Journal of Geoscience and Environment Protection, 2022, 10, 1-14
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

An Integrated Remote Sensing and GIS in Monitoring Landuse and Land Cover Change in Egbeda Local Government Area, Oyo State, Nigeria

Adewale Olusola Akingbade[1], Michael Ajide Oyinloye[2*], Sharafdeen Bolaji Olatunji[3]

[1]Department of Cartography, African Regional Institute for Geospatial Information Science and Technology (AFRIGIST), Ile-Ife, Nigeria
[2]Department of Urban and Regional Planning, Federal University of Technology, Akure, Nigeria
[3]Cooperative Information Network (COPINE), Advance Space Technology Application Laboratory (South West), Obafemi Awolowo University, Ile-Ife, Nigeria
Email: adewaleakingbade@gmail.com, ed@afrigist.org, *maoyinloye@futa.edu.ng, *micnicjide@yahoo.com, beejayolatunji.osb@gmail.com

How to cite this paper: Akingbade, A. O., Oyinloye, M. A., & Olatunji, S. B. (2022). An Integrated Remote Sensing and GIS in Monitoring Landuse and Land Cover Change in Egbeda Local Government Area, Oyo State, Nigeria. *Journal of Geoscience and Environment Protection, 10,* 1-14.
https://doi.org/10.4236/gep.2022.107001

Received: May 15, 2022
Accepted: July 5, 2022
Published: July 8, 2022

Abstract

Effective planning relies on accurate and up-to-date information on existing land use and land cover. The timely detection of trends in land use and land cover change and a quantification of such trends are of specific interest to planners and decision makers. The aim of this research is to use remote sensing and GIS to monitor landuse and land cover change in Egbeda Local Government Area, Oyo State with a view to determining how useful such information can be to planners and decision makers for effective urban management. The research was conducted using remote sensing and Geographical information System at determining the trend and extent of land use and land cover change and its driving force in Egbeda Local Government Area, Oyo State. The methods used include: digitization, digital image processing and spatial analysis using an inverse distance weighted (IDW) technique, Maximum likelihood supervised classification and post classification change detection techniques were applied to Landsat imageries acquired in 1984, 2006 and 2018. Imageries were classified into built-up area, vegetation, bare surface, cultivation and water body. The results of the analysis obtained showed drastic change in built-up area which rose to 32.8% from 25.4% between 1984 and 2018 periods. To reduce the effect of land use expansion in the study areas, policy measures were recommended which include proper inventory of land use and land cover, regular monitoring of urban areas spread of development and regional development programs. These will enable the govern-

ment, stakeholders, policy makers and planners to make informed decisions provided by these technologies to attain and sustain future urban development.

Keywords

Landuse, Land Cover, Urban Management, Remote Sensing, GIS, Satellite Imageries

1. Introduction

Land use change is arguably the most pervasive socio-economic force driving change and degradation of ecosystems. Deforestation, urban development, agriculture, and other human activities have substantially altered the Earth's landscape. Such disturbance of the land affects important ecosystem processes and services, which can have wide ranging and long term consequences (Bala, 2017).

According to Wu (2008), farmland provides open space and valuable habitat for many wildlife species. However, intensive agriculture has potentially severe ecosystem consequences. Czech, Krausman and Devers (2000) pointed out that habitat destruction; fragmentation and alteration associated with urban development have been identified as the leading causes of biodiversity decline and species extinction.

Efficient urban information system is a vital prerequisite for planned development and there is need to adopt remote sensing and geographic information systems approach in urban development and monitoring process for implementing pragmatic plan. This plan must integrate a spatial model using remote sensing and GIS database (Balogun, 2009). Satellite image data provides the potential to obtain land cover information at more frequent intervals which are more economical than those obtained by traditional methods (Martin & Howarth, 1989; Treitz, Howarth, & Gong, 1992; Trotter, 1991).

