AIJR Preprints
Section: Working Paper
Article Id: 412, Version: 1, 2022
DOI: https://doi.org/10.21467/preprints.412
URL: https://preprints.aijr.org/index.php/ap/preprint/view/412

{Click on above link or DOI to see the latest available version of this article}

NOT PEER-REVIEWED

Version 1: Received: 03 October 2022 / Approved: 04 October 2022 / Online: 05 October 2022

Towards Transforming Osogbo into a Sustainable City, The Remote Sensing Perspective

Olawale Williams Aluko[1], Apollonia Okhimamhe[1*], Sadiq Abubaker[1,2]

[1]Department of Geography, School of Physical Sciences, Federal University of Technology, Minna, Nigeria
[2]Strategic Space Applications, Cadastral Mapping and Urban Space Application,
National Space Research and Development Agency, FCT, Nigeria.

Abstract

This study has examined the impact of rapid urbanization on the sustainable development of Osogbo and demonstrated the use of remote sensing as a tool in achieving a sustainable city. Having identified urbanization in its entirety as a major determinant of whether or not a city will and can attain sustainability. Primary data through questionnaires administration was employed to obtain data on demography, occupation, waste management practices, etc, and three Landsat images (Landsat TM 5, ETM +7, and Landsat 8 OLI/TIRS) covering Osogbo for the years 1998, 2002 and 2017 respectively were analyzed into different land use land cover classes to demonstrate the impact of rapid urbanization on the study area over space and time serving as the major source of secondary data. The research revealed that, over the years there has been a shift from the vegetative type of land cover to other types of land use particular among which are settlement and commercial land use types leading to a considerable increase in urban area and a decrease in vegetation as evident in the analyzed satellite images and the questionnaire report. Based on the questionnaire report and field survey, there seems to be some positive change in Osogbo, especially in terms of waste management, road networks, and education facilities, which can be attributed to the state government's effort in making the capital city more conducive for residents and befitting as a state capital, but the city can still not be considered as been on the path to sustainability. Being the administrative and commercial center of Osun state, the city keeps increasing in population and as agreed by the respondents, there is the danger of overcrowding, destruction of green areas to erect buildings, increasing rate of unemployment, deforestation, and other population-related issues. These don't in any way portray Osogbo as a sustainable city or one in the making. Also, the city's energy sector is still highly dependent on fossil fuels (petroleum), and the transportation system needs improvement to reduce the city's contribution to the greenhouse gas effect.

Keywords: Urbanization, Sustainable Development, Sustainable City, Remote Sensing, Land Use, Land Cover.

How to Cite:

Itai Carmeli, "Towards Transforming Osogbo into a Sustainable City, The Remote Sensing Perspective". *AIJR Preprints*, 412, Version 1, 2022.

1 Introduction

Urbanization generally has been identified to have a direct impact on sustainable development both positively and negatively. "Cities are increasingly the home of humanity. They are central to climate action, global prosperity, peace, and human rights. More than half of all people live in cities and human settlements, and that proportion is projected to grow to two-thirds by 2050. To transform our world, we must transform its cities. Through SDG 11, urbanization is recognized as an important factor in sustainable development. Even though there are positive effects linked to urbanization, it also poses threats and challenges to certain aspects of sustainable development, as the quality of life can decrease through poorly managed urban migration."

A city that cannot contain effectively the resultant effect of urbanization cannot attain the status of a sustainable city because the more industrialized it becomes, the more people it attracts, and urbanization in all its form is accompanied with among other things, increased pressure on existing structures, the need for more and well-planned means of transportation, waste management problem, increase in slum population, pressure on available resources, increase in built-up area at the expense of vegetative cover, etc.

Making cities safe and sustainable means ensuring access to safe and affordable housing and upgrading slum settlements. It also involves investment in public transport, creating green public spaces, and improving urban planning and management in a way that is both participatory and inclusive. A city can therefore be defined as becoming more sustainable if it is reducing its resource inputs (land, energy, water, and materials) and waste outputs (air, liquid, and solid waste) while simultaneously improving its liveability (health, employment, income, housing, leisure activities, public spaces, and community).

This study aims to give the remote sensing approach to sustainable development planning of cities using the study area as a case study. In this study the land use and land cover dynamics of Osogbo will be assessed, the expansion of settlement within the city will be examined and the consequences of land cover changes in the city will be assessed in a bid to identify how the challenges of attaining the status of a sustainable city can be solved in the study area using remotely sensed data from Landsat Images.

Osogbo the capital of Osun lies between Longitudes 4˚ 28' 43'' and 4˚ 40' 12'' East and Latitudes 7˚ 42' 10'' and 7˚ 51' 10' North with an area of 47kmsq. According to the 2006 Population and Housing Commission Census, the city has a population of 156,694 people. It shares boundaries with Ikirun, Ilesa, Ede, Egbedore, and Iragbiji and it is easily accessible from any part of the state because of its central nature. It is about 48km from Ife, 32km from Ilesa, 46km from Iwo, 48km from Ikire, and 46km from Ila-Orangun.

The inflow of people into Osogbo started with the siting of the cotton growing and ginning industry in 1907 by the British cotton growing association. This continued with the building of the first factory by the Nigerian tobacco company (NTC) and the construction of railway tracks linking it to other parts of Northern Nigeria that same year. The emergence of Osogbo as the capital of the newly created Osun state in 1991 further brought about many infrastructural changes as well as an inflow of people who came seeking job opportunities resulting in urban growth which necessitate a lot of changes in land use and land cover (increase in built-up areas at the expense of vegetative cover). For a pre-existing city such as Osogbo, attaining the status of a sustainable city, therefore,

entails management directed towards reducing the inputs of energy, water, and food and reducing the outputs of heat, water, and air pollution. This requires deliberate action toward more sustainable living such as creating a greener ecosystem, a more energy-efficient environment, and a more innovative community that is safe for all forms of life. To achieve this, there is the need to monitor and assess the urbanization trend, its impact on the city, how the city is coping with this growth and look into how well this growth can be managed to set it on the path of attaining a sustainable status necessitating this research.

