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Land Use, Land Cover Changes and Their Driving Force in Wombera District, Benshangul Gumuz Regional State, Ethiopia

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Abstract: Land use Land cover (LULCC) were analyzed for wombera district along agro-ecological gradients (lower, middle & higher) using a Satellite image of Landsat Mass, Landsat TM, Landsat ETM+, and Landsat OLI/TIRS of 1973, 1986, 2000 and 2016 respectively. After reconnaissance survey and field observations 402 individuals were selected. They were categorized into 6 groups of Key informants interview (KII) and 12 groups Focus Group Discussion (FGD) for structural and open ended questions. One hundred thirty two GPS data were collected using handheld GPS Garmin Global Positioning System for confirmations of accuracy assessment. Five direct and seven indirect driving forces of LULCC were identified for each corresponding agro-ecology gradients for each year. ERDAS version 15, excel, and ArcGIS 10.3.1 used for satellite image calibration and analysis. Maps of Forest, woodland, scrubland, grassland, farmland, water body, and settlement were created. The finding reveals that croplands, settlements, and grasslands are increasing. However, woodland and forest are decreasing from 1973 and 2016. Among the indirect driving forces, Socio-cultural practice and demographics imposed a higher impact in 1970; conversely, institutional setup and technological advancements contribute the highest effect in 2000 &2016. Among the direct or proximate causes, farming activity and fire contribute the highest impact in 1970 in the lower and middle altitude. Farming activities and logging had the highest impact on the higher altitudes during 1970s.

Keywords: LULCC, Landsat, Dndirect Driving Force, Direct Driving Force, Population

1. Introduction

Land use and Land cover is described as the distribution of vegetation, water, desert, ice and the immediate subsurface, including biota, soil, topography, surface, and groundwater [1]. It also includes those structures created solely by human activities such as mine exposures and settlement [2]. However, some authors described, specifically, as an entire landmass area of the earth excluding the desert areas, water bodies, exposed rock surfaces, built-up areas, and other significant non-vegetation cover surfaces could be imagined to have been originally covered by vegetation [3]. However, Land use and land cover (LULCC) is not homogeneous across all parts of the world [4].

On global and local environmental changes, the LULCC varies across space and time [5, 6]. At the regional level, the LULCC can occur based on the altitudinal range, latitudinal range, and landscape. Some Land-use and land-cover changes are local and place specific [7]. Human land-use activities spread over 50% of the ice-free land surface starting, from the control over fire and domestication of animals and plants [8]. Thus the lands change from a primary forested land to a farming type, the loss of forest species within deforested areas is immediate and huge [9].

LULCC is a complex process triggered by the mutual interactions between environmental and social factors at different spatial and temporal scales [10, 11]. Expansion of agriculture, urbanization, deforestation, and the day-to-day activities of humankind resulted in temporal and spatial changes in the land use land cover, which, in turn affects ecosystem services such as hydrological regulation and soil erosion losses [12]. LULCC may also the result of various climate and physiographic conditions of an area and felt after an extended period [13]. In Ethiopia, the main agents of the observed for rapid LULCC over the last 40 years refer to the following categories: rapid population growth and resettlement, agricultural expansion, deforestation, and land clearing, and intensified anthropogenic fire regime [14]. Similarly, in wombera district, LULCC is caused by natural and humans induced factors.

LULCC is driven by multiple factors from environmental and social dimensions in a land system [15]. Land use changes are increasingly known as the consequence of actors and factors of interactions [16]. The causes LULCC were classified as proximate and underlying forces [17].

Underlying causes of LULCC originate froma complex interaction of social, policy, institutional, economic, demographic, technological, cultural, and biophysical factors [17, 18]. Political, legal, economic structure, and traditional institutions and their interaction with individual decision-making also influence LULCC [19, 20]. Demographic fertility and mortality; changes in the household structure; the breakdown of extended families into multiple nuclear families dynamics; labour availability, migration, urbanization [17] caused a large impact on proximate causes. The population growth mainly caused LULCC particularly, forest cover change: forest clearing for agricultural land, forest products, and the settlement which, has resulted in fragmentation of natural forest habitat in Ethiopia [21]. Cultural factors of populations encompass motivations, collective memories, personal histories, attitudes, values, beliefs, and perceptions of individuals, influencing communities and land managers [20]. All the underlying driving forces cause LULCC independently or in a synchronized way.

Proximate causes of LULCC are immediate actions of local communities and directly exerted on land resources due to different underlying causes [17, 22]. Among the proximate LULCC, agricultural expansion, wood extraction, and infrastructure expansion are major ones [18]. The agricultural expansion comprises permanent cultivation (large scale, smallholder subsistence, and commercial), shifting cultivation (slash & burn), and cattle ranching (large-scale and smallholder) [17]. In the study area, wombera district, proximate causes such as farming, fire, invasive herbs, logging, and firewood collection caused LULCC.

LULCC differ depending on the time period considered [23], geographical location [24] slope, and altitude [25, 26]. In Ethiopia, LULCC varies from place to place based on altitude variation. Tegene had identified up to eight major Land cover classes including Scrubland, shrub grassland, grassland valley-rim vegetation, cropland, all-weather roads, dry weather roads, and towns [27]. In Debre-Mawi watershed at the upper catchment of the Blue Nile Basin, Northwest Ethiopia, [28] Classified LULCC as natural forest, shrub and bush land, grazing land, cultivated and settlement land and plantation using aerial photograph and satellite image. In the Bale Mountains, [29] classified the land cover as water bodies, a barren and burned area, agricultural lands, Afromontane grasslands, Afromontane dwarf shrubs, and herbaceous formations, Afromontane rainforest, upper montane forest, Erica forest, isolated Erica shrubs, Afro-alpine, dwarf shrubs, and herbaceous formations and Afro-alpine grasslands. Many authors, Indicated that the area under natural forest, shrub, and grazing lands were declining continuously whereas cultivated and settlement expanding dramatically [17, 30, 31]. However in few areas the vegetation types are increasing whereas the bare land and croplands are declining [32].