Extensive research efforts have been directed to urban change detection by using remotely sensed imagery (Yeh & Li, 1996; Yang & Liu, 2005; Loft, 2001; Adebayejo & Abolade, 2006). In the studies carried out by Ramadan, Feng and Cheng (2004) in Shaoxing City in China using satellite imageries for the year 1984, 1997 and 2000, one of the goals of the study was to produce a land use map of Shaoxing City and its surroundings. The result shows that there are undoubtedly a lot of changes that occurred between 1984 and 19997 when compared with those of 2000. Eiter and Potthoff (2007) conducted study that focuses on understanding the driving forces affects land use changes in Norway. He found out that better knowledge was achieved when the source of the force and the force itself are separated from each other. Similarly, Brandt et al. (1999) conducted a study about land use development in urban rural areas in Denmark, focusing on changes in the urban fringe and marginalization of agricultural areas. He identified the five driving key factors that influenced the categorization which

are technology, natural environment, socio economic environment, policy and culture. These categories have a general character, which can lead to less detail information about the driving forces in a specific area. Andrej, Rosemarie and Tim (2015) studied suitability in land management in Northern Germany and concluded that differences in attitudes toward suitability were driven to a great extent by differences in the regional socio-economic setting particularly with regard to production issues. Balayneh and Eyasu (2021) investigated the driving forces influencing the landuse and land cover changes in Shenkolla watershed in South Central Ethiopia. The results disclosed that Shenkolla watershed has changed significantly during four decades between 1973 and 2017. The observed changes indicated that agricultural expansion, policy change and social unrest, population pressure, shortage of farmland, and biophysical factors were major driving forces of land use and land cover changes. Hundu et al. (2021) established the uniqueness of satellite remote sensing and GIS technique in producing accurate land use and land cover maps and changing statistics for Katsina-Ala Local Government Area Benue, Nigeria. The results clearly show constant positive increase in built-up area, and the farm land but a decrease in forest land cover. In response to the increasing urbanization, many local governments have imposed strict land use control in Oyo State. Some of the efforts have been quite successful in slowing down development. Results from this research will assist the public, land use planners, and policy makers to anticipate and plan for the future.

The objectives of this study include to:

1) Analyze the land use and land cover change of the study area at different times (1984, 2006 and 2018).

2) Analyze the driving forces responsible for landuse change.

3) Predict the land use change and its development in the study area.

2. The Study Area

The study area is Egbeda Local Government Area of Oyo State. It is located on the Longitude 30˚56'54.753"E and 40˚8'58.585"E and Latitude 70˚27'23.532"N and 70˚18'34.578"N. The Local Government (Egbeda L.G.A.) shared boundary with Ona, Ara L.G., Lagelu L.G., Ibadan North East L.G. and Irewolede L.G. in the State of Osun (see **Figure 1**).

Egbeda is one of the oldest communities in the ancient city of Ibadan that originated from Awaye compound/village. The Awaye people were known to be warriors, farmer, and accommodating in nature. The population of Egbeda Local Government Area, according to 2006 population census reached the size of 283,643 (NPC, 2006). In projected 2016 census, it rose to 398,500. This growth has been more phenomenal since the creation of the Local Government Area. The annual average temperatures range between 23.9˚C and 28.3˚C, and its mean annual relative humidity is about 77.1%. It is located within the tropical rain forest region of Nigeria where rainfall is high throughout the year. The area has an undulating terrain underlain by metamorphic rocks and characterized by