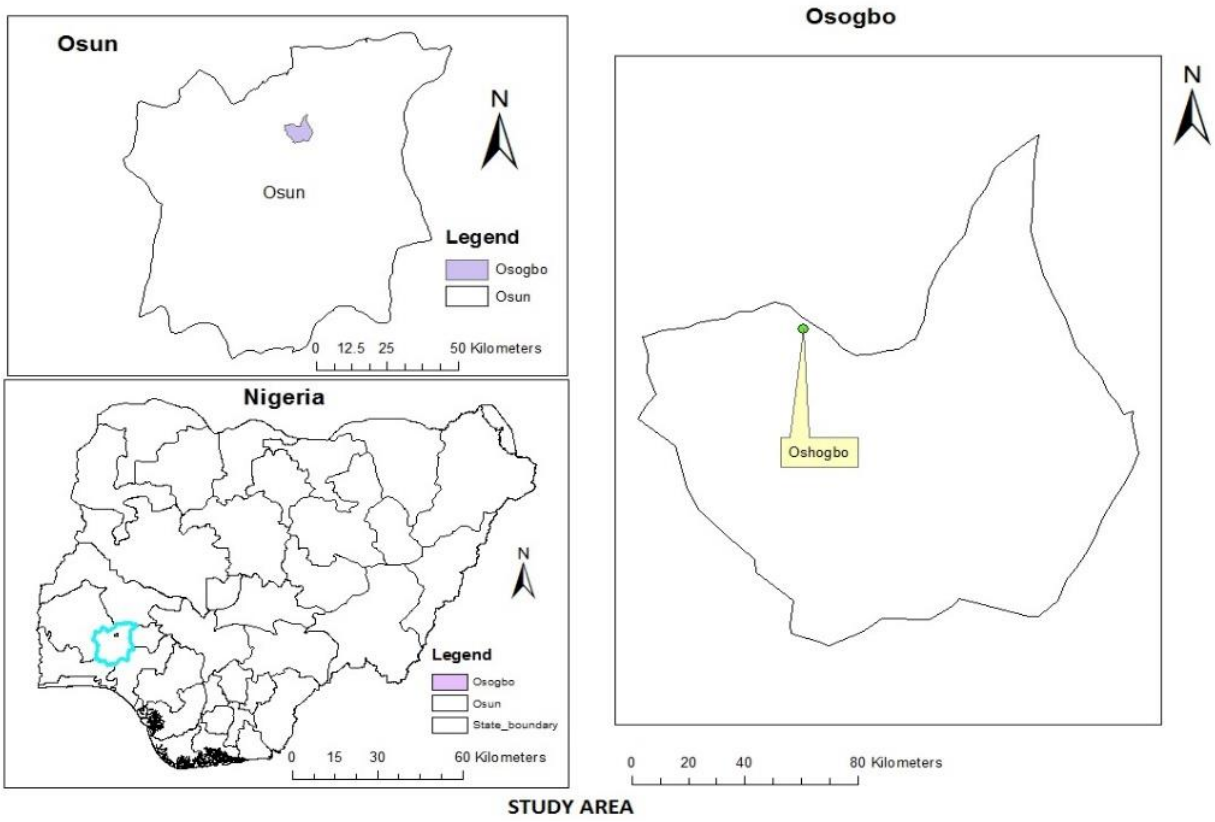

Figure 1.1: Study Area (Map of Nigeria, Osun showing Osogbo) Source: Author

1.1 Scope

Spatial Scope: This research will be restricted to the geographic boundary of study area (Osogbo) which is capital of Osun State. Osogbo the administrative center of Osun has experienced a lot of physical and infrastructural transformation, especially since becoming the state capital.

Temporal Scope: This study will examine the land use and land cover dynamics of the study area from 1997-2017 to see how it has been evolving over the years, especially since becoming the state capital in 1991. Although it became the state capital in 1991, it until 1996 housed the headquarters of two local government areas, Osogbo and Olorunda. Three datasets (for the years 1997, 2007, and 2017) will be classified into land use and land cover map with 1997 as the base year.

Content Scope: The content scope of the study will be basically on accessing the physical and socio-economic impact of urbanization on the study area. There is a need to understand the dynamics of a city's urban growth so as to know what really needs to be sustained and where efforts need to be channelled to achieve this. This study will therefore be restricted to accessing the impact of change in urbanization on the sustainability of the study area through the use of land use land cover change dynamics to demonstrate how much this change in urbanization has impacted the land use land cover of the study area.

2 Research Methodology

2.1 Data

So as to identify the different land use and land cover types, and get first-hand information about the people's mode of transportation, occupation, waste management practices, etc. A field survey will be carried out serving as the major source of primary data for this study.

Imageries from the Landsat mission which include Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) acquired on the 16th of November 1998, 3rd of January 2002 and 4th of January 2017 respectively are the main source of secondary data in this study.

The satellite images will be downloaded from the United States Geological Survey (USGS) website (http://earthexpolrer.usgs.gov/). The images have been processed by NASA which generates radiometric calibration and atmospheric correction algorithms. All bands will be used for this study to derive Land Use and Land Cover Classification.

2.2 Research Method

To evaluate the Spatio-temporal changes that have occurred within the data set periods so as to be able to evaluate the impact of rapid urbanization on Osogbo, the satellite imageries will be classified into land use and land cover classes.

To classify the images into land use and land cover classes, supervised classification using the Maximum Likelihood Classification algorithm which assigns a cell to the class of the highest probability in which the probability value is the statistical distance based on the mean values and covariance matrix of the clusters will be used. This method involves the spectral characteristics of the classes defined by identifying training samples after which the image classification will be done.

Based on the knowledge of the study area, the classes used for the classification are shown in table 2.0 below.

Table 2.0: Categories of land use types

S/N	LAND USE TYPES	DESCRIPTION
1.	Built-up area	All infrastructures such as commercial buildings, residential, roads, shanties, makeshift buildings, freight containers, and all other areas of conceivable water-closet less unheard-of set of roads; would be medium-sized villages or a hut with just one road passing through.
2.	Vegetation	All forms of vegetative cover growing on land, in between urban structures, and on water.
3.	Rock Outcrops	All visible bedrock on the surface.
4.	Water bodies	All water bodies including rivers, streams, lakes, reservoirs, tributaries, and channels

The workflow for the analysis is shown in figure 2.1.

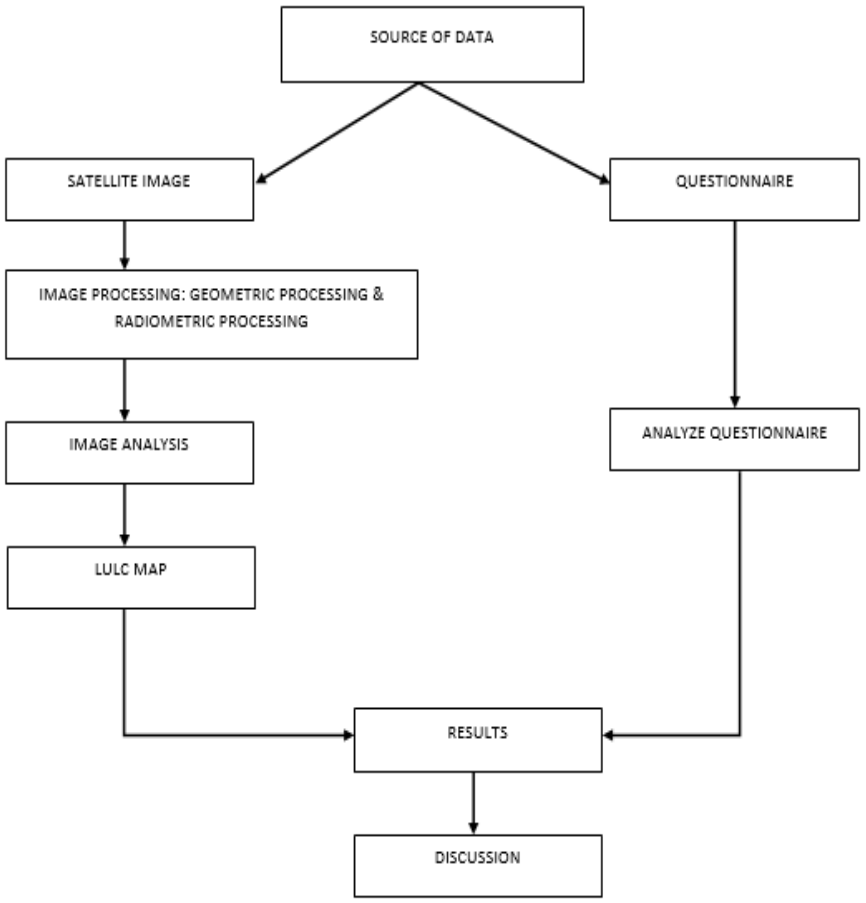

Figure 2.1: Workflow for analysis Source: Author

2.3 Sample Size

The sampling size will be determined using the formula proposed by Yamane using the 2019 projected population from the 2006 population data for Osogbo.