It would be necessary to conduct studies that explicitly reveal the variations in LULCC characteristics. The data needed to develop mitigation strategies that protect LULCCS for specific intervals into the future could not be generated and refined for use in land use classification. The socio-economic structure, population impact, infrastructure development, administrative role and cultural practice on LULCC were studied. This study carried out to obtain information on LULCC and socio-economic factors that stimulate the changes. No research has been addressed relevant issues on LULCC concerning the socio-economy and provides recommendations that may contribute to the sustainability of natural forests and the conservation of biodiversity and wildlife habitat in the study area. The objective was to classify land use and land cover changes and evaluate driving forces that intensified patterns. The following specific objectives were addressed: (1) the rate and patterns of LULCC; (2) the past and present LULCCS; and (3) the driving forces of LULCC.

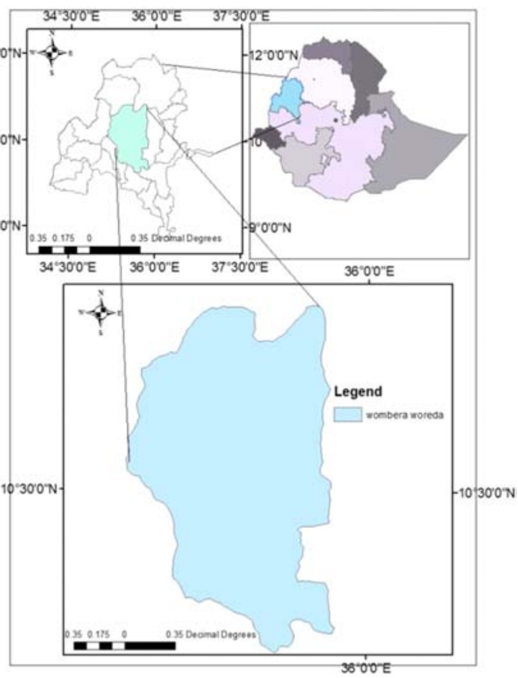


Figure 1. *Map of study area.*

2. Materials and Methods

2.1. Descriptions of the Study Area

Study area, Wombera district is 658km from the capital city, Addis Ababa. It is found in the Metekel administrative zone of Benishangul Gumuz national regional state in the northwestern part of Ethiopia. Wombera is one of the largest districts in the Metekel administrative zone. It is bounded by the districts of Guba and Dangur in the north, Bullen in the east, Agallometi, and Yaso in the south, and Serba Abbay and Sherkole in the west. The latitudinal and longitudinal extension of the woreda ranges between 9°57'30" to 11°08'45" N and 35°09'09” to 35°50'25" E respectively (Figure 1).

2.1.1. Topography

The topography is undulating and with few plain. The altitudes of wombera district range from 576 to 2615. The aspects vary in all of the three agro-ecological zones. The general agro-ecology of wombera district was classified into three agro-ecologies: higher, Middle, and lower altitudes. The classifications of agroecology were based on the vegetation strata, crop productivity, and altitudes range.

2.1.2. Vegetation

The lower altitudes are in *combretum-Terminalia* woodland vegetations [33]. The altitudes ranges from 576-1200masl. The majority of the study area lay in the lower altitudes (576-1200) followed by the higher altitudes which ranges form 2001-2616m. The Vegetation of higher altitudes is related to dry Afromontane which is part of the Gojam region vegetation type [34]. The middle altitudes range from 1201-2000. The middle altitude is mainly known for the productivity and abundance of coffee, fruits, spices, and vegetables. The vegetation layers mainly dominated by: *Albiziaschimperiana, Albiziagummifera, Millettiaferruginea, Cordiaafricana,* and *Ficus. Sp.*

2.1.3. Climate and Temperature

Climate data were obtained from the Ethiopian National metrological agency [35]. Twenty years of data (1999-2016) were taken from three districts record. For the higher altitudes, the data were taken from Wombera station record. The Annual temperatures range between a minimum of 7.2°C and a maximum of 26°C with an average of 15.9°C. The average annual rainfall was 1942mm. The second data were taken from Bullen metrology station record which represents the middle altitude of wombera district. The Annual temperatures range between a minimum of 11.9°C and a maximum of 30.6°C with an average of 20.7°C. Annual rainfall was 1560 mm. The third data were taken from Guba station which represents the lower altitude climate of wombera. The Annual temperatures range between a minimum of 18.8°C and a maximum of 37.2°C with an average of 25.7°C. The Annual rainfall was 1210mm (Figure 2).

