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## Analysis of Urban Expansion and Land Use Land Cover Change Trends in Jimma Town

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### Abstract

This study analyzes urban expansion trends in Jimma town, Ethiopia, and their impacts on land use/land cover (LULC) change. Using remote sensing (RS) and GIS techniques, satellite images from 2000, 2010, and 2021 were classified into five categories—built-up area, forest, agricultural land, grassland, and water bodies—through supervised classification, with ground control points collected for accuracy assessment. The findings indicate that built-up areas expanded significantly from 3,485.35 ha in 2000 to 5,452.17 ha in 2021, while agricultural land declined sharply from 3,053.57 ha to 1,303.21 ha over the same period. The main drivers of this transformation include industrial and manufacturing development, the town's strategic location, rapid population growth, and community-driven urban activities. Projections suggest that built-up areas may reach approximately 7,377.21 ha by 2031. These results highlight the urgent need for effective land use planning and management strategies to address the challenges posed by rapid urban growth. The study recommends the adoption of strong land management and monitoring systems, particularly through the integration of GIS and RS tools, to ensure sustainable urban development and mitigate the adverse effects of uncontrolled expansion.

**Keywords:** Change detection, Land use land cover, urban expansion trend

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## 1. Introduction

Urbanization, defined as the process of urban expansion, is a global phenomenon characterized by rapid population growth, an increasing share of the non-agricultural workforce, and the transformation of land use from agricultural to built-up urban areas (UN-Habitat, 2006). It is a continuous process and is often among the key development agendas influenced by socio-cultural, political, commercial, transportation, and industrial activities (G/Hiwot, 2006; Beka, 2016).

The causes of urban expansion vary across contexts. However, most scholars agree that migration, natural population growth, and the reclassification of rural villages into urban settlements are the primary drivers of rapid urban growth (Kaleb & Samuel, 2017). Among these factors, population pressure has particularly contributed to the horizontal expansion of urban areas (Firew, 2010). Numerous studies show that urban expansion is occurring at an alarming rate in developing countries compared to developed ones. Marshall et al. (2009) argue that rapid urban growth in developing nations is largely driven by rural-to-urban migration, population increase, and socio-economic and technological changes. While this process brings opportunities for economic development, it also produces significant challenges, including the large-scale conversion of agricultural land to urban uses (G/Hiwot, 2006; UN-Habitat, 2000).

Measuring urban expansion and assessing its trends and patterns can be carried out using different approaches. Aburas et al. (2017) note that remote sensing (RS) and geographic information system (GIS) techniques are more effective than traditional statistical and mathematical methods, as they provide spatially explicit tools for mapping urban expansion and land use/land cover (LULC) changes. Such approaches have become indispensable for urban studies.

In Africa, urbanization is typically characterized by rapid and often uncontrolled growth, leading to extensive LULC changes and environmental degradation (Shishay, 2011). This rapid urbanization is fueled by rural-to-urban migration, natural population growth, economic development, and favorable government policies (Kassa et al., 2011). While urbanization is frequently seen as a symbol of modernization, economic growth, and development, in Ethiopia it has often been accompanied by significant challenges, particularly unplanned settlements (Tamirat, 2016; Tegenge, 2002). High population growth rates have accelerated urban expansion, intensifying LULC changes and creating social and physical problems. One

notable consequence has been the conversion of agricultural land, which undermines rural livelihoods.

Urban expansion also imposes direct costs on surrounding rural communities, including eviction, environmental pollution, and socio-cultural disruptions. Although some measures have been taken to mitigate these effects, they have often been inadequate. Informal or illegal land and housing ownership—particularly prevalent in peripheral urban areas—remains a pressing challenge. Rapid urban growth, coupled with increasing land use changes, is evident in Ethiopia and other developing countries. Monitoring these changes is essential for understanding land cover dynamics across spatial and temporal scales and for ensuring effective land management (Mosammam, Nia, Khani, Teymouri, & Kazemi, 2017).

Jimma town, located in the Oromia Regional State, is one of the fastest-growing urban centers in Ethiopia. Its expansion has been largely irregular and uncontrolled, often resulting in fragmented urban development. The growth of industry, manufacturing, and service sectors has contributed to rapid socio-economic transformation (Bodo, 2019). Against this background, the present study seeks to analyze the horizontal expansion of Jimma town between 2000 and 2021, project its growth over the next decade, identify the key driving factors, and propose strategies for managing rapid urban development using remote sensing and GIS techniques

## **2. Methods and Materials**

### **2.1. Description of the study area**

The study was conducted in Jimma Zone, located in the Oromia National Regional State, southwestern Ethiopia (Fig. 1). Jimma town, the capital and administrative center of the zone, lies about 350 km southwest of Addis Ababa. Established along the Awetu River during the Italian occupation in the 1930s, Jimma has developed into the largest city in southwestern Oromia. Geographically, the town is situated between 7°35'00"–7°42'30" N latitude and 36°46'15"–36°53'45" E longitude. Prior to the 2007 census, it was reorganized administratively as a special zone. Topographically, the area forms part of the upper Gibe-Omo River basin and is characterized by gently sloping terrain.

