed that there is significant LULC change from the forest to cultivation land for the years 1974–12019.As reflection of overall study period, cultivation land and settlement land showedincrease by 12.5% and 2.03% respectively. Contrary to this, Forest land, Grass land and Wetland diminished by 2.26%, 10.48% and 1.79% respectively in this period (Table 8).

In general, the result indicated a dynamic change in LULC for the last 46 years (1974–2019). In this view, the trend has shown a trend towards more land being brought under cultivated land and settlement area. During the study period, more and more land covered with forest, grass and wetlands was transformed to cultivated and settlement areas.

Table 8: LULC change in Percentage 1974-2019

Class Name	LULC change in Percentage change (1974-2019)			
	1974-1991	1991-2005	2005-2019	1974-2019
CL	8.11	1.49	2.90	12.5
GL	-6.22	-2.45	-1.81	-10.48
FL	-2.24	-0.52	0.5	-2.26
SA	1.3	0.47	0.26	2.03
WL	-0.94	1.01	-1.86	-1.79

3.4 LULC Change Matrix

LULC matrix involves a pixel-to-pixel difference of the study year images through overlay analysis; also, it depicts the direction of change and land use type that remains originally. From 1974 to 2019, 2886.96ha (63.89%) of grassland converted to cultivation land, similarly 94.05ha (2.08%) converted to settlement area. On the other hand, from 1974 to 2019, 263.16ha (22.26%) and 6.57ha (0.56%) of wetland was converted to cultivated land and settlement area respectively likewise, from 1974 to 2019, 353.5ha (29.91%) of wet land converted to other land use category (Table 9). This implies the rapid expansion of cultivation land at the cost of wetland. These conversions could also beas a result of processes of natural and manmade factors.

Although some area gain was recorded for cultivation land and settlement areas, decline was also observed in forest cover, grassland and wetland over the study period. The leading contributors for the decline of forest cover was largely due to conversions of into cultivation land 2126.99ha (64.69%), wetland 1.77ha (0.05%) and settlement area 40.5ha (1.23%) as shown in Table8.

These were intensified due to population pressure for the last decade as it is stated under the drivers LULC change. At the same time some portions of the original extent of farming land was simultaneously lost into other LULC classes such as settlement area563.12ha (2.25%).Cultivated land has also been expanded mainly due to the area gained from wet land 263.16ha (22.26%), forest land 2126.99ha (64.69%) and grass land 2886.96ha (63.89%) as shown in Table 9.This is largely associated with encroachment of cultivation land into wetland and natural forest as a result of population pressure. This is related with result of [2, 20, 64], who reported a significant increase of agricultural land at the expense of vegetation cover.

Population pressureresulted in the cutting of trees for firewood and construction of houses and hence has changed land cover and loss of biodiversity. During the study period (1974 – 2019) about 26,666.33 ha (77.25%) of the study area remained unchanged. This imply around 22.75% of the total land of the study area was converted from one LULC type to the other (Table 9).The net perseverance for cultivation land and settlement area was large, while it is closer to zero for the remaining LULC types (Table 9). This indicates that higher tendency of LULC types to continue rather than decline. Thisstudy is in line with the study of [2; 20, 63-64],who reported a significant increase of agricultural land at the expense of grass lands and forests.