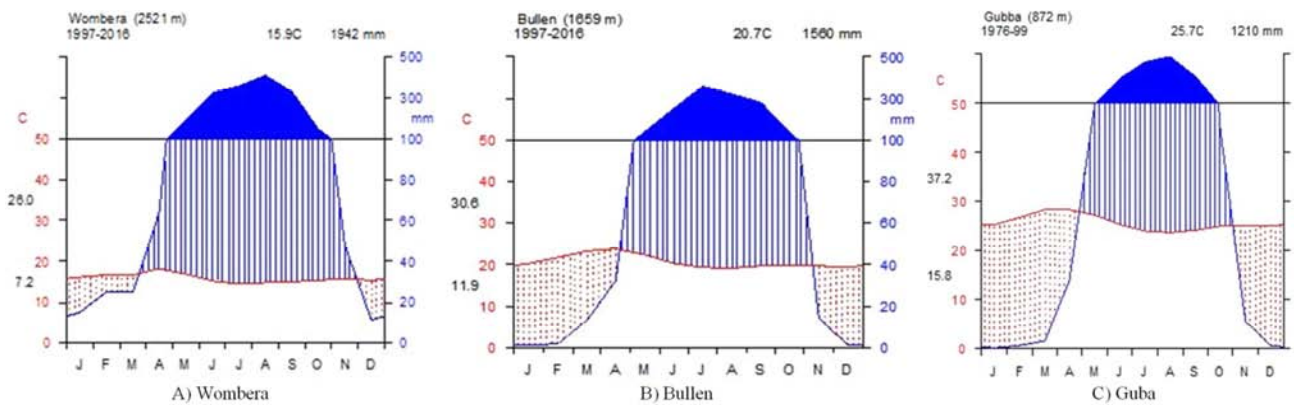


Figure 2. *Climate of Wombera district.*

2.2. Data Source and Analysis

The aim of this study was to analyze LULCC along an altitudinal gradient relating to driving force in wombera district during periods of 1973, 1986, 2000, and 2016. The driving forces of land use and land cover were identified and categorized into indirect and direct following the recommendation of different authors [17, 36] with some modifications respective to the study area. Five direct or proximate causes and seven indirect driving forces were identified. The driving forces were computed for each year along each agro-ecology independently. Four satellite images Landsat-mass 1973, Landsat-5 TM 1986; Landsat-7 ETM+2000, and Landsat-8 OLI- 2016 were used to analyze the LULCC change of the study area (Table 1). The images with a spatial resolution of 30 m were downloaded from the United States Geological Survey (USGS) Earth Explorer [37]. The images with high resolution and Minimum or less than 10% cloud covers were selected from several images for each period. The image in the summer season was not suitable as the ground is covered by extra green. On the other hand, the winter season image was not suitable as fire is released in the lower and middle altitude and smoke covers the lower atmospheres. The images taken in January and February were found to have no cloud and fire smoke cover. The selection of appropriate image acquisition dates is a precondition for clear identification of the LULCC types from satellite imageries [39]. Digital elevation data of the SRTM DEM was also obtained [37] with a spatial resolution of 30m and was used for the classification of geomorphologic terrain features:

elevation, slope, river basin, altitude, contour, and aspect variables of wombera district. Detailed characteristics of the image are described in table1.

Table 1. *Summary of spatial satellite data accessed from USGS.*

Data set Type	Acquisition	Pixel Resolution	Path / Row
Landsat Mass	1973-01-01	30	183/053 and 183/052
Landsat TM	1985-01-14	30	170/052, 170/053, 171/052, 171/053
Landsat ETM+	2000-01-15	30	170/052, 170/053, 171/052, 171/053
Landsat OLI/TIRS	2016-01-15	30	170/052, 170/053, 171/052, 171/053
Sentinel	2016	15	general
Google earth		general	general

2.3. Determination of Landover Types

In Land use land cover analysis, the first step was the recognition of the real object. In the context of this study, the remote sensing of land surface these categories could include Forest, woodlands, scrublands, croplands, settlements, water bodies, and grasslands (Table 2). The second stage in the classification process is the labeling of the entities (normally pixels) to be classified. The process of classification often requires the user to (1) determine a prior the number and nature of the categories in terms of which the land cover is to be described and, (2) assign numerical levels to the pixels on the basis of their properties using a decision making procedure, usually termed a decision rule or classification rule.

Table 2. *LULCCS in Wombera district and their descriptions.*

LULCCs	Descriptions
Forests	A land covers by Pioneer forests and climax forests. The forest portion of LULCC includes High land forests, Mountain forests, riverside forests and plantations. The forest covers are dense tree with thick canopy.
Shrub	Small tree, shrubs, bushes and pioneer forests on abandon lands
Grass land	The land covered by grass and herbaceous. Bamboo vegetation in middle attitude and short grasses on higher altitude. Abandoned lands were included in the grass land.
Settlement	It includes urban centers, villages and campus.
Water bodies	It includes rivers, dams and swamps and wet lands
Wood lands	The land covered with both open and closed (high) woodland with dominant species of *Combretum-Terminalia* wood land vegetation. It also includes acacia wood land and recovery forests from fire.
Farm lands	all cultivated land which includes crops and vegetable.

2.4. Supervised Classification of the Image into LULCCS Classes

Image classification is the process of sorting pixels into a finite number of individual classes, or categories of data based on their data file values. when a pixel satisfies a certain set of criteria, then the pixel was assigned to the class that corresponds to those criteria. For this study, a supervised classification scheme with maximum likelihood classifier decision rule was used by following three stages, assigning training sites, classification, and outputs [38]. The LULC classification was done on the basis of reflectance characteristics of the different land use land cover types by using false-color composites. This was supplemented by field visits that made it possible to establish the land use land cover types.

2.5. Accuracy Assessment

After classification was performed, the results were evaluated by accuracy assessment. It gives evidence how the results reflect the reality on the ground [40]. It was performed to confirm to what extent the produced classifications of LULCC were Compatible with what actually exists on the ground [36]. Accordingly error matrix was produced for all images in this study. The reference data used for accuracy assessment were obtained from GPS points during fieldwork and the original mosaic image. More than 132 Ground Truth Points (GTPs) were collected by using handheld GPS Garmin (Global Positioning System. Ground truth points are important for confirmations accuracy assessment [41, 42]. Google earth, sentinel image, and original mosaic image were also used for reference. An error matrix is a square array of rows and columns and presents the relationship between the classes in the classified and reference data [42]. Based on the error matrix overall accuracy and kappa statistics were used to illustrate the classification accuracy following [41].

2.6. LULCC Conversion Matrix

Conversion matrix was analyzed to show which Land cover type is converted into another Land cover type or Land use type. The conversion matrix shows the destination and source of land use land cover types [42, 43]. Analysis of conversion matrix was computed by overlaying classified images of two study years on ArcGIS 10.3. In all change matrixes, the row of the table stand for the initial year and the column of the table symbolize the final year of the change.

2.7. LULCCS Detection Analysis

LULCC statistics were computed in three different ways:

1) Total LULCC in hectare calculated by:

$$LULCCs = AreaofFinalyear - AreaofInitialYear \quad (1)$$

2) Percentage LU/LCC calculated using the following equation:

$$PercentageLULCCs = \frac{AreaofFinalyear - Areaof \text{ Initial year}}{AreaofInitialYear} * 100 \quad (2)$$

3. Rate of LU/LCC: computed using the following simple formula:

$$Rate = \frac{AreaofFinalyear - Areaofinitial}{\text{Year of Final year} - \text{Year of Initial year}} \quad (3)$$

3. Results

3.1. Characteristics of LULCC

Seven major LULCC types: Woodland, Forest, scrubland, grassland, Cropland or farmland, settlement, and water bodies were created by using the field data and satellite images of Landsat MSS 1973, Landsat TM 1985, Landsat ETM+ 2000, and Landsat OLI/TIRS 2016 (Figure 3 A-D).