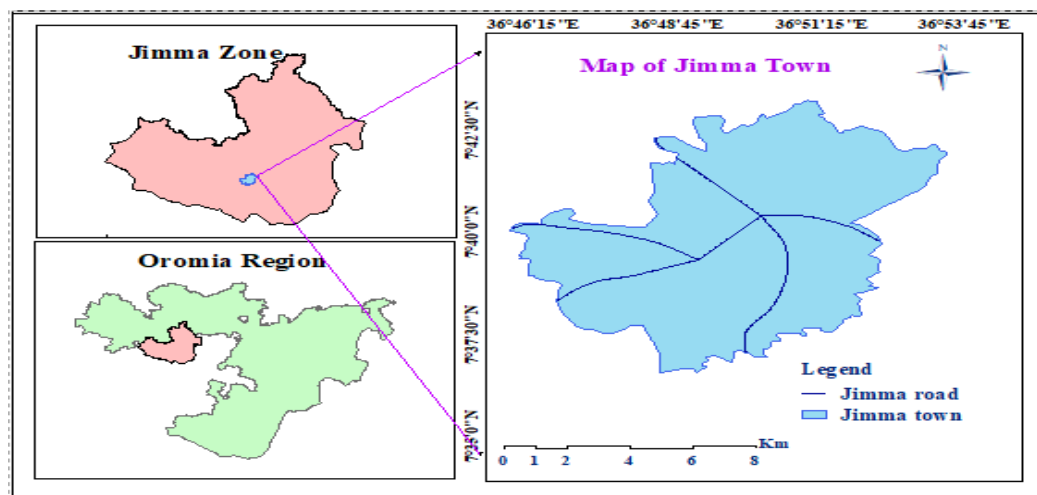


Fig.1. Location Map of study area, Source: Developed by the researcher based on Ethio-GIS 2017 data using Arc Map 10.8.

Jimma experiences a relatively cool tropical monsoon climate (Köppen Am), with a prolonged rainy season lasting from March to October. The mean annual temperature ranges between 12.1°C and 28°C, while annual rainfall averages 1,420–1,800 mm (Gemedo et al., 2020). The town is located on a short hill along the left bank of the Gibe River's alluvial plain and is intersected by several small streams. According to the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), Jimma Zone had a population of 120,960, of whom 60,824 were men and 60,136 women. The town covers 50.52 km<sup>2</sup>, with a population density of 2,394 persons per km<sup>2</sup>, and all residents classified as urban dwellers. A total of 32,191 households were recorded, with an average of 3.76 persons per household, and 30,016 housing units. The Oromo (36.71%), Amhara (27.14%), and Dawro (10.05%) were the three largest ethnic groups, while other ethnic communities collectively accounted for 26.1% of the population.

## 2.2. Methods and data collection and analysis

An explanatory research design was adopted to investigate urban expansion trends and their effects on land use/land cover (LULC) change in Jimma town. This approach was chosen because it allows clarification of urban expansion patterns across different time periods and their corresponding impacts on LULC. To achieve the stated objectives, both qualitative and quantitative methods were employed, with secondary data serving as the primary source of information.

Landsat imagery was used as the main dataset, specifically Landsat Thematic Mapper (TM), Landsat Enhanced Thematic Mapper (ETM), and Landsat 8 images for the years 2000, 2010, and 2021, respectively. These images were obtained from the USGS Earth Explorer platform.

Images from January were selected to minimize cloud cover and ensure consistency in classification. The data were processed using ArcGIS 10.8 software to generate historical LULC maps and analyze urban expansion trends. For data management and presentation, descriptive statistics such as percentages, tables, and graphs were applied.

Supervised classification was employed to categorize the images into five hierarchical classes: built-up area, forest, agricultural land, grassland, and wetlands, based on a modified classification scheme. The maximum likelihood classification algorithm was applied, as it estimates class probabilities by calculating means and variances of training samples while accounting for variability in brightness values (Perumal & Bhaskaran, 2010). Training samples were carefully selected for each image to ensure accurate separation of land use classes. The methodological steps included image acquisition, preprocessing, classification and map generation, accuracy assessment, LULC change detection, and spatial expansion analysis.

### 2.2.1. Accuracy Assessment

Accuracy assessment was conducted to evaluate whether the classification process achieved its intended objectives. It involves measuring the reliability of the final categorical maps produced through image classification (Levin, 1999). The most commonly applied accuracy assessment procedures include producer’s accuracy, user’s accuracy, overall accuracy, and the Kappa coefficient (Anupam, 2017). These procedures were applied to assess the classification performance for the years 2000, 2010, and 2021. The equations used for these calculations were adopted from Anupam (2017) and Congalton (1991). Producer’s accuracy refers to the probability that a pixel belonging to a given class has been correctly classified (Anupam, 2017), as shown in Equation 1.

$$\text{Producer's Accuracy \%} = \left[ \frac{\text{Total number of correct pixels in a category}}{\text{Total number of pixels of that category derived from the reference data (i.e., row total)}} \right] 100 \% \dots\dots\dots (\text{eq.1})$$

User’s accuracy is defined as the probability that a pixel classified on the image actually represents that category on the ground (Anupam, 2017). It is calculated as shown in (Equation 2).

$$\text{User's Accuracy}\% = \frac{\text{Sum of the diagonal elements (true samples)}}{\text{Total number of pixels of that category derived from the classified data (i.e., column total)}} \times 100\% \dots\dots\dots (\text{eq.2})$$

The collective accuracy of map for all the classes can be described using overall accuracy, which

$$\text{Overall Accuracy \%} = \frac{\text{Sum of the diagonal elements (true samples)}}{\text{Total number of accuracy sample pixels}} \times 100\% \dots\dots\dots (\text{eq.3})$$

**KAPPA Coefficient**

Accuracy for the entire image across all classes is measured by overall accuracy. It ignores off-diagonal elements such as errors of omission and commission. Further, it is difficult to compare different overall accuracy values if different number of accuracy sites were used. This paves way for use of other accuracy assessment methods which is more commonly used method known as Kappa analysis, in which off-diagonal elements are incorporated as a product of the row and column marginal totals (Anupam, 2017). Kappa analysis generates a kappa coefficient or Khat statistics, the values of which range between 0 and 1. Kappa coefficient (Khat) is a measure of the agreement between two maps taking into account all elements of error matrix (Anupam, 2017). It is defined in terms of error matrix as shown in (Equation 4).

$$\text{Khat} = (\text{Obs} - \text{exp}) / (1 - \text{Exp}) \dots\dots\dots (\text{eq.4})$$

The accuracy recorded in the error matrix (overall accuracy) is represented by Obs = Observed correct. The correct categorization is represented by Exp = Expected Correct.