The formula is stated thus:

Where:

n = Required sample size from the population under study

N = The population of the study area.

e = Sampling error.

Taking e to be 0.05 and N to be 787,676 people which is the 2019 population of Osogbo as projected from the 2006 census data.

n = 400.203.

n ≈ 400.

Since the research is scoped spatially within ten (10) out of the fourteen (14) districts in Osogbo. 290 questionnaires will be administered and used for this study, representing the ten (10) districts out of the total 14. This number was arrived at after dividing the sample size (n) above by 14 (being the total number of districts in Osogbo), the answer gotten which is 29, was now multiplied by 10 (being the total number of districts selected for the questionnaire survey) to get 290.

Sample Frame: The sample frame will be all the population in the selected ten (10) districts in the study area out of the total 14 districts and the information gathered will be used to generalize for the interest of the entire population. These districts are Aiyetoro, Alekuwodo, Oke Ijetu, Odiolowo, Oke Ayepe, Oke Oniti, Okefia, Ota Efun, Ajegunle, Fagbewesa. These districts were chosen based on their locations. Oke Ayepe and Oke Ijetu are located on the outskirt of Osogbo and hence still have some natural vegetation, also they are gateways to the city's centre and point of call for first timers to the city while the remaining districts (Aiyetoro, Alekuwodo, Odiolowo, Okefia, Ota Efun, Ajegunle, Fagbewesa.) are in the city's centre constituting the bulk of the urbanized areas and are the central business districts. This is done in other to have an idea about how infrastructural services are distributed and to know if the government gives as much attention as it is given to the central business districts to the surrounding districts (identify if development is spread across the city or not) because one of the principles of sustainable development is that of intragenerational equity. A total of 29 questionnaires will be administered to each of these districts (making a sum of 290 for the 10 districts).

Sample Procedure: The sampling procedure to be used is the stratified random sampling technique which will involve the division of the population into strata. The ten (10) districts chosen will form the strata for the sampling and will serve as the sampling population which will best represent the entire population being studied.

The questionnaires will be administered to randomly selected members of each stratum. The data obtained from the questionnaire will then be analysed statistically in order to assess the impact of rapid urbanization on the sustainability of Osogbo.

3 Results and Discussion

3.1 Assessment of Land Use and Land Cover of Osogbo 1998, 2002 and 2017

As discussed in the methodology, supervised maximum likelihood classification was used to obtain the land use and land cover (LULC) maps for all three years (1998, 2002, and 2017) after which the statistics showing the area estimates and changes that have occurred in the study area were computed. The land use and land cover (LULC) change data were analysed into four categories which are Built-up land, rock outcrops, vegetation, and water bodies.

Figures 3.1, 3.2, and 3.3 show the LULC maps for the years 1998, 2002, and 2017 respectively.