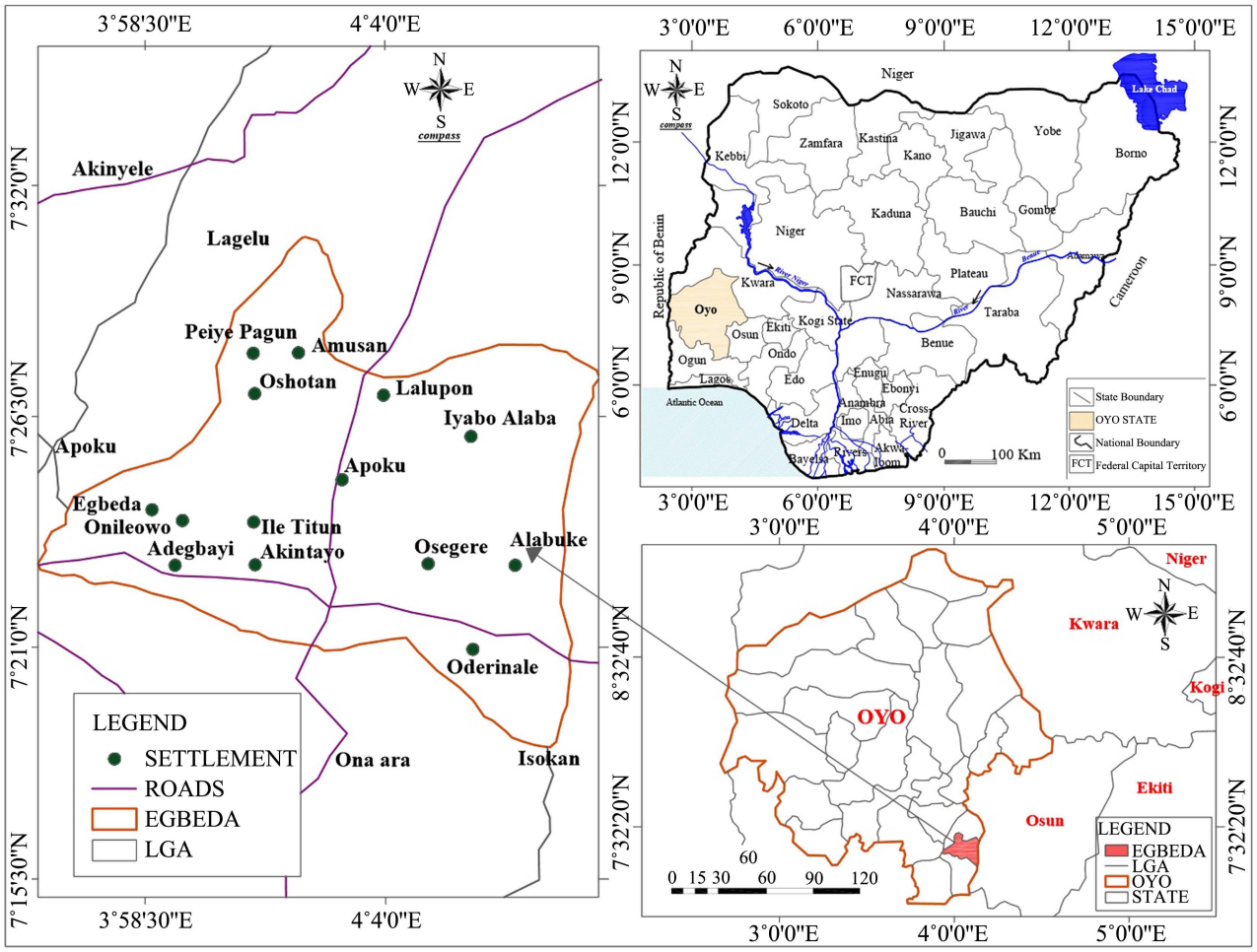

Figure 1. Maps of Nigeria showing Oyo State and Egbeda local government area.

two types of soils, deep brown clay soils and sandy soils. These soils have laudably supported the growing of cash crops such as cocoa, bread fruit, palms and cassava. Others common crops which are mostly, staple food include cocoyam, sugar cane, banana, plantain and vegetables. The topography of the area rises up to 500 meters and above the mean sea level in some places with the highest hill occurring in the northern part of the mapped area (Olatunji, 2022).