**2.2.2. Change Detection Analysis**

Land cover change detection refers to the process of assessing spatial and temporal variations in land use/land cover (LULC) within a given study area (Ahlam, 2017). It involves identifying changes in land cover types by analyzing a specific area at different points in time using multi-temporal satellite datasets (Sewunet, 2017). In this study, satellite images of Jimma town for the years 2000, 2010, and 2021 were processed and classified to generate thematic LULC maps. These maps were subsequently compared and overlaid to visualize spatial changes across the study period. Furthermore, the extent of increase or decrease in

each LULC category was quantified, and percentage changes for each class were calculated using the formula proposed by Sewunet (2017), as shown in Equation 5.

$$\text{Change in \%} = \left[ \frac{\text{Total Area in T2} - \text{Total Area in T1}}{|\text{Total Area in T1}|} \right] 100\% \dots \text{(eq.5)}$$

Where T1 is earlier point of time and T2 is the later or recent point of time in the series.

### 2.2.3. Spatial Expansion Rate Analysis

The dynamic degree of spatial structure is an indicator that can reflect rate of spatial expansions and were calculated using the formula (Sewunet, 2017) as shown in (Equation 6).

$$\text{DC} = \left[ \frac{\text{BA2} - \text{BA1}}{\text{BA1}} \times \frac{1}{\text{T2} - \text{T1}} \right] 100\% \dots \text{(eq.6)}$$

Where; -

DC is the dynamic change rate of urban expansion for a period,

T1 and T2 are specific years,

BA1 is total built-up area at time T1, and

BA2 is total built-up area at T2.

The total areas covered by each class in each study year will be calculated and the amount and rate of change for each land cover classes should be analyzed.

### 2.2.4. Future Built-up Area Computation

Exponential Growth Model (EGM) is used to make future predictions of urban built areas (Dean, 2013). Accordingly, in order to compute the future built up area growth of Jimma town, it is compulsory to calculate average growth rate. So based on the urban expansion of town form 2000-2021 years the average growth rate of the expansion has been calculated using exponential growth model formula as shown in (Equation 7 and 8).

$$Bf = Bo e^{rt} \text{ -----} \rightarrow r = \frac{1}{T} * \ln \left[ \frac{Bf}{Bo} \right] \text{ -----} \rightarrow \text{eq (7)}$$

Where:

Bf = current built up,  
 Bo = initial built up,  
 r = growth rate and  
 t = Time (year).

$$Bf = Bo * (1+r/100)^{t(f-o)} \dots\dots\dots \text{Eq. (8)}$$

Where: B = Built-up area,  
 f = future year,  
 o = initial/base year,  
 % (r) = average growth rate per year and  
 t = time in year.

This model provided the basis for projecting the future spatial expansion of Jimma town’s built-up area over the coming decade

**3. RESULT AND DISCUSSION**

**3.1.Trend Detection Mapping**

**3.1.1. Land use Land covers (LULC) Analysis**

The land use/land cover (LULC) of Jimma town for the years 2000, 2010, and 2021 is presented in Table 1 and Figure 2. In 2000, built-up areas covered the largest portion of the town, accounting for 3,485.35 ha (38.05% of the total area). Agricultural land was the second largest category at 3,053.57 ha (33.34%), followed by grassland at 2,065.74 ha (22.55%), forest land at 543.34 ha (5.93%), and water bodies at 10.83 ha (0.12%).

By 2010, the town had experienced notable expansion, driven in part by the establishment of industries. Built-up areas increased to 4,734.38 ha (51.69%), remaining the dominant LULC class. Grassland covered 1,730.8 ha (18.9%), agricultural land 1,396.58 ha (15.25%), forest land 1,292.13 ha (14.11%), and water bodies 5.44 ha (0.06%) (Table 1; Fig. 2).

In 2021, further expansion occurred, including infill residential developments and continued industrial growth. Built-up areas continued to dominate, covering 5,452.17 ha (59.52%). Forest land accounted for 1,466.34 ha (16.01%), agricultural land 1,303.21 ha (14.23%), grassland 928.78 ha (10.14%), and water bodies 9.83 ha (0.12%) (Table 1; Fig. 2).

These results indicate a clear trend of increasing urbanization, primarily at the expense of agricultural and grassland areas, highlighting the town’s rapid spatial expansion over the past two decades.