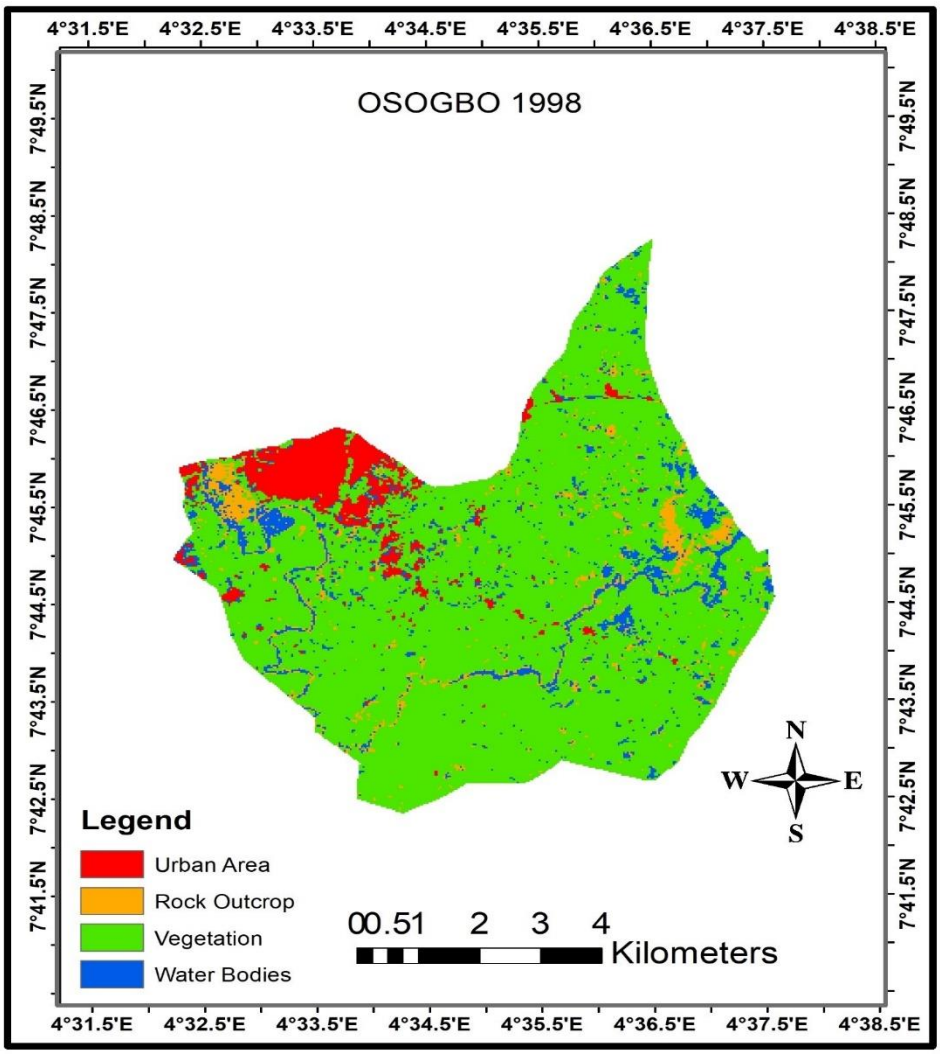

Figure 3.1 Land Use Land Cover of Study Area in 1998

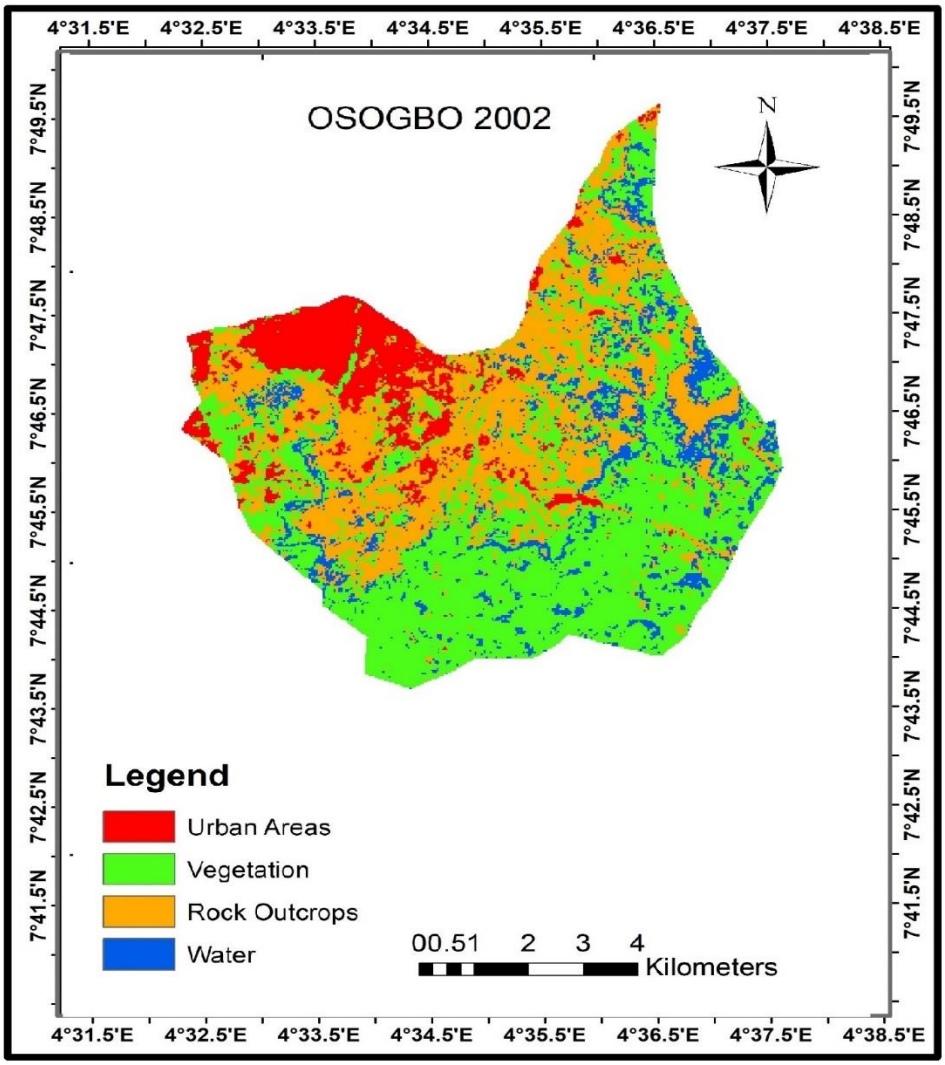

Figure 3.2 Land Use Land Cover of Study Area in 2002

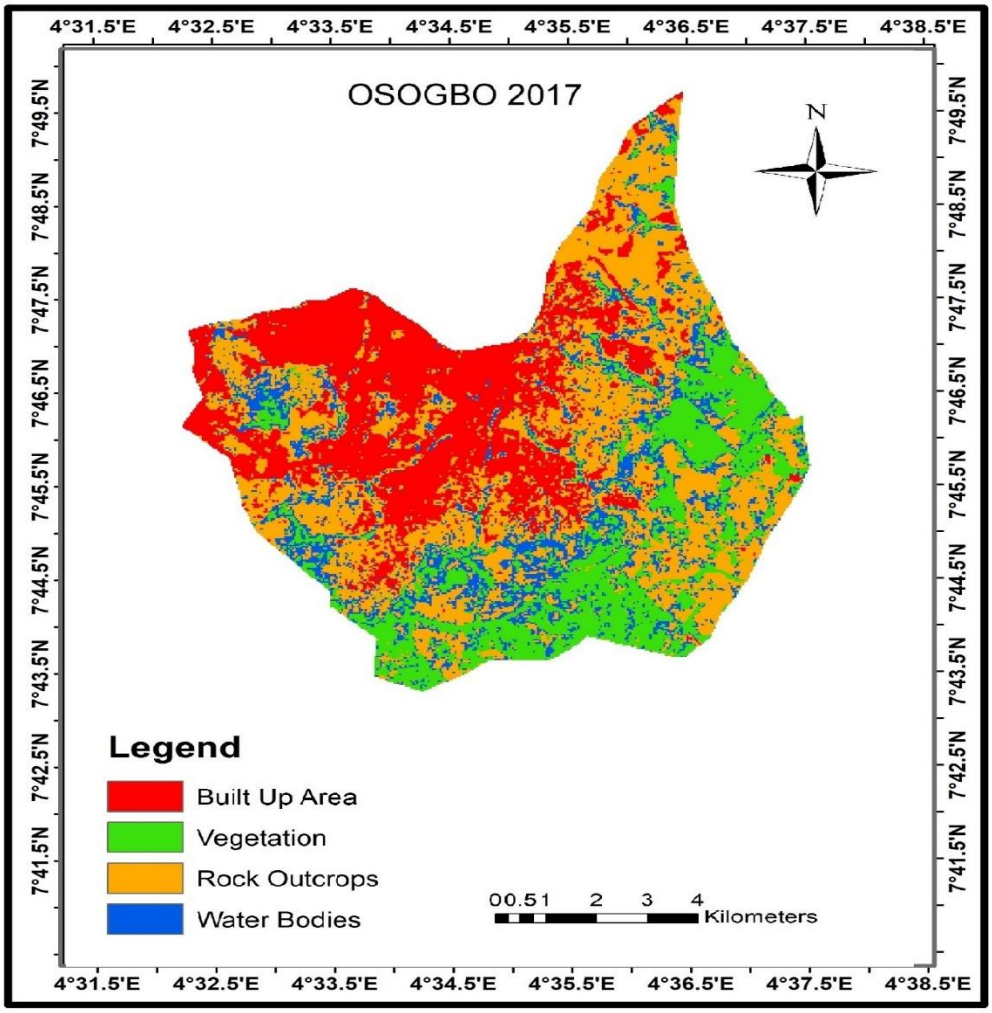

Figure 3.3 Land Use Land Cover of Study Area in 2017

3.2 Spatial Extent of Land use and land cover

Table 3.1 gives an overview of the area estimates for the land use and land cover classes of the study area derived from the classification results.

Table 3.1: Area Statistics of Land use and land cover Classes for 1998 – 2017

LULC	1998		2002		2017	
	Area(km²)	%	Area(km²)	%	Area(km²)	%
Urban Area	3.72240	6.71	6.50250	11.73	15.88500	28.65
Vegetation	44.86230	80.91	24.81930	44.76	10.49850	18.93
Water Bodies	4.08690	7.37	6.05610	10.92	8.06220	14.54
Rock Outcrops	2.77470	5.00	18.06840	32.59	21.00060	37.88
Total	55.44630	100	55.44630	100	55.44630	100

For the years 1998 and 2002 respectively, vegetation was the predominant land use type having 80.91% and 37.88% of the total area, this is in agreement with 45% of the questionnaire respondents (28% for forest/woodland and 17% for farmland). In 1998 rock outcrops occupied 5% of the total area, water bodies 7.37%, and the urban area occupied 6.71% of the total area.