Table 9: LULC classes changed to another LULC classes in 1974- 2019

LULC class	Changed to	1974-2019		LULC class	Changed to	1974-2019	
		Ha	%			Ha	%
Cultivation Land	Cultivation Land	24036.21	96.15	Grass Land	Cultivation Land	2886.96	63.89
	Grass Land	276.21	1. 10		Grass land	443.79	9.82
	Forest Land	123.61	0.49		Forest Land	1092.77	24.18
	Settlement Area	563.12	2.25		Settlement Area	94.05	2.08
	Wet Land	0.45	0.002		Wet Land	1.3	0.03
Total		24999.6	100	Total		4518.87	100
Forest Land	Cultivation Land	2126.99	64.69	Settlement Area	Cultivation Land	0.58	0.11
	Grass Land	20.02	0.61		Grass land	0	0
	Forest Land	1098.51	33.41		Forest Land	0.64	0.12
	Settlement Area	40.5	1.23		Settlement Area	528.97	99.77
	Wet Land	1.77	0.05		Wet Land	0	0
Total		3287.79	100			530.19	100
Wet Land	Cultivation Land	263.16	22.26				
	Grass Land	162.4	13.74				
	Forest Land	191.1	16.17				
	Settlement Area	6.57	0.56				
	Wet Land	558.85	47.28				
Total		1182.08	100				

3.5 The major driving forces of LULC dynamics in the study area

LULC changes are governed by a combination of proximate and underlying driving forces [72].The result of this study revealed that in the study area, expansion of cultivated land at the cost of other LULC categories have been major immediate causes for the observed changes. This was also confirmed by the results of focus group discussions and reports from key informants (Table 9).

3.5.1 Direct Drivers of LULC change

Eight drivers were identified by HHs but three of them as being significant direct drivers of LULC dynamics in the study area (Table 9). More of the respondents, 95.5% supposed farm land expansion as the main drivers of LULC dynamics. This is in agreement with the study made by [73], who reported that agricultural expansion is the leading proximate cause for LULC dynamics. As reported from discussion and interview with FGD, expansion of agriculture including crop farming and other cash crops are the major drivers of LULC dynamics in study area (Figure 3).

This finding agreed with [74, 75 76]. They reported that the expansion of agricultural land is the major driver of LULC dynamics. The satellite image analysis of the study area revealed that, of the total 13,225.43 ha of land that undergo conversion, farmland constituted 68.5% indicating that agricultural expansion is important proximate cause for LULC change in the study area.

Figure 3: Deforestation and ploughing of steep slope in Jimma Rare district

According to the investigation and field observation multiple drivers contributed to land cover modification within the study area. Comparable to the remote sensing data results, the results have shown that forest cover and wet landdecreased. The majority of the respondents reported that fuel wood collection, house construction for settlement, land degradation, over grazing and charcoal making, i.e. 93.3%, 90%, 88.8%, 88.8%, and 87.3% respectively, are important direct causes for the observed LULC dynamics in the study area (Table 9; Figure 4 & 5). It was also understood from the explanation of the elder people during the FGDs indicate fuel wood extraction in the form of charcoal and fire wood is also a major driver for the diversion of forest in study area. The result of this study agreed with [69, 77]. They reported the causes for the decline of forest resource is the frequent collection and production of fuel wood and charcoal as being sources of energy (Figure 4) [63], reported similar results in south central high lands of Ethiopia. Fuel wood collection and charcoal production were the main drivers of forests in Ethiopia [74].

Figure 4: Charcoal production and Fuel wood extraction in study area

As indicate in Figure5, land degradation is the driver of LULC dynamics. About 88.3% of the respondents and FGD confirm that land degradation is the driver of LULC dynamics. Because of small land holding size and shortage of land in the study area, farming of steep slopes is contributing to land degradation and this result is similar with [75].

Figure 5: Degraded land (personal Observation, 2020)

Over grazing was also viewed by respondents as one of the important drivers for changes in the study area (figure 6a). Cattle are allowed to graze on the remaining crop stalks on the cultivation land after harvest and on communal grazing lands. However, with detailed discussion among the FGD members, the currently existing grazing land is below the carrying capacity of their livestock, which is associated to declining area of grazing land over time. They pointed out that cultivation land and settlement expansion are responsible for the conversion(Figure 6b). As a result, they confirmed that there are farmers who are sending their cattle to the remaining forests, which they also did not view as a sustainable system (Table 9).

a) 

b) 

Figure 6: a) Degraded communal grazing land over time b) grazing land converted to settlement area..