3. Data Acquisition and Method

This study was interested in the urban land use and land cover change of Egbeda Local Government Area, Oyo state. The methods employed for data analysis include study area mapping, mapping from remotely sensed images of land use and land cover change, driving forces and future change/development mapping using IDV analysis tool of geo-statistical interpolation. To achieve this, images of Egbeda Local Government Area, Oyo State were acquired for 1984, 2006 and 2018. The images are geometrically corrected and ground control point obtained through intensive ground surveys permitted the co-registration of all images to Universal Transverse Mercator (UTM). The Satellite imageries were made to

pass through process of image enhancement, geo referencing, resampling, and image classification. A supervised classification with a Maximum Likelihood analysis was successful after creating five regions of interest with five training sites each. The map produced were: Land use/cover 1984 from TM Landsat image, Land use/cover 2006 from ETM+ Land sat image and Land cover 2018 from OLI Land sat image, based on built-up, cultivated land, bared land, natural vegetation and water body categories as regions of interest. Post classification was done using classified images for the purpose of confusion matrix, change detection and change statistics. Both classified and post classified images were converted to vector and exported to ArcMap 10.1 as shape files for statistical analysis and mapping.

4. Results and Discussion

The findings of this research shows that underlying drivers of land use an land cover are specific to a location as revealed by other similar studies elsewhere (Geist & Lambin, 2002; Lepers et al., 2004; Rudel et al., 2005). The major driving factor is environmental consequent to the expansion. There are dense agglomerations of people and economic activities associated with urban expansion impose pressure on the environment that can shape the physical landscape and the function state of the ecosystem. Another driving factor is the social ills such as unemployment, poor quality of housing, traffic congestion, poverty, poor standard of living, overcrowding which put pressures on the local government to provide basic social amenities and infrastructure for the growing population.

Another driving force of urban expansion is loss of open space which has been eaten up by this rapid expansion.

Deforestation and colonization of adjacent farm lands through uncontrolled urban expansion is another serious factor. This is likely due to population increase and therefore pressure on lands for food.

The changes that occurred in Land use and Land cover in Egbeda Laocal Government Area, Oyo State for the past 34 years are shown in the following landuse and land cover maps, tables and charts for 1984, 2006 and 2018. However, the total area of each of the landuse and land cover was calculated in 1984, 2006 and 2018. Table 1 is the summary of the area coverage in areas and percentage of land use and land cover types under study which includes the total area covered by the classification.

Figure 2 and Table 2 show the result of the land use landcover for the year 1984 with bare surface, cultivation, built up, vegetation and water body as 0.08%, 10.57%, 9.81%, 78.58%, and 0.96%, respectively. The vegetation cover was much intact with fewer patches of cleared/cultivated areas. Also, the built-up area was characterized with scatter settlement pattern with few clusters along the two (2) major roads.