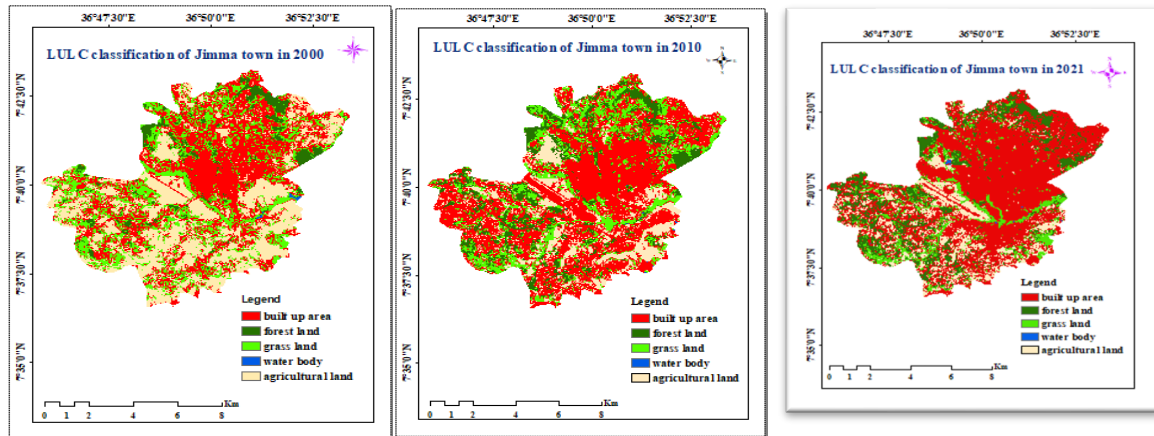


Fig.2 supervised classifications in 2000, 2010 and 2021,

**Table 1: Area and percentage coverage of land use land cover (LULC) from (2000-2021)**

No	LULC type (Land use land cover)	Years and Area coverage in hectare & Percentage					
		2000		2010		2021	
		Area(ha)	Area (%)	Area(ha)	Area (%)	Area(ha)	Area (%)
1	Built-up area	3485.35	38.05	4734.38	51.69	5452.17	59.52
2	Forest land	543.34	5.93	1292.13	14.11	1466.34	16.01
3	Grass land	2065.74	22.55	1730.8	18.9	928.78	10.14
4	Water body	10.83	0.12	5.44	0.06	9.83	0.12
5	Agricultural land	3053.57	33.34	1396.58	15.25	1303.21	14.23
	Total	9158.83	100	9158.83	100%%	9158.83	100%

### 3.1.2. Accuracy Assessment

A map produced using remotely sensed or other spatial data cannot be considered complete without evaluating its accuracy and validity (Congalton, 1991). Accuracy assessment is essential for comparing the outcomes of different classification algorithms and for determining the quality and reliability of the results. In this study, a substantial number of samples—ranging from 35 to 105 pixels per class—were collected, as sample size is a critical factor in accuracy testing.

#### Producer’s Accuracy

Producer’s accuracy measures the proportion of correctly classified pixels in a particular category relative to the total number of pixels that truly belong to that category in the reference data (Eq. 2). The minimum producer’s accuracy for this study was 72.7%, 75%, and 81.2% for the 2000, 2010, and 2021 classification maps, respectively. Across all categories, producer’s accuracy ranged from 72.7% to 100%, indicating that the classification performance was reliable and acceptable.

### **User's Accuracy**

User's accuracy is the probability that a pixel classified into a given category actually represents that category on the ground, calculated as the ratio of correctly classified pixels to the total pixels assigned to that category (Eq. 1). In this study, user's accuracy ranged from 83.3% to 91.6% for 2000, 85.7% to 91% for 2010, and 83.3% to 92.8% for 2021. These results, together with producer's accuracy, indicate that the classification was performed effectively and that error margins were within acceptable limits.

### **Overall Accuracy**

Overall accuracy represents the proportion of all pixels correctly classified across all categories (Anupam, 2017; Eq. 3). The calculated overall accuracies were 88.2%, 88.4%, and 90.1% for 2000, 2010, and 2021, respectively.

### **Kappa Analysis**

Kappa analysis quantifies the agreement between the classified map and reference data while accounting for random chance. Values range from 0 to 1, with results closer to 1 indicating stronger agreement (Eq. 4). The overall Kappa statistics were 0.851, 0.853, and 0.873 for 2000, 2010, and 2021, respectively. These values suggest that the classification process successfully avoided approximately 85.1%, 85.3%, and 87.3% of errors that would occur in a completely random classification, confirming the reliability of the results.

### **3.2.Change Detection analysis**

The growth of the town continued between the years 2000 and 2021 particularly infill developments in terms of residential development. Generally as shown in (Figure 4.1, Table 2). the agricultural land 1585.03 hectares, forest land 63.22 hectares and grass land 733.5 hectares change into Built-up area in 2000 to 2010.in the next the agricultural land 617.34 hectares, forest land 450 hectares and grass land 832.27 hectares change into Built-up area in 2010 to 2021. This indicated that built up areas consuming a considerable amount of other land use land cover (LULC) types.

**Table 2: Change Detection of three year LULC**

LULC in hectare		2010 LULC				
		Agricultural land	Built-up area	Forest land	Grass land	Water body
2000 LULC	agricultural land	<b>1075.80</b>	1585.03	58.20	329.73	0.09
	built up area	231.13	<b>2345.79</b>	256.64	646.27	1.20
	forest land	10.33	63.22	<b>408.57</b>	59.73	0.76
	grass land	77.71	733.50	564.83	<b>683.92</b>	3.21
	water body	0.00	0.34	1.63	8.70	<b>0.09</b>

LULC in hectare		2021 LULC				
		agricultural land	built up area	forest area	grass land	water body
2010 LULC	Agricultural land	<b>574.72</b>	617.34	71.21	133.74	5.96
	Built-up area	598.88	<b>3533.18</b>	350.75	227.22	0.74
	Forest land	18.22	449.99	<b>722.34</b>	102.84	0.66
	Grass land	109.89	832.27	318.95	<b>462.29</b>	1.73
	Water body	0.09	3.51	0.15	0.94	<b>0.73</b>