About 19.1% of respondents responded that timber trade is another prominent problem threatening the forest cover of the study area where inhabitants cut off huge amount of trees (Figure7). Rapid increase of human population demanding huge amount of timbers for construction purpose in the town have also triggered series illegal logging forest. This has been triggered by the general increase in price of the timber in the town. Although the government has put strong rules and regulation on preventing illegal logging people have been still involved in cutting trees in the study area.

What are Proximate Causes of LULCC?	Frequency	Percent
Agricultural land expansion	52	29.2
Deforestation	34	19.1
Settlement	28	15.7
Infrastructure development	12	6.7
Charcoal production	17	9.6
Over grazing	15	8.4
Land degradation	10	5.6
Timber Production	8	4.5
Total	**178**	**100.0**

Table 9: Proximate drivers of LULC dynamics in Jimma Rare

Construction of infrastructure like schools and roads also contributed for the conversion of grazing land. Some 29.2%, 19.1%, 15.7%, of the respondents argued that the Agricultural land expansion, Deforestation and expansion of rural and urban settlement areas were the causes of LULC dynamics in the Jimma Rare (Table 9). Previous studies also highlighted that better market and road infrastructure availability were the driving forces of LULC changes [37, 78]

Figure7. Illegal logging of tree for timber in Jimma Rare Field

3.5.2 Indirect Drivers of LULC change

This study has shown that about 42.13% of respondents confirmed that population growth is the primary underlying drivers of LULC change recognized in the Jimma Rare District. This study is similar with the research result of [20, 74,79]. They indicated that, population pressure is one of the major underlying drivers of LULC change in different parts of Ethiopia.FGD participant supposed that population of Jimma Rare has been increasing from time to time. The insight of respondents is agreement with CSA reports that showed an increase in total population of the study area. In 1994 the total population in the study area was 39,924 [80]. In 2019 it increased to 80,437 with population density of 233 person/ km^2 [81]. This implies that between these two years the number of population in study area increased by about 40,513 with yearly rate of about 1,621 persons / year.

The land cover conditions of the Ethiopia have also been modified or significantly transformed by the rapidly increasing population pressure and growing livestock population [76]. The rapid population growth increases the demand for land for agricultural activities and biomass as the source of fuel and construction materials. This in turn resulted in forest and wetland encroachment for settlement, new agricultural land and fuel wood extraction.

Policy and institutional factors also were found to be underlying drivers of LULC change accounting for about 29.78% responses. Information obtained from FGD indicated that policy during the Derge regime forced people shall be clustered in small towns which were known as “Sefera” and the resettlement policy contributed to expansion of settlements and agricultural land.National and regional policies on land use and economic development such as infrastructural expansion (e.g. roads, schools, markets etc.), attained food self-sufficiency through investment on agriculture are the other factors contributing to LULC change. The presence of weak enforcement of land use plans is another policy related driver of forest and vegetation cover change.It is characterized by encroachment of vegetated land especially forest, wetland and cultivation of steep slope. Weak law enforcement is also crucial driver of LULC change.

Information obtained from FGD indicated that manifestations of weak law enforcements in the study area due to corruption and delay in decision making by the courts further compounded deforestation and land degradation.Participants of the FGD informed that change in land tenure system was another policy related driver of forest and vegetation cover change. In 1973 and subsequent years, in Ethiopia, there was a change in the feudal regime to a military regime [24]. The military regime proclaimed the nationalization of all rural land by abolishing private and common property of the land, thereby giving a usufruct rights for all. This policy made land and land related resources absolutely owned by the state, which in turn was unable to monitor and enforce laws. As a result, forest land was converted to settlements, agricultural land and highly degraded because of low level of land management practices. The Ethiopian People Revolutionary Democratic Front (EPRDF) and the current government

(Prosperity Party), also maintains the same status, where land is the property of the nations, nationalities and people of Ethiopia according to Article 40(3) of the constitution endorsed in 1994 [82]. This makes land related resources to be easily changeable to agricultural land, however in the study area participants of the FGD agreed that farmers are still lacking confidence and feel as they have no right over their land. This joined with a very low land holding per household motivated local farmers to invade in to vegetated lands for cropping, grazing and settlement.

