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Urban Growth and Its Impact on Urban Land Cover Change in Akure South Local Government, Ondo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Urban Growth and its Impact on Urban land cover change in Akure South Local Government area was investigated to bridge the knowledge gap created by data deficiency on the nature, scope, and magnitude of urban threat on the land use/land cover type, most especially the agricultural land in the area. This was done through the analysis of Landsat images of three epochs from 2000 through 2010 to 2020. The processing of the satellite images was done in ArcGIS 10.8, while the analysis and 2030 projection were done in Microsoft office excel using the result from the analysis. QGIS was used to remove the scan lines error on the 2010 image. The result showed increasing urban growth (built-up area), reducing vegetation and farmlands, and increasing rock outcrops. The changes vary among the different classification characteristics. Both farmlands and vegetation increased in the first epoch and reduced in the second epoch due to man's urbanization and other socio-economic activities. The increasing change in the second epoch was higher in built-up areas while rock outcrops increased throughout the study period. The research was able to assess the magnitude of farmland and vegetation that have been converted for urban uses over time. It also proved the efficiency of Remote Sensing and GIS technology in urban growth studies.

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Keywords: Urban growth; vegetation; farmland; classification; assessment; built-up; rock outcrop.

1. INTRODUCTION

Land is a basic resource for the survival and continued expansion of cities [1]. The knowledge of land use dynamics is a sine qua non to evaluate the various ecological and developmental consequences of change in land use over time [2-3]. This necessitated the relevance of land use mapping and change detection in implementing appropriate policy responses (Fasona and Omojola et al, 2005). Land-use change analysis helps to identify the process of change and characterize the land-use dynamics.

Land use/cover change impacts several related processes operating over a wide range of scales in space and time [3]. Jwan et al, 2013, identified three major causes of land use/land cover changes with differing rates and different time scales besides military conflicts. They are biophysical factors, technological and economic considerations, and institutional and political arrangements.

With rapid urbanization and a finite land area, the available land per individual shrinks drastically. The result is an urgent need for proper geo-management of land dependent upon the availability of detailed, accurate, and up-to-date data [4]. Regionally, Africa had the largest annual rate of forest loss, estimated at 0.49%, and reports from African countries documented that about 82 million ha of forest have been converted into other land uses between 1990 and 2015 [5].

Urbanization has contributed to significant changes in land use and cover types, including forest cover and agricultural land [6]. Urban expansion is a threat to both vegetation and agricultural lands in its vicinity. This is noticeable in the conversion of agricultural lands that are close to urban areas to other uses [4].

Urban growth will continue to pressure the urban ecosystem [7-8]. The conversion of agricultural lands for other urban uses tends to be very attractive in the short term because of the high economic returns from the sale of these lands and the general perception that increased urbanization is a good index of economic growth. However, these attractive benefits will present a challenge to future food production and ecosystem services that should support urban life [9].

Understanding urban expansion processes at a local scale and their impact on other types of land use that provides support for the urbanization process will help in coping with the emerging problems associated with urban development, and to ensure both environmental and socioeconomic sustainability for the ever-growing urban population [10].

The land cover change in the study area resulted from natural and socioeconomic factors and their utilization by man both in time and space [11]. Population growth and urban expansion are the primary drivers of land cover change anywhere in the world [12]. Understanding an area's spatiotemporal land cover status is an important procedure to implement future conservation measures [10].

Remotely sensed data from aerial photographs or satellite images are now being used for mapping land use and land cover changes. Remote Sensing, which is not a solution in itself but only a means to an end, has become a powerful tool in surveying and evaluating land resources, monitoring changes in the atmosphere and overall land utilization [13]. The detection of land use changes in urban and rural areas can be done much faster with the aid of data gathered from Remote Sensing devices, which can be manipulated and subjected to digital analysis. The technique has created unprecedented opportunities for nations to undertake proper inventories and evaluation of their resources, make appropriate plans for their utilization, and monitor both natural and human-induced changes in the environment [13].