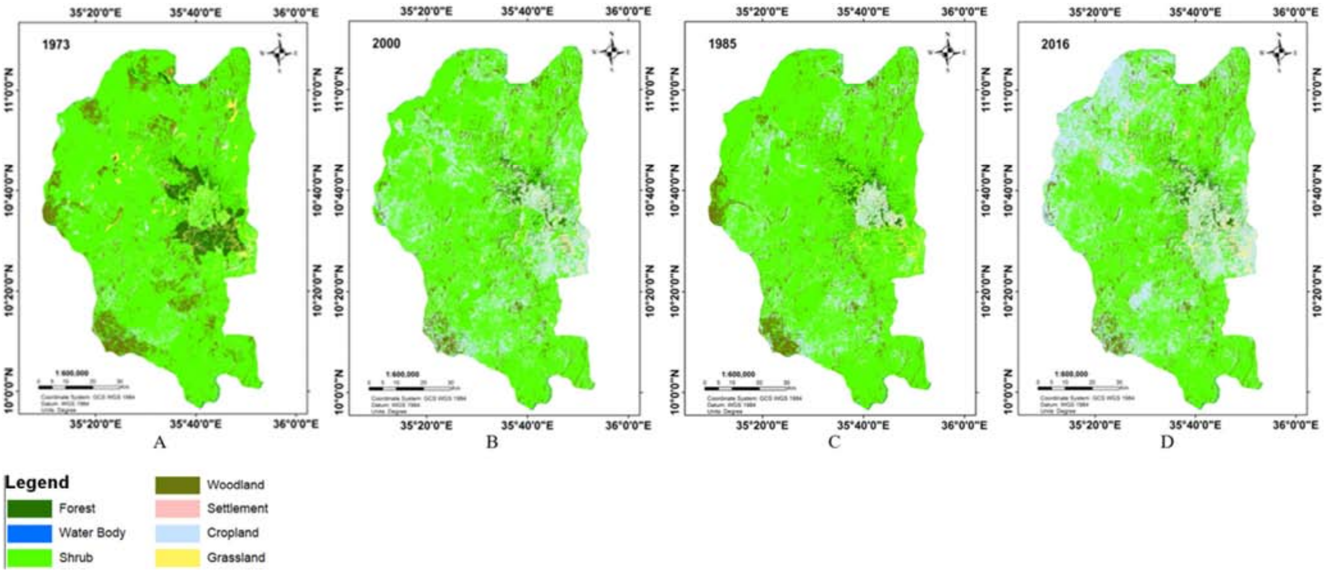


Figure 3. *LULCCA. 1973; B. 1985; C. 2000; D. 2016.*

3.2. Land Use/Land Covers in 1973-2016

Wombera district has a total of 723246 hectares of Landover. Woodlands have largest coverage (503251, 69.6%) followed by farmlands (102092, 14.11%) and Shrub bland (59829, 8.27%) in 1973. The woodland declined from 503252 to 430076 ha from 1973 to 2016. The Forest coverage also highly declined from 49019 to 16692 ha. Bush bland moderately declined from 59825 to 46623 ha. Water-body rarely declined from 2103 to 2169 ha during 1973-2016. Settlements increased from 1814 to 4530 ha. The grasslands highly increased from 5142 to 13558 ha, and farmlands twofold increased from 102092 to 209598 ha during 1973-2016 (Table 3).

Table 3. *Proportions and percentages of LULCC from 1973-2016.*

LULCCs	1973		1985		2000		2016	
	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
Forest	49019	6.77	30421	4.2	20029	2.76	16692	2.3
Waterbody	2103	0.29	2133	0.29	2028	0.3	2169	0.3
Shrub	59825	8.27	50026	6.91	48219	6.67	46623	6.44
Woodland	503251	69.6	481056	66.51	461686	63.83	430076	59.48
Farmland	102092	14.11	151128	20.9	180208	24.91	209598	28.99
Settlement	1814	0.25	2161	0.29	3280	0.46	4530	0.62
Grassland	5142	0.71	6321	0.9	7796	1.07	13558	1.87
Total	723246	100	723246	100	723246	100	723246	100

3.3. The Rate of Land Use Land Covers Change

Amongst the increasing LULCCS, the farmland was the highest in annual rate change followed by grassland from 1973-2016. For the declining LULCCs, the Shrub lands were the highest in annual rate change followed by Forest from 1973-2016. The net change for increasing LULCCs, grassland were highest (163.67%), followed by settlement (149.72%) and farmlands (105.30%). Forest was the highest amongst declining net changes (-65.94%), followed by shrub bland (-22.07%) and woodland (-14.54%). Farmlands were the highest from 1985-1973 (49036, 48.03%) and settlement was highest from 1985-2000 (1119, 52.78%). Forests were the highest in declining changes (-18598, -37.94% to -10392, -34.16%) from1973-1985 and 1985-2000 respectively followed by shrubs (-22195, 4.41% to -31610,-6.85%) from 1973-1985 and from 2000-2016) respectively. The vegetation covers (Forests, woodland, and scrubland) were declining whereas, the farmland and settlements were increasing while the water body rarely changes (Table 4).