Figure 3 and Table 3 show the result of the land use land cover for the year

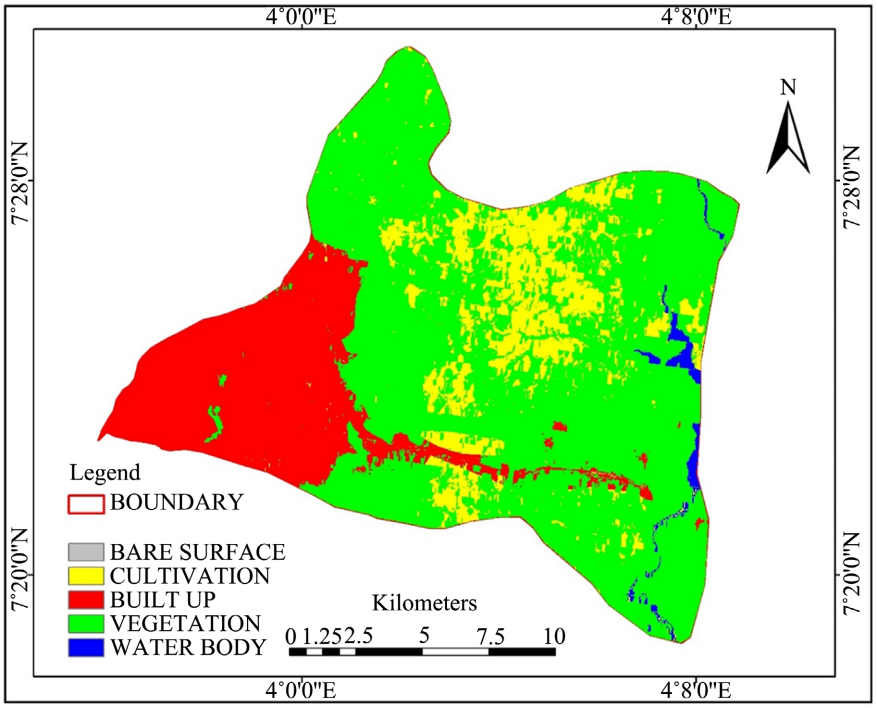

Figure 2. Classified Land use/cover Map of the study area for the year 1984.

Table 1. Trend showing the landuse/cover 1984, 2006 and 2018 (km²).

1984	Area (km²)	Area (%)
bare surface	0.204	0.079
Cultivation	27.405	10.566
built up	25.457	9.815
Vegetation	203.823	78.584
water body	2.480	0.956
2006	**Area (km²)**	**Area (%)**
bare surface	0	0
Cultivation	34.575	13.419
built up	55.171	21.413
Vegetation	164.984	64.034
water body	2.919	1.133
2018	**Area (km²)**	**Area (%)**
bare surface	0	0
Cultivation	9.177	3.562
built up	84.512	32.801
Vegetation	160.804	62.412
water body	3.157	1.226
Total	257.650	100

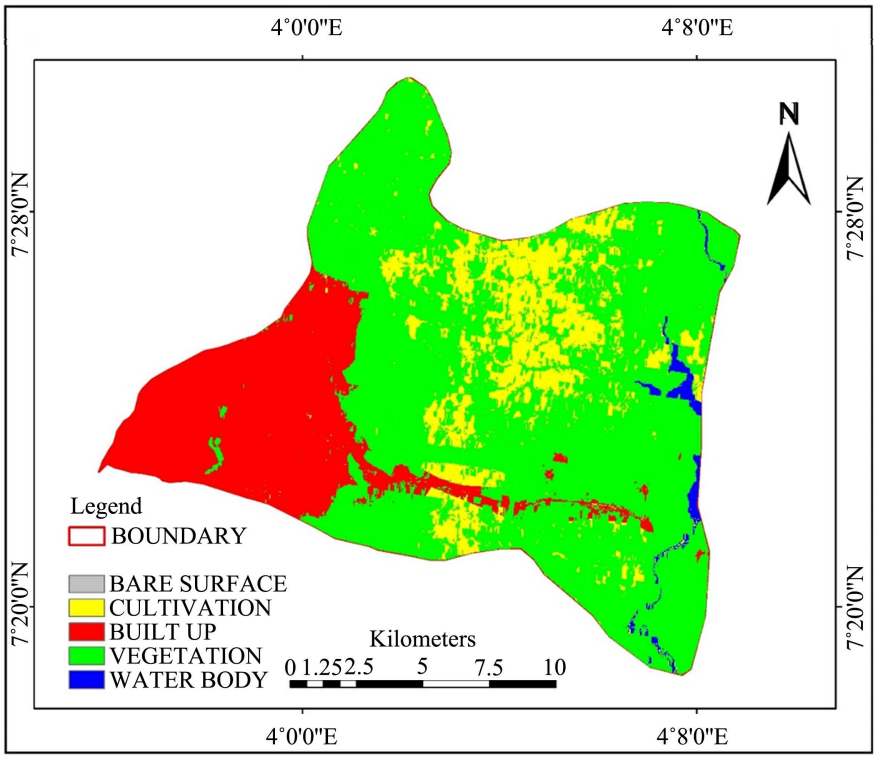

Figure 3. Classified Land use/cover Map of the study area for the year 2006.