Satellite data have several advantages over conventional methods [14]. They provide regular and repetitive coverage; thus, the required information can often be simply extracted from them. The data are available in digital format and so can be used directly in digital cartographic production systems. Data costs are usually much less, and the cost of establishing ground control is much easier. They are also used to gather information on inaccessible terrain [2].

1.1 Statement of the Problem

Since inception, Akure South Local Government Area of Ondo State has undergone tremendous growth and development (Fagbohunka, 2019). This has resulted in increased modification and

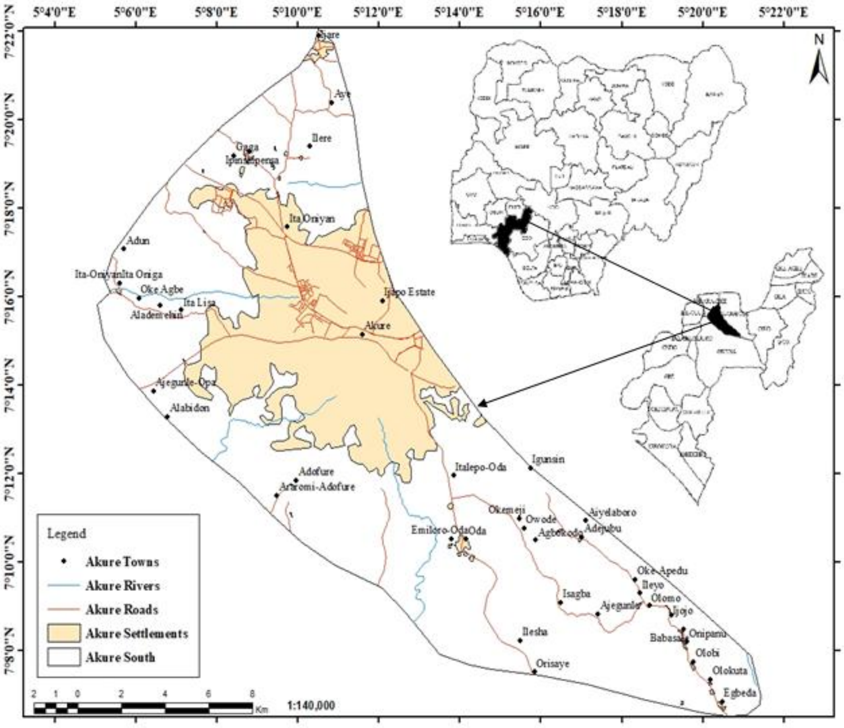

Fig. 1. The study area

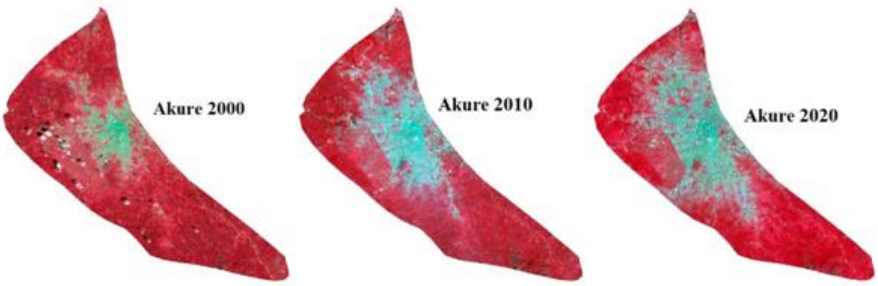

Fig. 2. Landsat Images of Akure at different Epochs

alterations in the status of its land use and land cover over time. This change has continued without any attempt at the documentation or comprehensive evaluation to know the magnitude and status. This study was instigated to bridge the huge data gap by evaluating the magnitude and rate of change in the Local Government Area from the year 2000 to 2020 to predict the projected change in the future. The product of the study will provide baseline information to policymakers on the status of the LU/LC in the study area.