Table 4. *Land use land cover change and rate change.*

LULCC	1985-1973			2000-1985			2016-200			Net (2016-1973)	
	Change (ha)	%	ha/year	Change (ha)	%	ha/year	Change (ha)	%	ha/year	Change (ha)	percent
Forest	-18598	37.94	1430.62	-10392	34.16	-692.80	-3337	16.66	-208.56	-32327	-65.95
Waterbody	30	1.43	2.31	-105	-4.92	-7.00	141	6.95	8.81	66	3.14
Shrub	-9799	16.38	-753.77	-1807	-3.61	-120.47	-1596	-3.31	-99.75	-13202	-22.07
Farmland	49036	48.03	3772.00	29080	19.24	1938.67	29390	16.31	1836.88	107506	105.30
Settlement	347	19.13	26.69	1119	51.78	74.60	1250	38.11	78.13	2716	149.72
Grassland	1179	22.93	90.69	1475	23.33	98.33	5762	73.91	360.13	8416	163.67
Farmland	49036	48.03	3772.00	29080	19.24	1938.67	29390	16.31	1836.88	107506	105.30

3.4. The Comparative LULCC Rates

Farmlands were the first in an average rate change per year from 1973-2016, 1973-1985, and 1985-2000. Grasslands were increasing land-use type from 1973-2016. Among the decreasing Land cover changes, Woodlands was the first in rate change per year from 2000-2016, 1973-1985, 1985-2000, and 1985-2000. Forestlands were decreasing in average rate change from 1973-2016, 1973-1985, and 1985-2000. Shrub lands were the third in an average rate of change from1973-1985 and 1985-2000. Settlements and water bodies has steady rate of change (Figure 4).

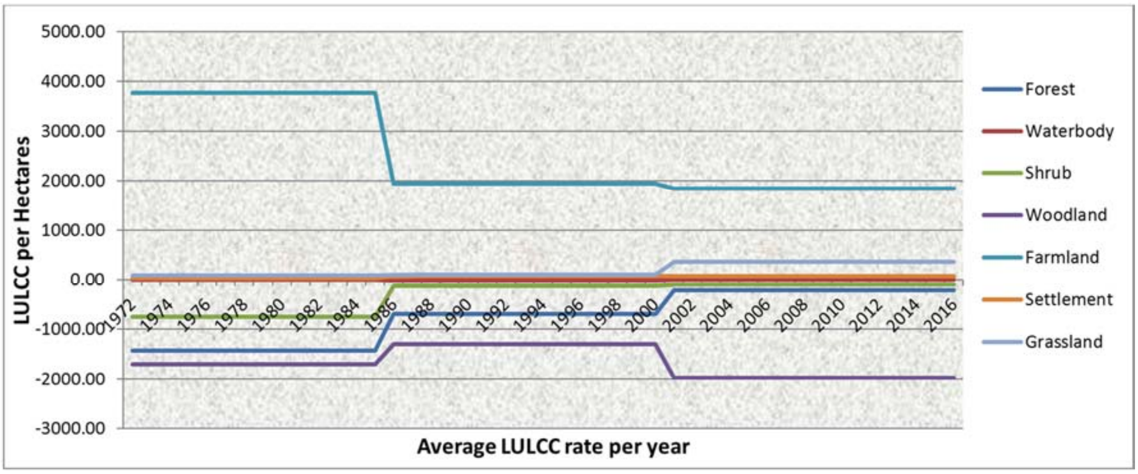


Figure 4. *Average rate of LULCC from 1972-2016.*

3.5. Land Use/Land Cover Change Matrix

The change detection matrices for the periods 1973–1985, 1985–2000, and 1973–2016 were classified separately. In the change matrix analysis, some land use/cover types gain and some other loss. The diagonal Bolden numbers indicate the unchanged matrix (Tables5-8). The maximum stagnant land-use type recorded in 2000-2016 (596,788ha), followed by the year 1973-1985 (576,495 ha) and 1985-2000 (544,966 ha).

Table 5. *LULCCs matrix between 1973 and 1985.*

LULC Class	Forest	Water Body	Woodland	Shrub	Settlement	Farmland	Grassland	Class Total
Forest	12447	1	3648	5	10	423	24	16558
Water Body	1	1776	259	86	16	228	48	2414
Woodland	3605	183	463340	9949	14	18603	1348	497042

LULC Class	Forest	Water Body	Woodland	Shrub	Settlement	Farmland	Grassland	Class Total
Shrub	1	55	6419	39959	12	1051	3	47500
Settlement	3	4	2321	20	848	84	28	3308
Farmland	1493	158	79655	8869	100	50102	4564	144941
Grassland	28	43	2515	6	15	853	8023	11483
Class Total	17578	2220	558157	58894	1015	71344	14038	723246

Table 6. *LULCCs matrix between 1985 and 2000.*

LULCC Classes	Forest	Water body	Woodland	Shrub	Settlement	Cropland	Grassland	Class Total
Forest	8447	1	3648	5	210	423	24	12758
Water Body	1	676	259	86	516	1008	48	2594
shrub	3105	183	413340	4149	214	26703	1348	449042
Woodland	1	395	6419	26925	112	8141	3	41996
Settlement	3	204	2321	20	1715	10384	28	14675
Cropland	4973	672	68507	16309	226	86295	2464	179446
Grassland	28	283	2548	6	315	11987	7568	22735
Class Total	16558	2414	497042	47500	3308	144941	11483	723246

Table 7. *LULCCs matrix between 2000 and 2016.*

LULC Classes	Forest	Water Body	woodland	Shrub	Settlement	Farmland	Grassland	Class Total
Forest	6447	1	3648	5	510	1623	24	12258
Water Body	1	676	259	86	523	908	48	2501
Woodland	2805	193	403340	2549	414	1703	1301	412305
shrub	1	395	6419	20947	332	2046	2	30142
Settlement	3	244	2321	94	11715	15384	1028	30789
Farmland	3473	792	30507	15309	526	137795	4464	192866
Grassland	28	293	2548	3006	655	19987	15868	42385
Class Total	12758	2594	449042	41996	14675	179446	22735	723246