Source: Developed by the researcher from arc map 10.8 classification output

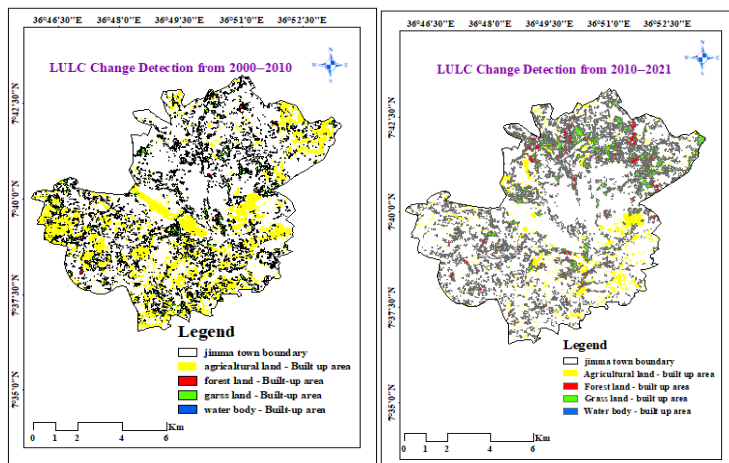


Fig.3. Three session of land use land cover Change Detection.

As shown in Table 2, the land use/land cover (LULC) changes over the study period are highlighted. The diagonal values in bold indicate areas where no LULC change occurred, while the off-diagonal values represent pixels that changed from one class to another and vice versa.

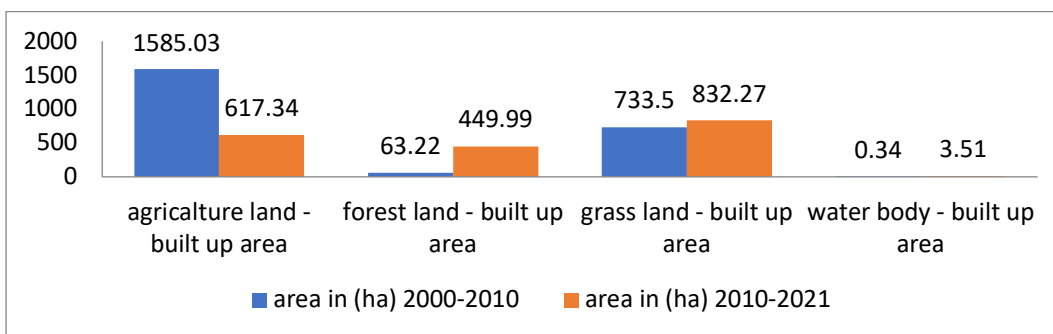


Chart 1: Graph of land use land cover Change Detection of the above map, Source:

### 3.3. Change Comparison from 2000-2021

To compare and analyze the dynamics of land use/land cover (LULC) between 2000 and 2021, the total area (in hectares) and percentage coverage of each LULC class were calculated using GIS. This enabled quantification of the spatial extent and magnitude of changes for each category, as summarized in Table 1.

As shown in Table 1, the built-up area increased significantly from 3,485.35 ha (38.05%) in 2000 to 5,452.17 ha (59.52%) in 2021, while agricultural land declined sharply from 3,053.57 ha (33.34%) to 1,303.21 ha (14.23%) over the same period, indicating that the reduction of agricultural land contributed substantially to urban expansion. Trends in other LULC categories varied over time, reflecting both increases and decreases. These patterns highlight the conversion of agricultural and other lands into built-up areas. The temporal trends for all categories are further illustrated graphically in Figure 2 (bar chart), providing a clear visual representation of the changes.

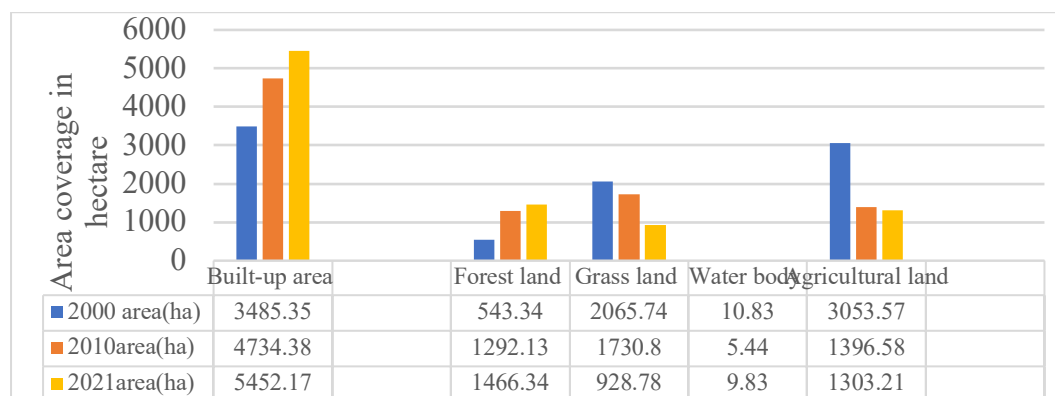


Chart 2: Graph of total area for all land use land cover classes from 2000–2021.

The percentage change, including the magnitude of increase (positive) and decrease (negative) for each LULC category, was also calculated. The results, presented in Table 3 and Chart 3, illustrate the percentage change for each category as computed using Equation 5.