1.2 Aim and Objectives

The research aimed to evaluate the impact of urban development on the immediate land use/land cover in Akure from 2000 to 2020 using geospatial technology. This was achieved through the following objectives.

1. to produce the land use land cover map of Akure and its environs using multi-temporal satellite imageries of the study area.
2. to determine the nature and scope of change (primarily urban) through the analysis of the map produced above.
3. to determine the annual rate of change in the land use cover and predict the future change in the area.
4. to evaluate the socioeconomic implications of the LULC change in the study area.

1.3 The Study Area

Akure South Local Government is one of the eighteen local government areas in Ondo State with the administrative headquarters in Akure, the state capital. It is located between longitude 5^0 5^1 00^{11}E to 5^0 22^1 00^{11}E and latitude 7^0 6^1 00^{11}N to 7^0 22^1 00^{11}N with an area of 317.61km^2. It is bounded by Owo Local Government Area in the east, Akure North and Ifedore Local Government Areas in the north, Ile-Oluji/Oke-Igbo Local Government Area in the west, and Idanre Local Government Area in the south. The city's rapid growth, particularly within the last 28 years, has made it one of the fastest growing metropolitan cities in Southwestern Nigeria [15]. Akure experiences a warm, humid tropical climate, with two distinct seasons, the rainy and dry [16]. The rainy season lasts for about seven months, April to October. Akure and its environs experience a frequent annual rainfall of over 1500 mm with a short August break. The average temperature is about 22°C during harmattan (December to February) and 32°C in March. The vegetation is tropical rainforest and drained by River Ala and its tributaries [16]. The majority of the people in the area are predominantly farmers that engage in both arable farming such as yam, cocoyam, cassava, corn, plantain etc, and cash crops such as cocoa, Kola nut, palm tree etc. The population was 353, 211 (175,495 males and 177,716 females) according to 2006 population census by the National Population Commission. The major occupation in the area is agriculture. Trading is a common economic activity among the women.

2. METHODOLOGY

Landsat images of three epochs of the study area for year 2000, 2010 and 2020 were downloaded from the Glovis website. The scan lines on the 2010 image were removed through the raster analysis in QGIS 3.18. The different scenes of the images at various epochs were subset into the area of interest using the Local Government administrative boundary of Nigeria obtained from the office of the Surveyor-General of the Federation. ArcGIS 10.8 was used in image processing (colour composite and subsetting), analysis (image classification through maximum likelihood classifier, vectorization and geometric calculations), and cartographic presentation of results. Statistical analysis was done using Microsoft office excel 2016. The 2030 projection was made using the forecast function of Microsoft office excel, while the annual rate of change was calculated using the formula;