In 2002, rock outcrops occupied 32.59% of the total area, water bodies 10.92%, and the urban area occupied 11.73% of the total area.

In 2017, vegetation was 18.93% of the total area, rock outcrops occupied 37.88% of the total area (the highest land cover type in the year 2017), water bodies 14.54%, and the urban area occupied 28.65% of the total area. Water constitutes the lowest land cover type in all three years with 7.37% in 1998, 10.92% in 2002, and 14.54% in 2017 of the total area.

There was a great increase in urban area in the study area from 6.71% in 1998 to 11.73% in 2002 and 28.65% in 2017 while on the other hand, vegetation greatly decreased from 80.91% in 1998 to 37.88% in 2002 and 18.93% in 2017, as attested to by 92% of the questionnaire respondents who indicated that there has been an increase in urban area at the expense of vegetation which 54% of them agreed has actually experienced a decrease.

Graphically the area statistics of LULC classes presented in table 1 above are represented in figure 3.4 below.

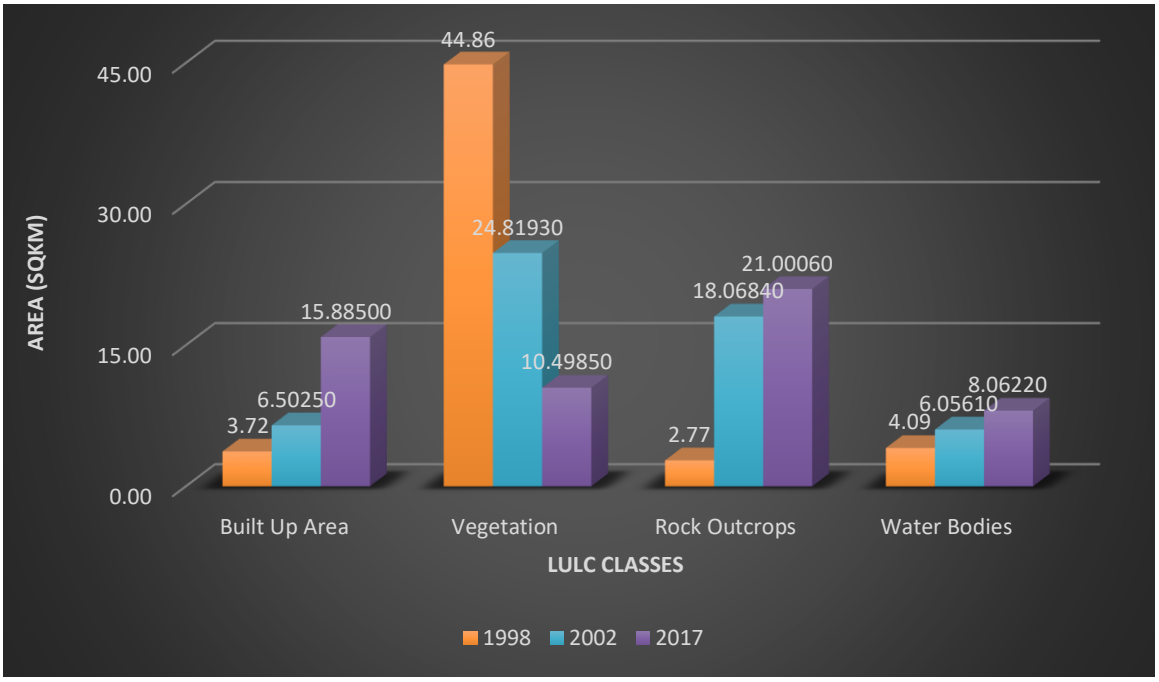

Figure 3.4 Land Use Land Cover distribution and changes in the study area 1998-2017

3.3 Area Statistics of Land use and land cover and Net Changes during 1998-2017

Table 3.2: Area Statistics of Land use and land cover and Net Changes during 1998– 2017

LULC	1998		2002		2017		Net Changes
	Area(km²)	%	Area(km²)	%	Area(km²)	%	km²
Urban Area	3.72240	6.71	6.50250	11.73	15.88500	28.65	12.1626
Vegetation	44.86230	80.91	24.81930	44.76	10.49850	18.93	-34.3638
Water Bodies	4.08690	7.37	6.05610	10.92	8.06220	14.54	3.9753
Rock Outcrops	2.77470	5.00	18.06840	32.59	21.00060	37.88	18.2259
Total	55.44630	100	55.44630	100	55.44630	100	

The table above presents the net changes that have occurred in the different land cover and uses over the study year (1998-2017) in square kilometers and are presented graphically in figure 3.5 below.