Table 8. *LULCCs matrix between 1973 and 2016.*

LULC Classes	Forest	Water Body	Woodland	Shrub	Settlement	Farmland	Grassland	Class Total	Loss
Forest	8267	1	3328	205	410	23	24	12258	3991
Water Body	101	406	259	86	123	908	618	2501	2095
Woodland	2805	193	403240	2549	314	1703	1501	412305	9065
Shrub	1	391	6419	20947	136	2246	2	30142	9195
Settlement	3	244	22221	2094	15	5384	828	30789	30774
Farmland	6373	692	120107	30007	16	35093	578	192866	157773
Grassland	28	293	2583	3006	1	25987	10487	42385	31898
Class Total (2016)	17578	2220	558157	58894	1015	71344	14038	723246	
Gain	9311	1814	154917	37947	1000	36251	3551		
Net gain	5320	-281	145852	28752	-29774	-121522	-28347		
Net persistence	0.6435	-0.692	0.3617	1.373	-1.985	-3.4628558	-2.70306		

3.6. LULCCS Accuracy Assessment

Overall accuracy assessment were: 85.40% (1973), 85.88% (1985), 86.82% (2000) and 87.67% (2016). It was achieved by the Landsat mass 1973, TM of 1985, Landsat ETM+ of 2000, and Landsat OLI/TIRS of 2016 correspondingly (Tables 9-12).

Table 9. *LULCC accuracy for 1973.*

LULC Classes	Forest	Water Body	woodland	Shrub	Settlement	Farmland	Grassland	Classified total	User accuracy
Forest	16	0	1	0	0	0	0	17	94.12
Water Body	0	13	0	0	1	0	0	14	92.86
Woodland	1	0	21	2	0	0	0	24	87.50
shrub	0	0	0	20	0	1	0	21	95.24
Settlement	0	1	0	0	15	0	2	18	83.33
Farmland	0	0	0	0	0	19	1	20	95.00
Grassland	0	0	0	1	1	0	14	16	87.50
Reference (T)	17	14	22	23	17	20	17	130	
Producer accurecy	94.12	92.86	95.45	86.96	88.24	95.00	82.35		

Over all classification accuracy =85.40%; Over all kappa statistics = 0.8022

Table 10. *LULCC accuracy for of 1986.*

LULC Classes	Forest	Water Body	woodland	Shrub	Settlement	Farmland	Grassland	Classified total	User accuracy
Forest	15	0	1	0	0	0	0	16	93.75
Water Body	0	14	0	0	1	1	0	16	87.50
Woodland	1	0	24	0	0	0	1	26	92.31
shrub	0	0	0	21	0	1	0	22	95.45
Settlement	0	1	1	0	17	0	0	19	89.47
Farmland	0	0	0	2	0	16	0	18	88.89
Grassland	0	0	0	0	1	0	14	15	93.33
Reference (T)	16	15	26	23	19	18	15	132	
Producer accuracy	93.75	93.33	92.31	91.30	89.47	88.89	93.33		

Over all classification accuracy =85.88%; Over all kappa statistics = 0.8022

Table 11. *LULCC error matrix of 2000.*

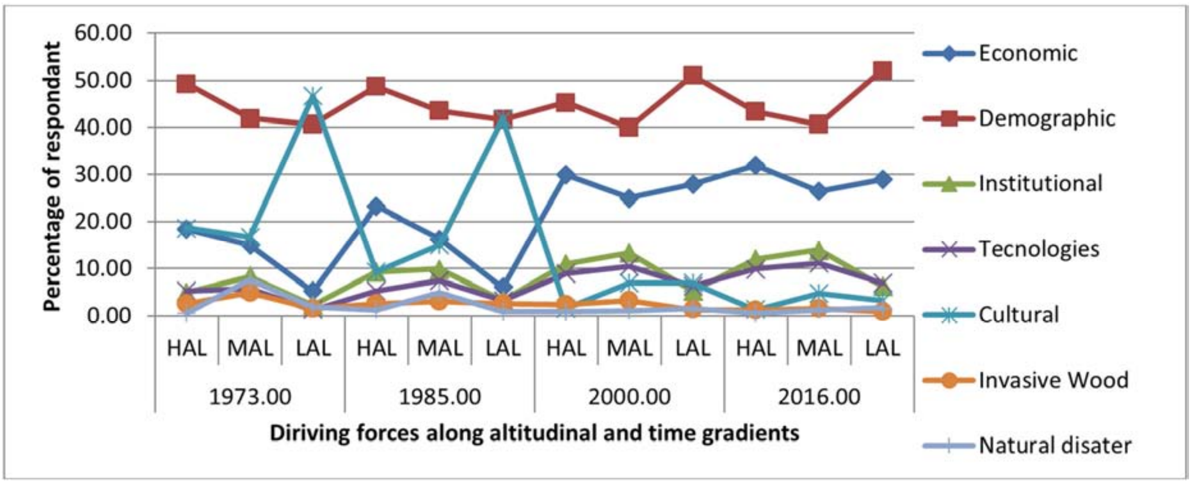
LULC Classes	Forest	Water Body	woodland	Shrub	Settlement	Farmland	Grassland	Classified total	User accuracy
Forest	15	0	1	1	0	0	0	17	88.24
Water Body	0	16	0	0	1	0	0	17	94.12
Woodland	1	0	22	0	0	1	1	25	88.00
shrub	0	1	0	21	0	0	0	22	95.45
Settlement	0	0	0	0	17	1	0	18	94.44
Farmland	0	0	1	0	0	17	0	18	94.44
Grassland	0	1	0	0	0	0	14	15	93.33
Reference (T)	16	18	24	22	18	19	15	132	
Producer accuracy	93.75	88.89	91.67	95.45	94.44	89.47	93.33		

Over all classification accuracy =85.88%; Over all kappa statistics = 0.808

Table 12. *LULCC accuracy for 2016.*

LULC Classes	Forest	Water Body	woodland	Shrub	Settlement	Farmland	Grassland	Classified total	User accuracy
Forest	14	0	1	1	0	0	0	16	87.50
Water Body	0	15	1	0	1	0	1	17	88.24
Woodland	2	0	25	2	0	0	1	30	83.33
shrub	0	0	1	19	0	0	1	21	90.48
Settlement	0	0	0	0	18	1	0	19	94.74
Farmland	0	0	0	0	1	17	0	18	94.44
Grassland	0	0	0	1	1	0	14	16	87.5
Reference (T)	16	16	28	23	21	18	17	137	
Producer accuracy	87.50	93.75	89.29	82.61	85.71	94.44	82.35		