Poverty, unemployment due to lack of off-farm jobs (especially for landless and educated youth) and change in rural economic activities are the economic causes of LULC changes in study area. About 14.61% respondents and focus group discussants stated that these were the major underlying economic factors behind the expansion of agriculture, illegal logging and fuel wood extraction in the form of charcoal and fire wood. Owing to lack of off-farm employment opportunities, adults in study area remain in their area as unemployed. This resulted in land fragmentation due to sharing of lands from their families and encroachment of forest in search of new cultivation land and fuel wood.Hence in the study area those economically poor and landless households were engaged in fuel wood extraction in the form of charcoal and firewood to fulfill the livelihood requirement of their family. To show the role of poverty on environmental change the World Commission on Environment and Development pointed out that people who are poor and hungry always destroy their immediate environment in order to survive [78].

Socio-cultural factors, an important underlying driving force of LULC change, represented by 11.24% of respondents (Table 10). Lack of awareness about the negative impacts of forest conversion, distribution of land and other resource are the socio-cultural causes for the expansion of agricultural lands at the expense of other LULC types mainly wetland, grassland and forest.

Table 10: Underlying Causes of LULC dynamics in Jimma Rare

What are Underlying causes of LULCC?	**Frequency**	**Percent**
Population Growth	75	42.13
Policy and Institution	53	29.78
Income	26	14.61
Socio - Cultural	20	11.24
Bio-Physical	4	2.25
Total	**178**	**100.0**

Biophysical factor such as flood was another underlying driving force of LULC change, identified by 2.25% of respondents and FGD particularly in highland of the district. In summer season, when more rain is arriving, this biophysical factor appeared. Because of this factor the soil fertility and land covered by crops is eroded. As FGD indicates that, at this time more people extract fire wood and charcoal to fulfill their livelihood necessity of their family.

3.6 Ecosystem service valuation

The ecosystem service values across the study period have been reduced by 12.9%. In relation to the changes in ESVs for each land use classes, cultivated land and settlement area showed increasing trendwhile grassland and forest land had shown a reduction (Table 11&12). But, wet land showed fluctuation in the values where it tend to reduce in the first, third and fourth period as well as an increase of the values in the second period (1991-2005). The overall reduction in the vital ecosystem service values are attributed to the reduction in the vital components of the landscape such as grass land, forest land and wet land. This result is similar to the findings of [60] which asserted that the dominant land use with the highest ESVs was cultivated land with an increasing values whereas the highest reduction in overall ESVs were recorded for forest land followed by the reduction in the total ESVs of wet land (30.15%). A general reduction in ESVs was also reported elsewhere in Malawi [83], Central highlands of Ethiopia [24] and Andassa watershed in Ethiopia [25].

Table 11 Total ecosystem service values estimated for each land use and land cover category and changes from 1974 to 2019 in the study area

LULC Class	ESV(US$ million)				ESV(US$ million) change			
	1974	1991	2005	2019	1974-1991	1991-2005	2005-2019	1974-2019
Cultivated land	200.64	223.11	227.23	235.27	22.47(11.10)	4.12(1.84)	8.04(3.53)	34.63 (17.2)
Grass land	7.21	3.78	2.43	1.44	-3.43(-47.57)	-1.35(-35.71)	-0.99(-40.74)	-5.77(-80)
Forest Land	391.49	299.06	277.93	298.47	-92.43(-23.6)	-21.13(-7.06)	20.54(7.39)	-93.02(-23.7)
Settlement Area	5.91	11.51	13.45	14.5	5.6(94.75)	1.94(16.85)	1.05(7.8)	8.59(145.3)
Wetland	57.5	41.83	58.53	27.35	-15.6(-27.25)	16.7(39.92)	-31.18(-53.27)	-30.15(-52.4)
Sum	662.75	579.29	579.57	577.03	-83.46(-12.59)	0.28(0.04)	-2.54(-0.43)	-85.72(-12.9)