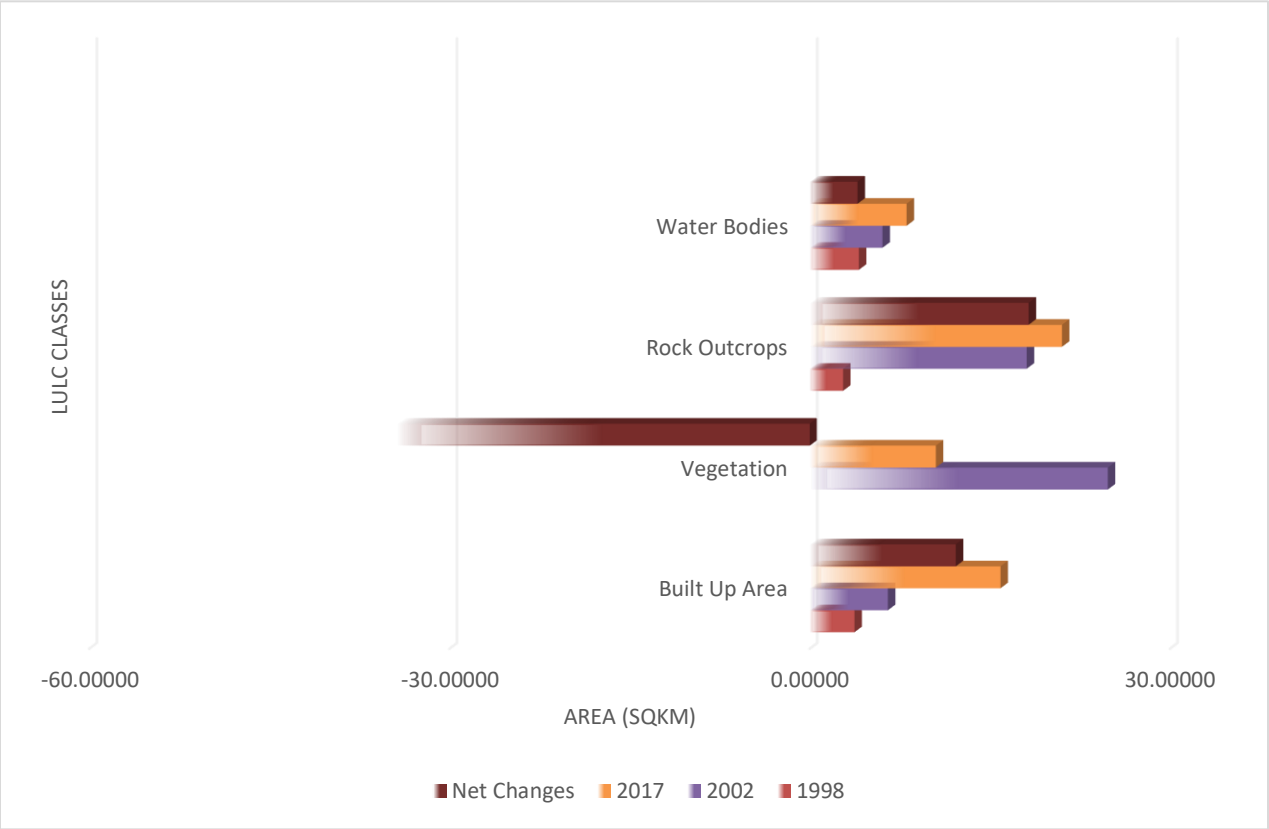

Figure 3.5 Land use and land cover and Net Changes during 1998– 2017

3.4 Perception of respondents on land use and related changes in Osogbo

The result of the field survey carried out for this research is discussed in this section. A total of 290 questionnaires were administered, 254 were returned while 36 copies were not returned. The questionnaire data are analyzed and discussed below.

3.4.1 Perception of Respondents on Land Use.

Table 3.3: Dominant land use type 10yrs ago.

LULC	No of Respondents	Percentage
Settlement	90	35%
Farmland	42	17%
Commercial land	42	17%
Forest/woodland	70	28%
Water bodies	9	4%
Bare land	1	0%
Total	**254**	100%

The dominant land use type 10yrs ago is settlement as agreed by 35% of the respondents followed by forest/woodland with 28%, farmland, and commercial land both with 17%, water bodies with 4%, and bare land with 0%.

At present, the dominant land use type still remains settlement as agreed by 62% of the respondents followed by forest/woodland with 18%, commercial land with 9%, water bodies with 6%, farmland and bare land with 2% each.

Table 3.4: Dominant land use type presently.

LULC	No of Respondents	Percentage
No response	3	1%
Settlement	158	62%
Farmland	5	2%
Commercial land	23	9%
Forest/woodland	46	18%
Water bodies	15	6%
Bare land	4	2%
Total	**254**	100%

Table 3.4 is represented in figure 3.6 below.

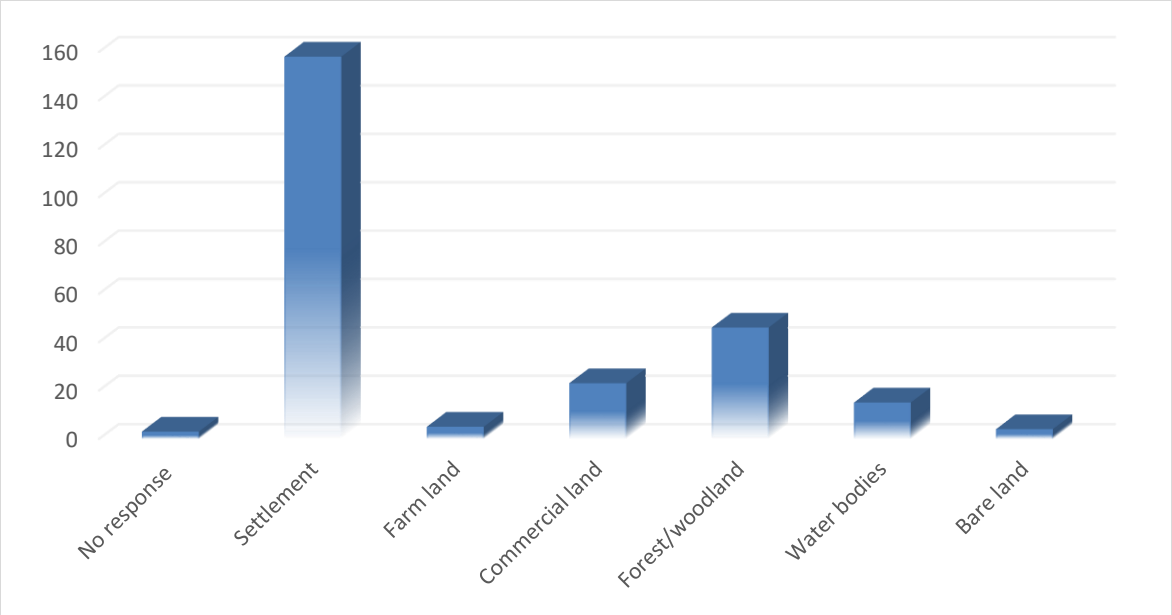

Fig 3.6 Dominant land use type presently.

3.4.2 Land Use and Land Cover Change in Osogbo

Table 3.5: Land use and land cover change in Osogbo

LULC TYPE	Increased	%	Decreased	%	Neutral	%	Sum
Settlement	234	92%	12	5%	7	3%	253
Farmland	75	30%	135	54%	40	16%	250
Commercial	174	72%	15	6%	54	22%	243
Forest/Veg	71	29%	134	54%	43	17%	248
Water bodies	81	33%	57	23%	108	44%	246
Bare land	69	28%	75	31%	100	41%	244

According to the respondents, there has been an increase in settlement, commercial land use type, and water bodies (92%, 72%, and 33% respectively) while farmland, forest/vegetation, and bare land decreased (as agreed by 54%, 54% and 31% of respondents respectively) as shown in table 8 above and represented in figure 12 below. This is evident in the image analysis of the study area which also showed that there is a drastic increase in the urban area and a decrease in vegetation.