Over all classification accuracy =87.67%; Over all classification accuracy =87.67



HAL =Higher altitude, MAL= Middle Altitude and LAL = Lower altitude

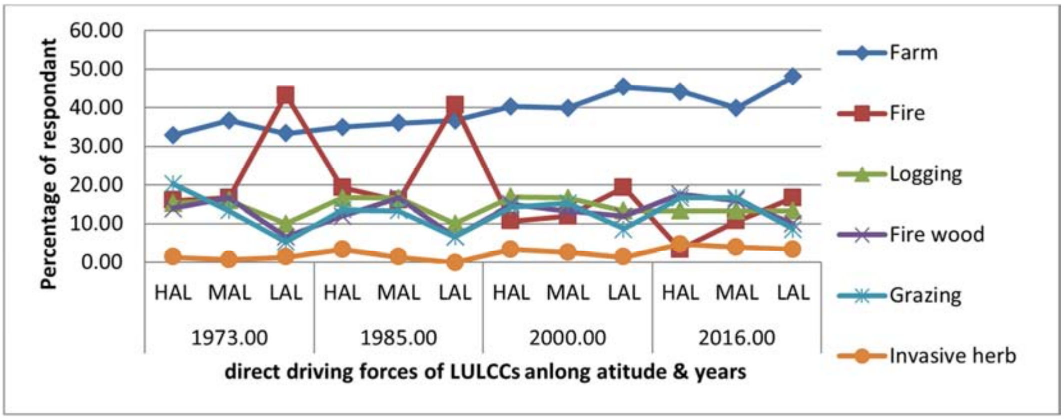
Figure 5. *Indirect driving forces of LULCC.*

3.7. Indirect Driving Force of Land Use Land Covers Changes

The demographic driving force was the leading cause of LULCCs from 1973 to 2016 in the three agro-ecological zones. The culture was the second indirect driving force for direct driving forces, followed by the economic driving force. The economy was the third driving force mainly, in the Lower altitude in the early times (1973-1985). Institutional and Technologies had increased in all altitudes in late times 2000-2016. Woody Invasive and Natural disasters had the minimum impact on LULCCs (Figure 5).

3.8. Proximate Cause of LULCCs

Proximate driving forces triggered indirect driving forces. Population pressure which indirectly changes or act on the land cover and change into another land use type. The farming activity contributes the highest share among the proximate causes of LULCCs from 1973-2016 in higher altitude and middle altitude agro-ecological zones. The vegetation changed to croplands annually. Among the direct driving forces, fires contributed the highest impact on LULCC in the lower altitude from1973 to 1985. Logging and firewood collection had second and third values at higher altitudes in 2000 and 2016. Herbal invasive species have no impact on LULCC in all years in all agro-ecology of wombera district (Figure 6).



HAL =Higher altitude, MAL= Middle Altitude and LAL = Lower altitude

Figure 6. *Direct or proximate driving forces of LULCC.*

4. Discussion

4.1. Characteristics of LULCC Units

Seven main LULCC types were visible under satellite image analysis (Figure 4). Other authors in similar agro-ecology identified similar LULCC types [17, 28, 36]. However, according to [28] who accessed aerial photographs and recent satellite images identified more distinguished LULCC types. The forest includes dry Afromontane, riverside forest, eucalyptus plantations, coffee forests, and mountain forests. In the same manner [36] classify human-made plantation forests, riverside forests, dry evergreen forests, and moist mountain forests as forests.

The dominancy of woodland is because of 65% the study is in lower altitudes. It might be related to the change of climate and the expansion of woodlands along altitudinal gradients. The woodlands are expanding to middle altitude. The first and the most dominancy of woodlands in the lower altitudes is its ecological range. Lower altitudes own high temperature and low humidity. So, people preferred to live in middle and higher altitudes. In addition, the environmental conditions of lower altitudes are most suitable for non-communicable diseases causing vectors for instance malaria and snake;

Consequently, it is severe for the resident; however, during and before 1973 and in early 1985 the impact of most indirect and direct driving of LULCC was lower than in the 2000s and 2016s. The second most important reason for woodland dominancy is the dependency of inhabitants on shifting cultivation and hunting that maintains the woodland agro-ecology at equilibrium.

4.1.1. Higher Altitude LULCC

Population growth pressures are expanding the area of land-uses such as agriculture and settlement into natural habitats in all parts of the world to meet the demand for food and housing [45, 46]. The decline of forest from 49019 hectares in 1973 to 16692 hectares in 2016 confirms deforestation and forest resource over-extraction in general. As result Biodiversity has been diminishing considerably by land change; while lands change from primarily forested land to a farming type, the loss of forest species within deforested areas is immediate and huge [9].

The maximum forest coverage changed during 1973-1985 (-1430.62 per year, -18598 ha (-37%) and minimum during 2000-2016 (-208 per year,-3337ha (-16.66%)) were evidence for the impact of indirect driving forces on the proximate cause of LULCC. Drivers/causes of LULCC changes can be from a range of biophysical, demographic, economic, infrastructural and technological factors [47]. The demographic change was the most root cause of the direct driving forces. In the early times (before 2000), population growth synchronized with the socio-cultural practices and aggravated the proximate driving forces. The lower development of Technological and infrastructure and weak administrative practice had aggravated the LULCC. The demographic structure, Economic developments, and cultural practice imposed enormous impact on direct driving agents mainly farming, grazing, logging, firewood, and fires.

In the early 1970s, the Feudal collapse and the emergence of the military force created an administrative gap that made unable to control forest resources over exploitation. The political transitions fail to establish strong institutions, infrastructure, and administrative bodies. The failed law enforcement, the lower infrastructure developments, high cultural practice synchronized population growth aggravated the effect of the direct agents of LULCC. To feed the increasing populations, forestlands have been cleared to increase agricultural productivity [48-51]. The administrative gap was also in line with the finding of [52]. The expansion of farmlands at the expense of other LULCC types in the study area, especially forests, bush lands, and woodland is an effect of the weak or inappropriate institutional arrangements.