**Table 3: Change in percent in time series analysis from 2000-2021**

No	LULC type (Land use land cover)	Change (2000-2010)		Change (2010-2021)	
		Area(ha)	(%)	Area(ha)	(%)
1	Built-up area	1249.03	35.84	717.79	15.16
2	Forest land	748.79	137.81	174.21	13.48
3	Grass land	-334.94	-16.214	-802.02	-46.34
4	Water body	-5.39	-49.76	4.39	80.69
5	Agricultural land	-1656.99	-54.264	-93.37	-6.68

Source: Developed by the researcher from arc map 10.8 LULC classification output.

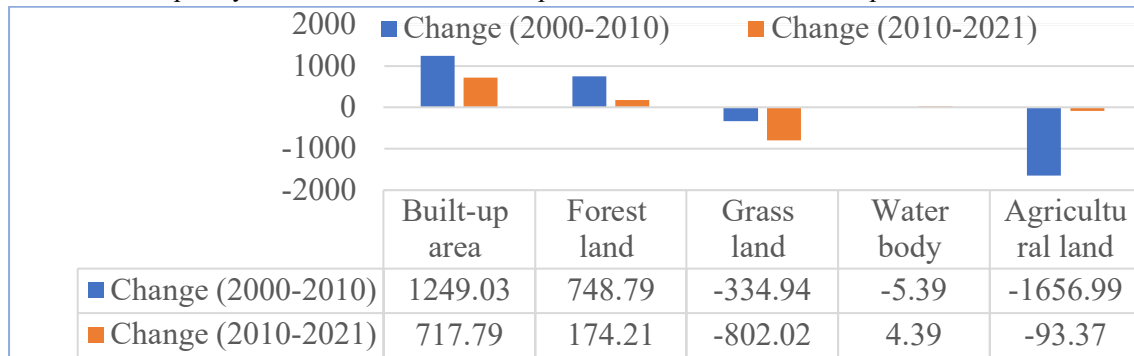


Chart 3: Change in percent in time series analysis from 2000-2021

The results indicate that the built-up area increased by 1,249.03 ha (35.84%) between 2000 and 2010, and by 717.79 ha (15.16%) between 2010 and 2021. In contrast, agricultural land declined by 1,656.99 ha (54.26%) from 2000 to 2010 and by 93.37 ha (6.68%) from 2010 to 2021. The most significant urban expansion occurred during the first decade, highlighting the town’s rapid growth. Other LULC categories, such as grassland and forest, exhibited only minor decreases and increases, respectively. These trends indicate that the conversion of agricultural land was the primary driver of the town’s built-up area expansion.

### 3.4. Change in Built-up Area (2000-2021)

The changes in built-up areas between 2000 and 2021 were mapped to visualize urban expansion over time. Classification results for each year were displayed on a single map, with green representing built-up areas in 2000, yellow for 2010, and red indicating newly developed areas in 2021. The map clearly illustrates a substantial increase in built-up areas, reflecting rapid and unprecedented urban growth that has encroached upon surrounding non-built-up lands (Fig. 5; Chart 4).

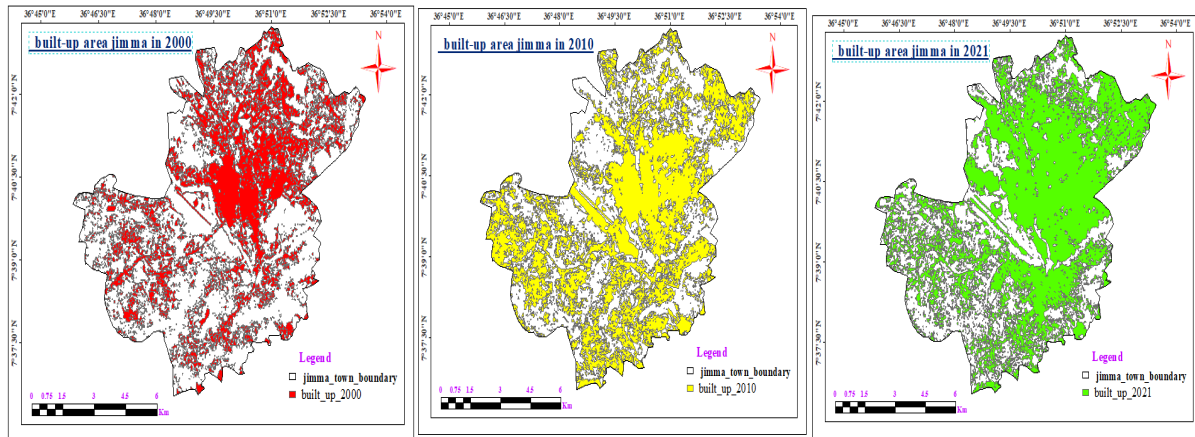


Fig.4. Change in Built-up Area (2000-2021), Source: Developed by the researcher from LULC change detection.