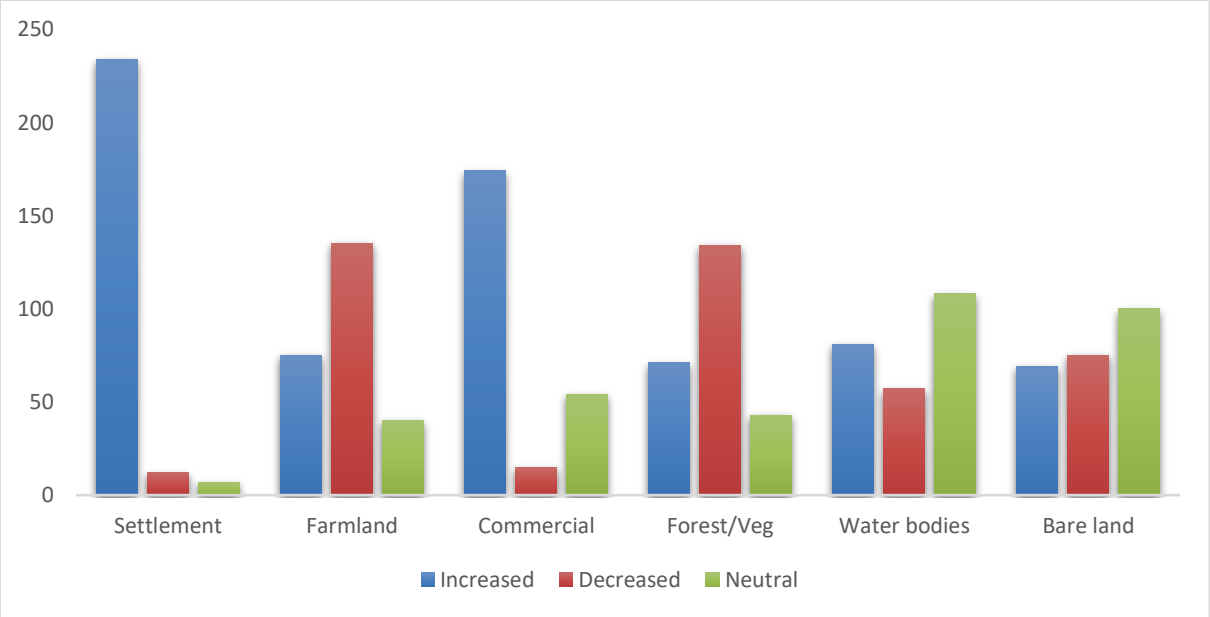

Fig 3.7 Land use and land cover change in Osogbo**.**

3.4.3 LULC Compliance with the International Standard for Sustainable Cities.

Out of the total respondents, 74% own a building, 23% have no building, and 3% gave no response. 66% out of the 74% that have a building indicated that they have a building permit for the land use type, 71% have a certificate of occupancy for their lands while 26% have no permit, and 21% have no certificate of occupancy. 65% indicated that their buildings are in conformity with the land use type in their area. 85% are connected to utility services and as well pay for the rendered services.

This statistic is presented in figure 3.8 below.

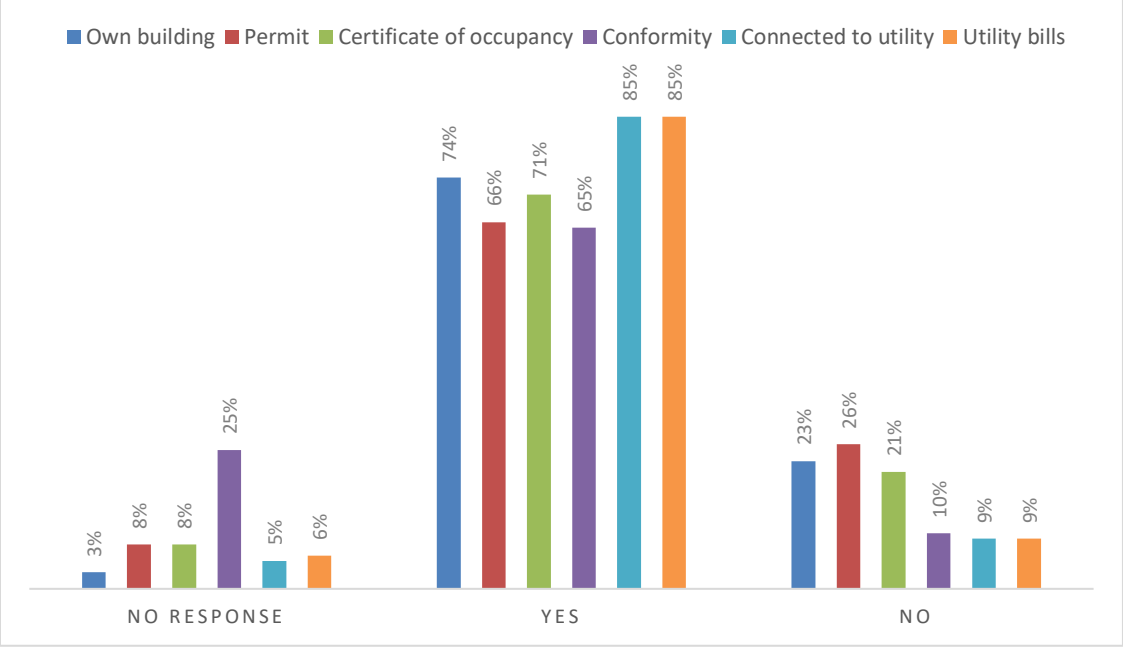

Fig. 3.8 LULC compliance with the international standard for sustainable cities.

As shown in table 3.6 below, 61% of the respondents agreed that buildings are in good condition, 4% indicated they are dilapidated, 6% indicated they need renovation, 13% said buildings require demolition while 8% are of the opinion that they require development.

Table 3.6: Condition of buildings in Osogbo

Building status	**No of response**	**Percentages**
No response	20	8%
Good condition	154	61%
Dilapidated	10	4%
Requires renovation	16	6%
Requires demolition	33	13%
Requires development	21	8%
Total	**254**	**100**

Access to infrastructural services

One of the features of sustainable cities is the availability and accessibility of infrastructural services. 15% of the respondents are of the opinion that the proximity of their area to health facilities is very good, 43% good, 26% fair, 0% bad while 13% said it is very bad. On proximity to school(s), 23% very good, 51% good, 21% fair, 2% bad and 3% very bad. Proximity to police station and market, 12% and 36% very good, 18% and 29% good, 49% and 28% fair, 12% and 2% bad, 8% and 3% very bad. Access to potable water and electricity supply, 22% and 12% very good, 34% and 48% good, 38% and 31% fair, 0% and 3% bad, 4% very bad for each. Access to refuse disposal facilities, 10% very good, 27% good, 47% fair, 13% bad, and 3% very bad.

Good drainage facilities, 14% very good, 26% good, 45% fair, 10% bad, and 4% very bad. Access to good road networks and streetlights, 15% very good for each, 29% and 19% good, 37% and 34% fair, 14% and 22% bad, 4% and 9% very bad respectively. Safety and access to fire station, 27% and 10% very good, 26% and 14% good, 39% and 46% fair, 2% and 13% bad, 5% and 17% very bad respectively. From most of the resident's responses, a good number indicated that they have access to infrastructural services such as portable water, good roads, etc. However, areas such as street lighting, waste management, and fire stations need to be greatly improved base on the responses. The above statistics are presented in figure 3.9.