The minimum forest coverage changed during 2000-2016 (-208.56 ha per year, -3337Ha (-16.66%) is the result of the better-organized administration built and infrastructure developments. So the rate change of vegetation cover has been decreased. At higher altitudes, the population pressure is increased by environmental conditions. It is the most comfortable area than the middle and lower. Most people prefer to live on the higher altitudes [53]; so, the impact of indirect driving forces: Demographic, Socio-culture, Economic, or income-generating imposes an effect on direct driving forces. It is in line with the report of different scholars [52, 54].

4.1.2. Middle Attitude LULC

In the middle altitudes, the LULCC was caused by indirect driving forces on direct driving forces in a similar way to lower attitude and higher altitudes. The impacts of Population, cultural influence and economic were similar with higher altitudes to some extent. The developments of infrastructures and institutional policy were lower in the middle latitudes. The sloppy natures of the landscape hinder the supply infrastructure. Among direct causative agents, Fire burn was also the highest in the area. Illegal loggings were more severe as the area is in the ecology of timber trees such as Cordiaafricana. According to [36] Economic transformation is the leading agent of LULCC.

4.1.3. Lower Altitude LULCC

In lower altitudes, the effects of indirect driving on direct driving forces are more severe. The direct driving forces of LULCC was caused by a range of demographic, economic, technological, institution or policy, socio-cultural, spatial disasters, and invasive woody tree species. These underlying forces facilitate LULCC independently or in a synchronized way.

In the early times, during 1973-1985, the same way as to upper and middle altitudes dwellers among indirect forces LULCC, the demographic and cultural values impose change on the direct agents mainly, farming and Fire. The vegetation coverage change was slower than the upper and middle altitude agro-ecologies. The changed woodland coverage was minimum during 2000-1985 (-19370ha, -4.03%, -1291.33 ha/year). The impacts of indirect driving force were lower than during the 2000s. During the early periods, the main factors of LULCC in the lower altitude were agricultural expansion, hunting, and Fire burn. These factors induced LULCC independently or in a synchronized way. However, shifting cultivation balanced the change. It is agricultural activity in which forests were slashed and burnt and used for crop cultivation. After two to three years of crop cultivations, the lands were abandoned so that the trees can regenerate within three to five years. This type of agricultural practice changes the forest coverage at equilibrium. The second factors were the deliberate and unintentionally releasing of fires. The Fires burns many hectares of wood and shrubs annually. However, the fire also initiates the seed to germinate. The regeneration of the forest again balances the rate LULCC. As result, woodlands change was minimum from 1985-1973 and 2000-1985).

Land-use systems are dynamic in response to population and economic growth, public and private investments, and market and government actions [53]. From 2000 onwards, cultural practices, economic activity, institutional arrangement, and infrastructure developments have changed. They revolutionized economic activity by integrating institutional structure, Cultural Revolution, and technological advancement. As result, the LULCC in the lower altitude became increasing at alarming because all the indirect deriving impacts tend to increase. Investment (economic growth) and population movements had caused a large influence on direct driving forces, mainly on farming. The technology-aided mechanized and manually intensified farming had imbalanced the equilibrium impact on proximate driving forces of LULCC. The investors and non-indigenous higher altitude dwellers changed the shifting cultivation custom and intensified the rate of LULCC.

According to FGD and KID, in the 1980s, the population growth of the GUMUZ ethnic group was at equilibrium. Even though they had the culture of Polygamy marriage and an uncontrolled birth rate, the population growth was regulated by cultural practice. Naturally, the population growth was also regulated by natural disasters such as drought and diseases such as malaria, and other bites of wild animals. Because of low infrastructure developments, they had no access to education and health services. Population regulation was also controlled by human-induced problems such as mini conflicts (war) with clans of Gumuz ethnic groups and other ethnic groups. However, the building of more advanced infrastructure (2000 to 2016) tremendously change the social structure at an alarming rate.

4.2. Land Use Land Cover and Rate Change

The Farmland is highly changing among the LULCC. It is directly related to the food demand at the local, regional and global scale. Patterns of land use land cover change, and land management are shaped by the interaction of economic, environmental, social, political, and technological forces on local to global scales [42]. The increasing populations from year to year that demands food primarily cause farmland expansion at an alarming rate. Secondly, the global trade (globalization) across continents encourages investment; which seeks farmland expansion. It is similar to the finding of [50] as the main drivers of LULCC are related to farmland expansion and population growth.

4.3. Accuracy Assessment of LULCC

Among the accuracy assessments, the highest result was recorded from Landsat OLI/TIRS 2016, followed by Landsat ETM+ of 2000, Landsat TM of 1985, and Landsat mass-1973. These were related to the quality of the image acquired. The better quality of the image, the better visibility of the land covers will be on the ground and the map.

4.4. Matrix of LULCCs

The change of land cover type to other land cover types declined from 1973 to 2016 in general. The unchanged land cover types were maximum during 2000-2016 (596788 ha, 82.52%) and least during 1985-2000 (544966, 75.35%). These indicate the impact of direct and indirect driving forces of LULCC were high during 2000-2016 and least during 1985-2000.

5. Conclusion

A satellite image analysis indicates that Land cover/ land use has been changing at an alarming rate in the wombera district since 1973. Woodland, forest cover and scrublands were the dominant land cover types. The vegetation cover has declined, whereas the cropland and settlements have been increasing. The demographic, cultural practice and economic system have been imposing the direct driving forces mainly, farming in the early times. The demographic driving force was the leading cause of LULCC from 1973 to 2016 in the three agro-ecological zones. In 1970, the lower development of Technological and infrastructure; and weak administrative practice had aggravated the LULCC. Among direct causative agents, Fire was also the highest in the middle altitude and lower altitude.

Conflict of Interest

The authors declare that they have no competing interests.

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