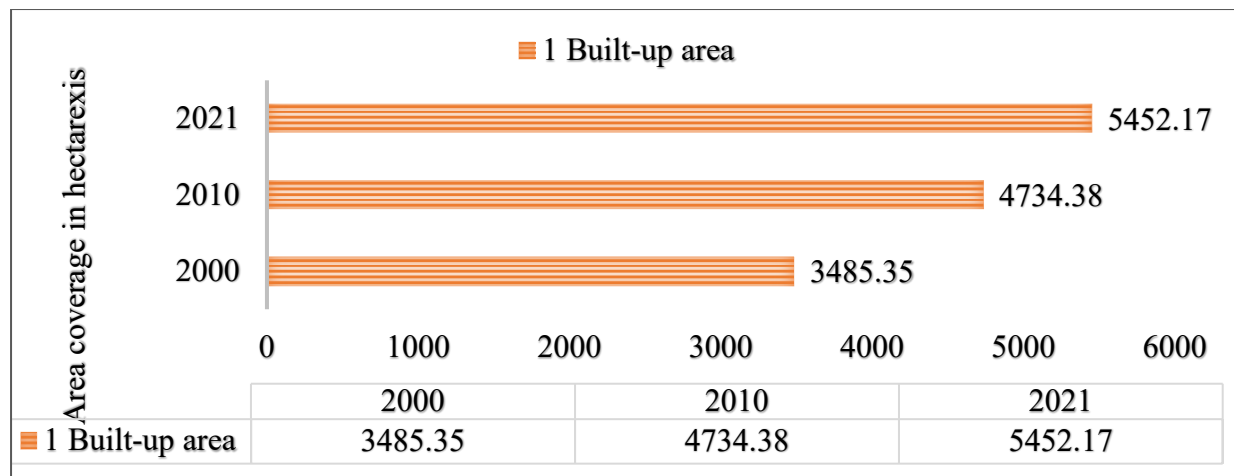


Chart 4: .Built up area coverage in hectare (2000, 2010 and 2021).

Table 4: Change in percent in time series analysis from 2000-2021

No	Year	Built-up (Ha)	Area Urban Expansion (HA)	Urban Expansion (%)
1	2000	3485.35	—	—
2	2010	4734.38	1249.03	13.64%
3	2021	5452.17	717.79	7.83%

Source: Developed by the researcher from change classification.

As shown in Chart 4 and Table 4, the built-up area of Jimma town expanded by 1,249.03 ha (13.64%) between 2000 and 2010, and by 717.79 ha (7.83%) between 2010 and 2021.

### 3.5. Dynamic Change Detection

The rate of change or rate of spatial expansion is used to compute built up area in between two time periods. Therefore, the dynamic change of built-up area between the years 2000-2010 and 2010-2021 was calculated as follows using (Equation 6).

$$\begin{aligned}
 \text{DC (2000\_2010)} &= \left[ \frac{4734.38 - 3485.35}{3485.35} \times \frac{1}{2010 - 2000} \right] 100\% = 3.58\% \\
 \text{DC (2000\_2010)} &= \left[ \frac{5452.17 - 4734.38}{4734.38} \times \frac{1}{2021 - 2010} \right] 100\% = 1.34\%
 \end{aligned}$$

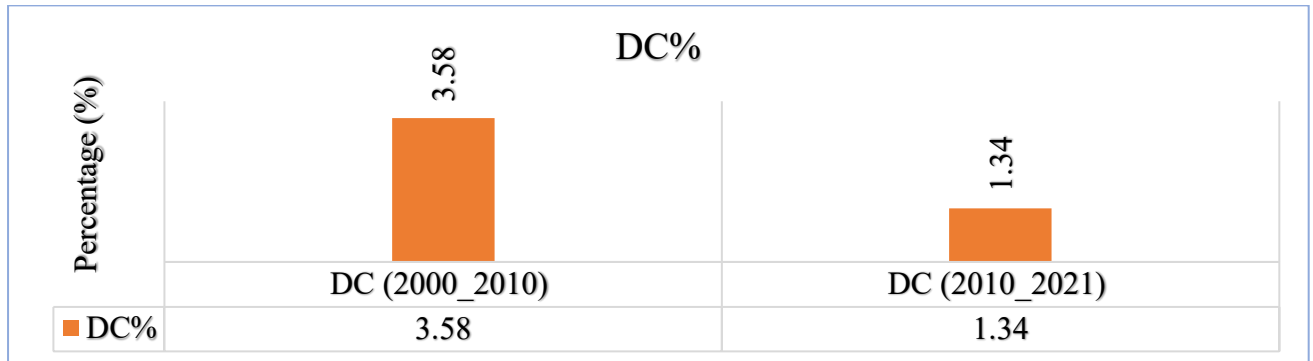


Chart 5: The rate of change in built up area from 2000–2021.

As shown in Figure 4.9, the spatial extent of built-up areas in Jimma town increased by 3.58% between 2000 and 2010 and by 1.34% between 2010 and 2021. The rate of change during 2010–2021 was lower than that of 2000–2010, indicating that urban expansion was most pronounced in the earlier period. This trend reflects the conversion of surrounding agricultural land into urban areas, which has been increasingly utilized for new housing and industrial development.

### 3.6. Estimation of built-up area for the year 2031

To estimate the future growth of built-up areas in Jimma town, it was necessary to calculate the average annual growth rate. Based on urban expansion over the past 21 years (2000–2021), the average growth rate was computed using the exponential growth model (Equation 7). The model is expressed as:

Find the growth rate of built-up area, it needs driving the formula from exponential growth formula. Thus,

$$B_f = B_o e^{rt} \text{ -----} \rightarrow r = \frac{1}{T} * \ln \left[ \frac{B_f}{B_o} \right] \text{ -----} \rightarrow \text{eq (7)}$$

The calculated average growth rate of built-up area was 3.07%. Using this rate, the town’s built-up area for 2031 was projected by applying the exponential growth formula as shown in Equation 8.

$$B_f = B_o * (1 + \%/100)^{t(f-o)} \dots\dots\dots \text{Eq. (8)}$$

$$B_f = B_o * (1 + \%/100)^{t(f-o)} \qquad B_f = 5452.17 (1 + 3.07 /100)^{10} \\ = 7377.21 \text{ hectare (built up area in 2031)}$$

Therefore, the urban expansion of the town is estimated as 7377.21 hectare in the coming 2031 it is increased by 1925.21hectare from 2021 which means 35.31 % expansion. A trend of the expansion from 2000-2031 it is presented as line graph in (chart 6) below.