Annual Rate of Change = % change/100 * number of study years

2.1 Land use/land Cover Distribution of the Study Area

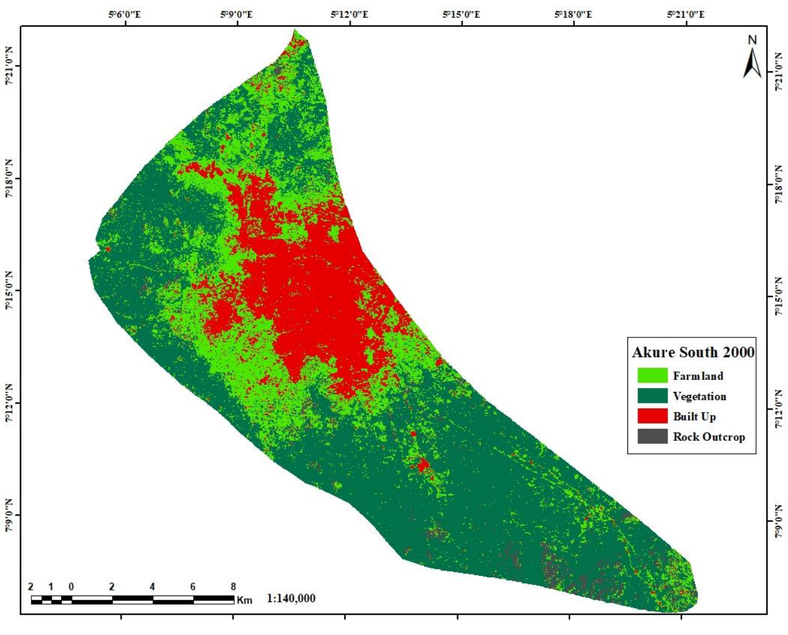

Fig. 3. Land Use/Land Cover map of Akure (2000)

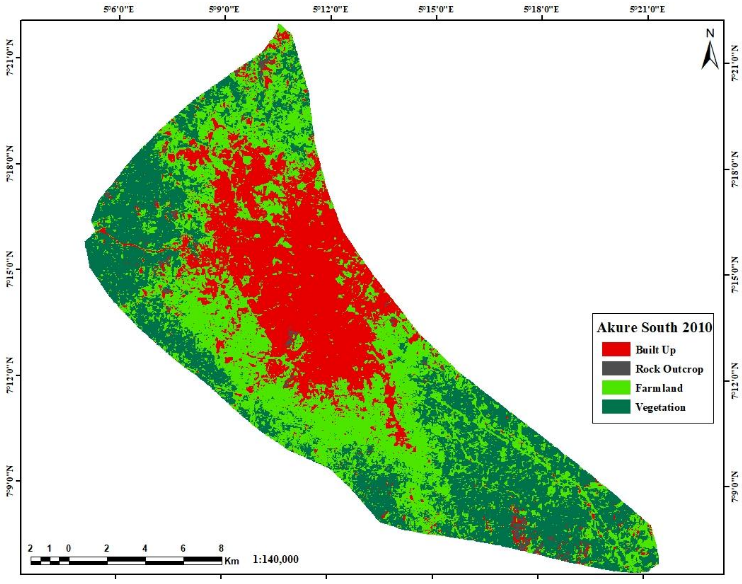

Fig. 4. Land Use/Land Cover map of Akure (2010)

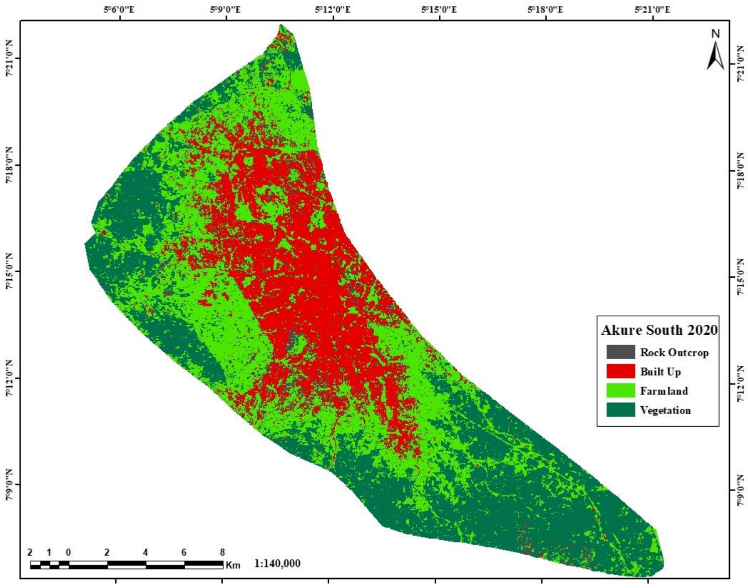

Fig. 5. Land Use/Land Cover map of Akure (2020)

3. RESULTS AND DISCUSSION

Figs 3-5 shows the land use/land cover of Akure South Local Government area in three epochs of 2000, 2010, and 2020. The land use/cover maps were produced at an overall accuracy of 90.22% and Kappa coefficient of 0.81 for 2020 datasets, 74.61% and 0.71 for 2010 dataset and 78.12% and 0.78 for 2000 dataset respectively.