Figures in the parenthesis refers to the percentage of change

Table 12.Total ecosystem service values estimated for each land use and land cover category and changes of 1974 and 2019 in the study area

LULC	**ESV(US$ million)**		**Change**	
	Year (1974)	Year (2019)	ESV	CC_k(%)
Cultivated land	200.64	235.27	34.63	5.22
Grass Land	7.21	1.44	-5.77	-0.87
Forest land	391.49	298.47	-93.02	-14.03
Settlement Area	5.91	14.5	8.59	1.29
Wetland land	57.5	27.35	-30.15	-4.54
Sum	662.75	577.03	-85.72	-12.9

Table 13estimated the annual value of each ecosystem services. In terms of the estimated each ecosystem service values, water (US$ 37.12 million /ha/yr), opportunities for recreation and tourism (US$ 29.85 million /ha/yr), raw materials (US$ 12.49 million) and existence and bequest values (US$ 9.44 million/ha/yr) were reduced while some gain in ecosystem service were observed for air quality regulation (US$ 6.62 million /ha/yr) and pollination (US$ 5.78 million /ha/yr) but the overall service were reduced by US$ 85.72 million/ha/yr. Of the twenty two individual ecosystem services identified, the highest loss of ESV was recorded for water with the least losses was for spiritual experience. Similarly, the highest gain of ESV was recorded for air quality regulation and the lowest gain was obtained for medicinal resources indicating the concomitant reduction of important land uses which play a significant role in maintaining the continuous flow of ecosystem services especially regulating and supporting services. The improved global value coefficients are found to be a reliable basis for estimating the changes between the services over spatial and temporal scales for each ecosystem services. Contrary to other findings elsewhere such as [60] ecosystem service for food decreased due to the reduction in wet land in the study area and the corresponding values assigned is found to be highest as compared to other land uses [59].

Table 13. Estimated annual value of each ecosystem services (ESV_f in US $ million per year)

Individual Ecosystem services	Ecosystem services				
	ESV_{f1974}	ESV_{f1991}	ESV_{f2005}	ESV_{f2019}	$ESV_{f1974-2019}$
Food	21.85	20.87	23.09	19.85	-2.00
Water	176.18	139.42	131.63	139.06	-37.12
Raw materials	43.61	32.6	30.56	31.12	-12.49
Genetic resources	0.12	0.09	0.10	0.07	-0.05
Medicinal resources	0.01	0.01	0.01	0.01	0
Ornamental resources	-	-	-	-	-
Air quality regulation	6.08	10.32	11.82	12.7	6.62
Climate regulation	3.78	3.98	4.08	4.21	0.43
Moderation of extreme events	40.92	39.32	44.39	36.87	-4.05
Regulation of water flows	6.68	5.42	6.66	4.45	-2.23
Waste treatment	3.45	2.89	3.61	2.35	-1.1
Erosion control	6.3	6.32	6.30	6.58	0.58
Maintenance of soil fertility	0.98	1.05	1.06	1.10	0.12
Pollination	40.33	43.84	44.45	46.11	5.78
Biological control	15.64	17.38	17.70	18.32	2.68
Maintenance of life cycles of migratory species	2.29	1.66	2.31	1.10	-1.19
Maintenance of genetic diversity	4.07	2.96	4.13	1.94	-2.13
Aesthetic information	9.93	11.03	11.24	11.60	1.67
Opportunities for recreation &tourism	254.64	221.29	214.35	224.8	-29.84
Inspiration for culture, art& design	1.83	1.22	1.03	0.80	-1.03
Spiritual experience	0.001	0.0008	0.001	0.0005	-0.0005
Information for cognitive development	0.80	0.45	0.36	0.20	-0.6
Existence & bequest values	23.32	17.32	20.74	13.88	-9.44
Total	**662.75**	**579.29**	**579.57**	**577.03**	**-85.72**