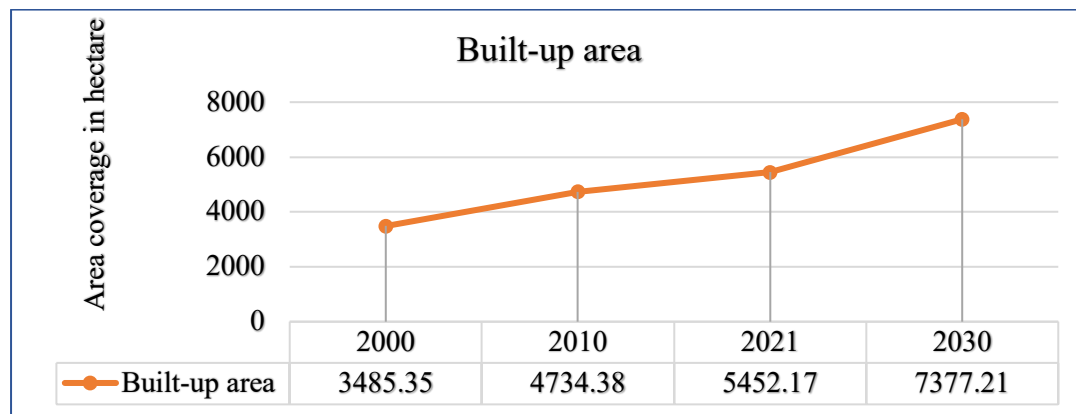


Chart 6: Urban expansion/ Built-up area estimation for 2031.

#### 4. Discussion of the Results

##### 4.1. Trend of Expansion and Land Use/Land Cover Change

To address the objectives of the study, LULC change trends for 2000, 2010, and 2021 were analyzed. In 2000, Jimma town occupied a moderate area concentrated around the town center. Between 2000 and 2010, the town expanded notably, particularly towards the northeast and central areas, driven by industrial development and infill residential projects. From 2010 to 2021, growth continued but at a slower pace, primarily along the northeast corridor and major asphalt roads connecting to Addis Ababa.

Overall, built-up areas expanded rapidly in all directions from 2000 to 2021. Similar studies have shown that horizontal urban expansion often results in the conversion of fertile agricultural land and impacts sensitive environments (Kassa et al., 2011; Diriba et al., 2015; Parvaiz et al., 2017; Sewunet, 2017). In this study, built-up area increased from 3,485.35 ha (38.05%) in 2000 to 5,452.17 ha (59.52%) in 2021, while agricultural land declined from 3,053.57 ha (33.34%) to 1,303.21 ha (14.23%), highlighting the dominant contribution of

agricultural land conversion to urban expansion. The spatial growth rate was 3.58% per year from 2000–2010 and 1.34% per year from 2010–2021, indicating the most rapid expansion occurred during the first decade.

#### **4.2. Driving Factors of Urban Expansion**

The study identified several key drivers of urban expansion in Jimma town, including population growth, industrialization, investment in commerce and services, road and transportation development, housing demand, informal access to land, urban plans, and the town's location and topography. Among these, natural population growth is a major contributor to urban expansion (Todaro, 1997). Other significant factors include economic pressure, industrial development, lack of affordable housing, and inadequate planning policies.

#### **4.3. Future Expansion of the Town**

Built-up area expansion is projected to continue in all directions, particularly along major roads and in the northeastern and central parts of the town. Based on the exponential growth model, Jimma town's built-up area is expected to reach approximately 7,377.21 ha by 2031, representing an increase of 1,925.09 ha (35.31%) from 2021.

### **5. Conclusion and Recommendations**

#### **5.1. Conclusion**

This study mapped urban expansion trends and assessed their effects on LULC dynamics in Jimma town using RS and GIS techniques, while also identifying the main drivers of urban growth from 2000 to 2021. The analysis revealed that built-up area increased significantly from 3,485.35 ha (38.05%) in 2000 to 5,452.17 ha (59.52%) in 2021, largely consuming agricultural land, which declined from 3,053.57 ha (33.34%) to 1,303.21 ha (14.23%).

The primary drivers of this expansion were industrial and manufacturing development, population growth, and the town's strategic location. Rapid urbanization, coupled with population pressure, has led to significant changes in key ecosystems, including natural forests, grasslands, and water bodies. Informal settlements in the urban periphery are a serious issue, as they contribute to inefficient land use and reduce government revenue while providing substandard living conditions. Future projections suggest that if current trends continue, built-up areas will reach 7,377.21 ha by 2031, an increase of 35.31% over 2021.

## 5.2. Recommendations

To manage the challenges of rapid urban expansion and LULC conversion, the study recommends:

1. **Strengthening land management and monitoring** using GIS and remote sensing to supervise urban land use changes and ensure adherence to urban plans.
2. **Future-oriented urban planning** by authorities, including consideration of population growth, infrastructure, and public service requirements.
3. **Sustainable urban development policies**, such as:
  - Controlling land use and residential development through land price regulations.
  - Regulating housing prices to reduce informal settlement pressure.
  - Prioritizing the renewal of existing buildings and infill development, including high-rise constructions, over conversion of agricultural land.

These measures will help balance urban growth, optimize land use, and support sustainable development in Jimma town.

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The authors declare no conflict of interest.

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