Table 1 and appendix 1show the study area's land use/land cover distribution in square kilometers and percentages. The built-up area increased from 59.68 km^2 (18.79%) in 2000 through 72.62 km^2 (22.86%) in 2010 to 87,18 km^2 (27.45%) in 2020. The rapid growth in the built-up area was due to the citizen's rush to the state capital for white collar jobs. This movement into the state capital resulted in population growth in Akure. The increased population needed shelter ad the best they could do was to destroy the surrounding farmlands and forest to erect a building. As long as the population in Akure continues to increase, the built-up area will keep on expanding.

Table 1. Land use/land cover distribution of the study area in square kilometers and percentages

	2000		2010		2020	
Classes	**Area (Sq.km)**	**Area (%)**	**Area (Sq.km)**	**Area (%)**	**Area (Sq.km)**	**Area (%)**
Built-Up	59.68	18.79	72.62	22.86	87.18	27.45
Farmland	82.77	26.06	120.18	37.84	114.34	36.00
Rock Outcrops	13.59	4.28	18.71	5.89	24.21	7.62
Vegetation	161.57	50.87	106.11	33.41	91.88	28.93
Total	317.61	100.00	317.61	100.00	317.61	100.00

Table 2. Change trend of the study area

Change	Built Up	Farmland	Rock Outcrop	Vegetation
2010-2000 (sq.km)	12.94	37.41	5.11	55.46
2020-2010 (sq.km)	14.57	-5.84	5.5	-14.23

Farmland covered an area of 82.77 km^2 (26.06%) in 2000 and absorbed an area of 120.18 km^2 (37.84%) in 2010. This cover type later contracted to 114.34 km^2 (36%) in 2020. The increase in the second epoch was a result of the conversion of vegetation to farmland due to increase in population. The reduction in the second epoch might be attributable to the diversification of the economy of the citizens to other sources of income outside agriculture and the degradation of the farmland to a wasteland.

Rock outcrops increased throughout the study period. It engrossed a total area of 13.59 km^2 (4.28%) in 2000, 18.71 km^2 (5.89%) in 2010 and 24.21 km^2 (7.62%) in 2020. The increasing trend was owing to the opening up of hidden/covered rock bodies for building, and other construction works in the state capital and its environs. It could also be due to erosion washing off the soil cover on the rock bodies.

Vegetation shrank throughout the study period. This was owing to the destruction of the vegetal cover for fuelwood and illegal logging activities. The vegetation close to settlements was also being gradually converted to farmland and built-up area. On this note the vegetation lessen from 161.57 km^2 (50.87%) in 2000 to 106.11 km^2 (33.41%) in 2010 and 91.88 km^2 (28.93%)

3.1 Nature and Magnitude of Change in the Study Area

Table 2 and appendix 2 show the change distribution in the study area from 2000 to 2020. Within the period under investigation, it was observed that built-up areas expanded from 12.94km^2 in the first epoch (2010-2000) to 14.59km^2 in the second epoch (2020- 2010). The change in the first epoch was not as big as the second. This change might be attributed to the corresponding increase in the population of the area. As the population grows, there is always the need to provide housing to shelter the populace.

Rock outcrop in the same vein gained throughout the study period. The increase might be due to erosion and deforestation in the area, exposing some rock outcrops. The use of this resource in almost all the construction works will continue to reduce its coverage in the area in the nearest future.

Farmland gained in the first epoch and lost in the second epoch. The reduction in farmland could be attributed to the anthropogenic activities of the increased population in the area. Farmlands that are hitherto close to settlements are also converted to build-up areas. The reduction in farmlands has reduced the land available for crop production. This has a negative effect on food security. The reduced decrease of farmland might be attributed to the diversification of the economy by the increasing population in the second epoch.