3.7 Elasticity of ecosystem services valuation

Table 14:Change in total NCV (%) and sensitivity coefficient (CS) after adjusting ESs values by ±50 % in for the years 1974-2019

	1974		1991		2005		2019	
	±%	CS	±%	CS	±%	CS	±%	CS
Cultivated land	3.784	0.0756	5.353	0.1070	5.550	0.1110	5.976	0.1195
Grass land	0.0245	0.0004	0.0077	0.0001	0.0031	0.00006	0.0011	0.00002
Forest land	0.9710	0.0194	0.6483	0.0129	0.5596	0.0111	0.6482	0.0129
Settlement area	0.0022	0.00004	0.0194	0.0001	0.0132	0.0002	0.0154	0.0003
Wet land	0.0512	0.0010	0.0310	0.0006	0.0607	0.0012	0.0133	0.0002

From analysis of elasticity of ecosystem service value changes, it was found that within the study period considered cultivated land dominated the watershed with the highest value of 0.0756, 0.1070, 0.1110 and 0.1195 for 1974, 1991, 2005 and 2019 respectively (Table 14). The least dominant land use was settlement area which indicates its lowest importance in ecosystem service provision due to low size and the importance of other land uses lies within the two values over the study period considered. This implies that the share of cultivated land use in terms of providing ecosystem services is significant followed by forest land and wetland. This value is consistent with other findings across a range of landscapes [26, 84]

4 Conclusion

This study investigated LULC dynamics and their driving forces over the last 46 years during a period of 1974-2019.The results of the study showed that grass and forest lands decreased from 4518.87ha (13.09%) in1974 to 902.42ha (2.61%) and declined from 3287.79ha (9.52%) in 1974 to 2506.63ha (7.26%) in 2019 respectively. The total forest land cleared between 1974 and 2019 amounts to 781.16ha (2.26%). Similarly, wetland declined to 562.37ha (1.63%) in the stated years. In the study area, cultivated lands and settlement area increased from 24999.6ha (72.42%) in 1974 to 29313.9ha (84.92%) in 2019 and 530.19ha (1.54%) in 1974 to 1233.21ha (3.57%) in 2019 respectively. The greatest expansion of cultivated land and settlement area occurred between1974-1991.

The observed conversion of LULC change occurred at the expense of grass land, forest land, and wetland. LULC change in study area was driven by a combination of proximate and underlying causes. Agricultural land expansion, deforestation for fuel wood and charcoal consumption, constructions of infrastructures, overgrazing and expansion of rural and urban settlement were among the major proximate causes. Similarly, major underlying drivers include population pressure, policy and institutions, income, socio-cultural and biophysical factors that drivers of LULC changes were identified by HHs interview and FGD of this study.

In a nutshell analyses of LULC changes over four decades using GIS and remote sensing revealed that there were significant LULC changes in the area during the 1974-2019 reference years. The most important changes were happened in forest land; wet lands and grass land are continuously declining. On the converse, cultivated land and settlement area were main land use types over the study period kept on expanding dramatically. Moreover, the assessments of ESVs have shown a decrease in the overall ESVs by 12.9% in the study area within the study period of 1974-2019. In terms of the individual ecosystem services, there existed diversity of changes in response to LULC change indicating the impacts of human activities not only influencing landscape characteristics but also affecting ecosystem service provision for human well-being. Hence, policy makers and practitioners need to take in to account the impact of land use changes on ecosystem services whenever any policy changes in land use are envisaged for local development purposes.

Conflict of interest

The authors declare no conflict of interest related to this paper.

Consent for publication

The authors have agreed to submit and approved the manuscript for submission.

Ethics approval and consent to participate

Prior oral informed consent was obtained from the local communities as well as from all individual participants.

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