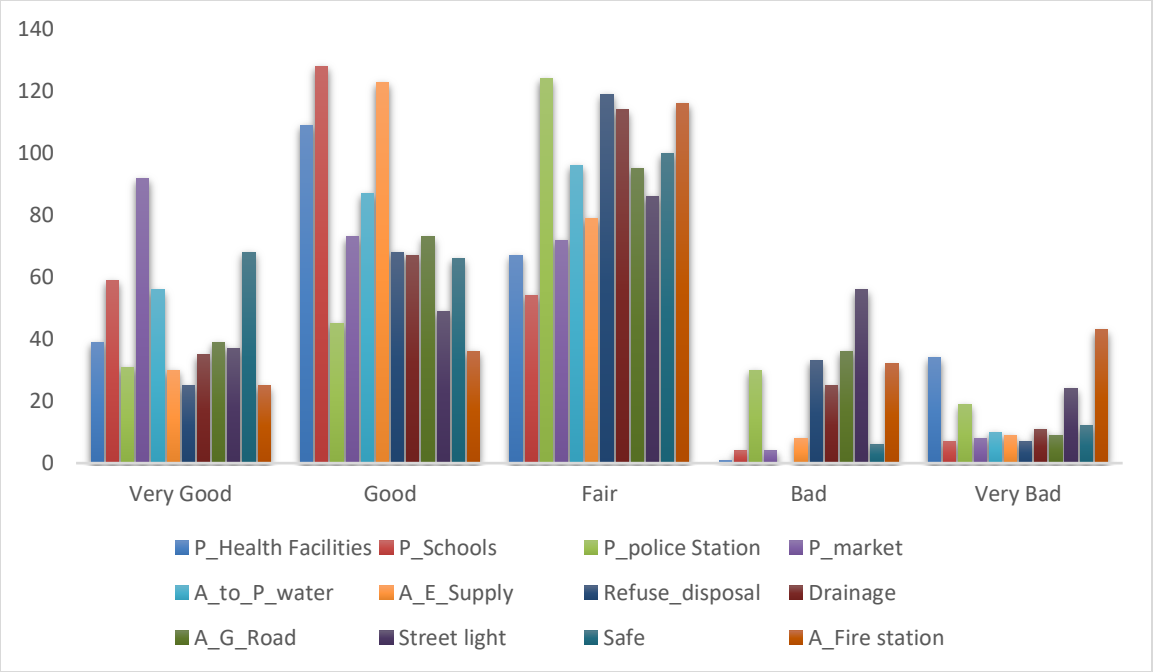

Fig. 3.9 Access to infrastructural services in Osogbo.

3.4.4 Respondents' Perception of Recommendations Towards Attaining Sustainability.

Table 3.7: Awareness of land use master plan for Osogbo

Aware of land use master plan	No of respondents	Percentages
No response	92	37%
Yes	105	40%
No	57	23%
Total	**254**	**100%**

As shown in table 3.7 above, 40% of the respondents are aware of the land use master plan for improving the development of Osogbo, 23% are not aware, and 37% gave no response.

As shown in table 3.8 below, 15% of the respondents believe the master plan has been realistic in the improvement of Osogbo into a sustainable city, and 42% didn't quite agree with this. 43% gave no response to this.

Table 3.8: Contribution of the master plan to the development of Osogbo

Contribution to the development of Osogbo into a sustainable city	No of respondents	Percentages
No response	110	43%
Yes	37	15%
No	107	42%
Total	**254**	**100%**

19% are satisfied with the current state of Osogbo, 63% are not satisfied, and 18% gave no response as shown in the table below.

Table 3.9: Satisfaction with the current state of Osogbo

Satisfied with the current state of Osogbo	No of respondents	Percentages
No response	46	18%
Yes	49	19%
No	159	63%
Total	**254**	**100%**

3.4.5 Recommendations of Respondents Towards Transforming Osogbo into a Sustainable City.

12% of the respondents recommended the planning of built-up areas (i.e. distinction of residential settlements from industrial centers), 11% recommended the demolition and redevelopment of slum settlements, 15% want the provision of infrastructural services, 12% will appreciate better access to educational facilities, 13% wants the use of energy-efficient facilities, 9% wants the government to create economic zones to stimulate the local economy, 13% recommended the creation of green area and open space for recreational purpose and 15% wants the transportation system improved. The data is presented in the table below.

Table 3.9.1: Respondents' recommendation

Suggestions	No of respondents	Percentage
Built up	165	12%
Slum development	158	11%
Infrastructure services	205	15%
Education facilities	171	12%
Energy efficient facilities	188	13%
Economic zones	128	9%
Recreational zones	186	13%
Transport improvement	208	15%

4 Conclusions

This study has examined the impact of rapid urbanization on the sustainable development of Osogbo and demonstrated the use of remote sensing as a tool in achieving a sustainable city, having in the previous chapters identified urbanization in its entirety as a major determinant of whether or not a city will and can attain sustainability. A field survey was embarked on so as to identify the different land use and land cover types, primary data through questionnaires administration was employed to obtain data on demography, occupation, waste management practices, etc.

Satellite data(imagery) are useful for different applications such as Land Use and Land Cover change detection because of their ability to keep track of changes that have occurred over space and time. Three Landsat images (Landsat TM 5, ETM +7, and Landsat 8 OLI/TIRS) covering Osogbo for the years 1998, 2002, and 2017 respectively were analysed into different land use land

cover classes to demonstrate the impact of rapid urbanization on the study area over space and time serving as the major source of secondary data.

As seen from the preceding chapter, over the years there has been a shift from the vegetative type of land cover to other types of land use particular among which is settlement and commercial land use types leading to a considerable increase in the urban area and a decrease in vegetation as evident in the analysed satellite images and also the questionnaire report.

Based on the questionnaire report and field survey, there seems to be some positive change in Osogbo, especially in terms of waste management, road networks, education facilities, etc. which can be attributed to the state government's effort to make the capital city more conducive for residents and befitting as a state capital, but the city can still not be considered as been on the path to sustainability. Being the administrative and commercial center of Osun state, the city keeps increasing in population and as agreed by the respondents, there is the danger of overcrowding, destruction of green areas to erect buildings, increasing rate of unemployment, deforestation, and other population-related issues. These don't in any way portray Osogbo as a sustainable city or one in the making.

Also, the city's energy sector is still highly dependent on fossil fuels (petroleum), and the transportation system needs improvement to reduce the city's contribution to the greenhouse gas effect.

5 Publisher's Note

AIJR remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

[1] UN, "Secretary-General's message on World Cities Day," 31 October 2016. [Online]. Available: https://www.un.org/sg/en/content/sg/statement/2016-10-31/secretary-generals-message-world-cities-day-scroll-down-french. [Accessed 2019].

[2] N. M. U. N. N. Y. NMUN.NY, 2018.

[3] UNDP, "Goal 11 - SUSTAINABLE CITIES AND COMMUNITIES," [Online]. Available: https://www.undp.org/sustainable-development-goals#sustainable-cities-and-communities. [Accessed 02 October 2022].

[4] N. Uddin, "Assessing urban sustainability of slum settlements in Bangladesh: Evidence from Chittagong city," *Journal of Urban Management,* vol. 7, no. 1, pp. 32-42, 2018.

[5] g. Osun state, "Osogbo," [Online]. Available: https://www.osunstate.gov.ng/about/major-towns/osogbo/. [Accessed 2019].

[6] Tutor2u, "Characteristics of a sustainable city," Maech 2021. [Online]. Available: https://www.tutor2u.net/geography/reference/characteristics-of-a-sustainable-city. [Accessed 02 October 2022].

[7] Meseret B. Toma,Mulugeta D. Belete,Mihret D. Ulsido, "Historical and future dynamics of land use land cover and its drivers in Ajora-Woybo watershed, Omo-Gibe basin, Ethiopia," Wiley Online Library, 2022.

[8] "Osogbo . Population," [Online]. Available: http://www.population.city/nigeria/oshogbo/.