Vegetation contracted throughout the study period. Trees are being cut down continuously to meet up with other human-induced activities in the area like furniture, roofing, and fire/fuelwood consumption. Some of these vegetations are being converted to farmlands. De-vegetation, on the other hand, exacerbates the loss of biodiversity. In all, there was a conversion of land use/land cover from one form to the other.

3.2 Annual Rate of Change

Table 3. Annual rate of change

LULC Classes	2010-2000	2020-2010	Annual Rate of Change	
	%	%	2010-2000	2020-2010
Built Up	4.07	4.59	0.41	0.46
Farmland	11.78	-1.84	1.18	-0.18
Rock Outcrop	1.61	1.73	0.16	0.17
Vegetation	-17.46	-4.48	-1.75	-0.45

3.3 Projection of Change

This was done using the forecast function [17-18] of the Microsoft office excel 2016

By 2030, the built-up area, farmland and rock outcrop are projected to cover about 100.66 km^2, 136.45km^2 and 25.08km^2 of the study area respectively in the increasing trend, while vegetation will cover 79.22km^2 in a reducing trend [19-20].

Table 4. 2030 projection of land use/land cover change in Akure

Classes	2000 km^2	2010 km^2	2020 km^2	2030 km^2
Built Up Area	59.68	72.62	87.18	100.66
Farmland	82.77	120.18	114.34	136.45
Rock Outcrop	13.59	18.71	24.21	25.08
Vegetation	161.57	106.11	91.88	79.22

4. CONCLUSION

The impact of urban development on farmlands and vegetation in Akure south local government was assessed from 2000 to 2020. This was done by classifying Landsat images of Akure from 2000 through 2020 using the supervised image classification method in ArcGIS. The LULC maps produced were used to investigate the loss of vegetation and farmlands to urban expansion in the study area. The analysis of the LULC maps showed the differences in farmland and vegetation loss in the area due to urbanization. Over the 20-year study period, urbanized (built-up) areas increased at a geometric rate. Agricultural land increased in the first epoch and reduced in the second due to rapid urbanization in the study area.

The study demonstrated that a rapid assessment of the magnitude of vegetation and farmlands that have been converted for urban uses over some time is achievable. Remote Sensing through satellite images provides a quick and effective way of monitoring the impact of urban expansion on the natural environment. Results from this study will serve as baseline information forpolicymakers and planners at the local level of administration in ensuring sustainable urban expansion. The loss of farmlands to urbanization will impact negatively on food production in the study area.

DISCLAIMER

The products used for this research are commonly and predominantly used in our research study area and country. There is no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for litigation but the advancement of knowledge. Also, the research was not funded by the producing company rather, it was funded by the personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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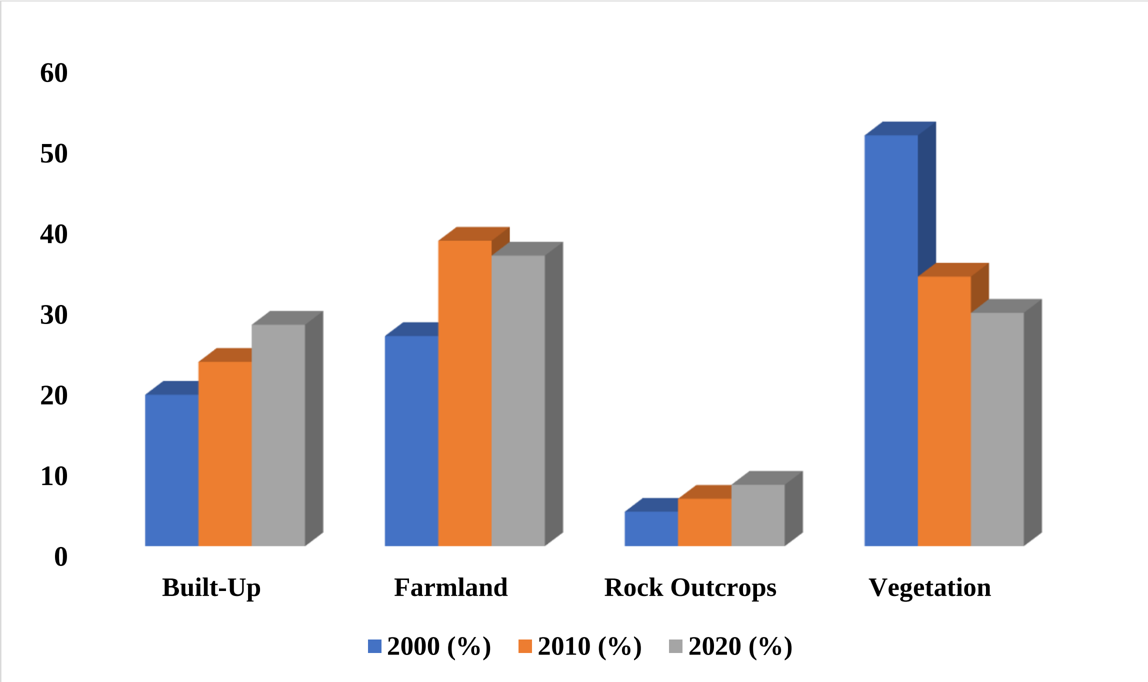
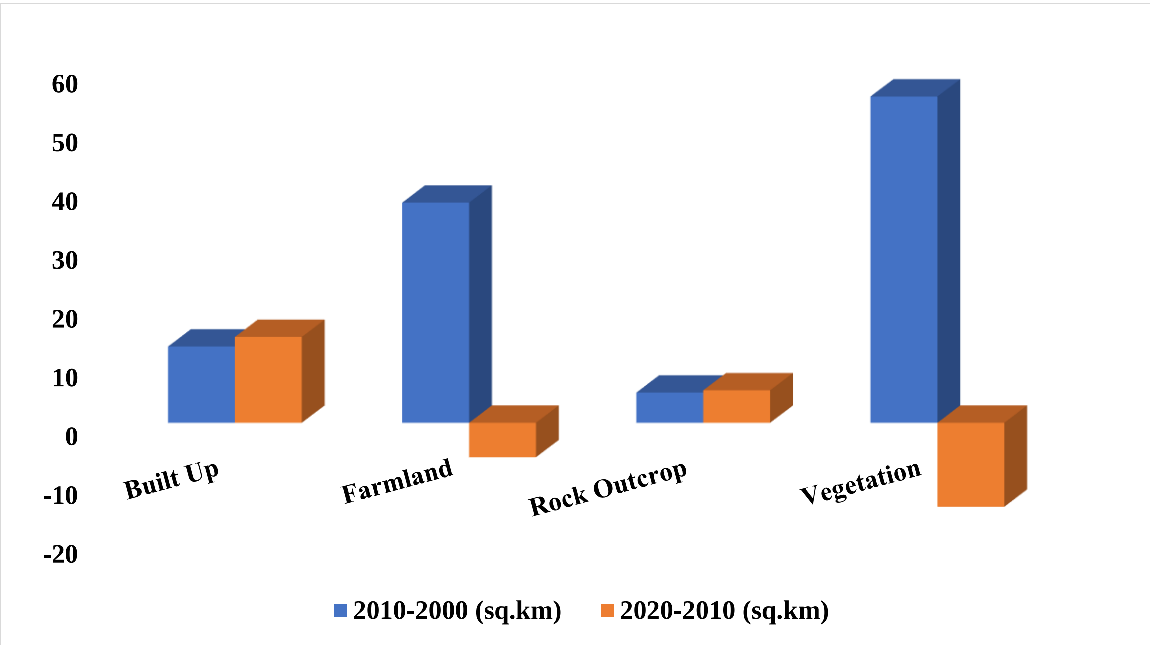
APPENDIX

Appendix 1. Bar chart showing the Land use/land cover distribution of the study



Appendix 2. Bar chart showing the dynamics of land use/land cover in the study area



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