Table 2. Change detection for the year 1984.

1984	Area (km^2)	Area (%)
bare surface	0.2043	0.08
cultivation	27.405	10.57
built up	25.4565	9.81
vegetation	203.823	78.58
water body	2.4804	0.96
total	259.3692	100

Table 3. Change detection for the year 2006.

2006		
class	Area (km^2)	Area (%)
bare surface	0	0.00
cultivation	34.5753	13.42
built up	55.1709	21.42
vegetation	164.9844	64.03
water body	2.9196	1.13
total	257.6502	100

2006 with bare surface, cultivation, built up, vegetation and water body as 0.00%, 13.42%, 21.42%, 64.03%, and 1.13%, respectively. The settlement as at 2006 became more clusters towards the central business area of Egbeda Local Government, Oyo State. However, linear settlement was also observed towards the two major high ways.

Figure 4 and Table 4 show the result of the land use landcover for the year 2018 with bare surface, cultivation, built up, vegetation and water body as 0.00%, 3.56%, 32.80%, 62.41%, and 1.23%, respectively. In 2018, Urban sprawl was observed as shown in Figure 4 as it was also observed that there were more scattered patches of settlement along the two (2) major roads than observed from the two previous years.

Figure 5 and Table 5 below show 1984 and 2006 Classified Image, it was observed that Built-up area gained from Bare Surface, Cultivation, Vegetation, and

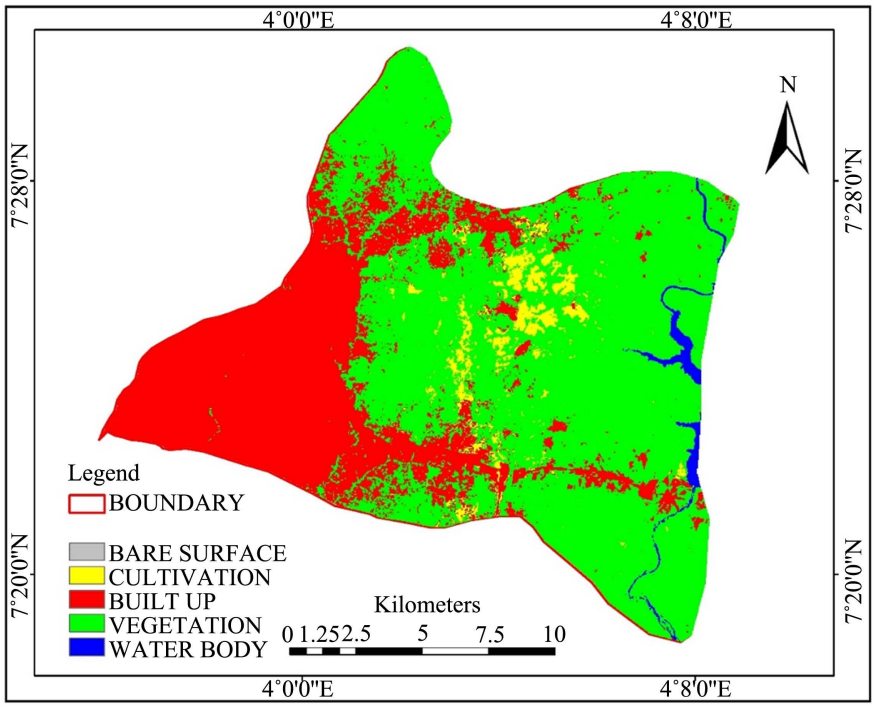

Figure 4. Classified Land use/cover Map of the study area for the year 2018.

Table 4. Change detection for the year 2018.

2018	Area (km^2)	Area (%)
bare surface	0	0.00
cultivation	9.177	3.56
built up	84.512	32.80
vegetation	160.804	62.41
water body	3.157	1.23
total	257.650	100

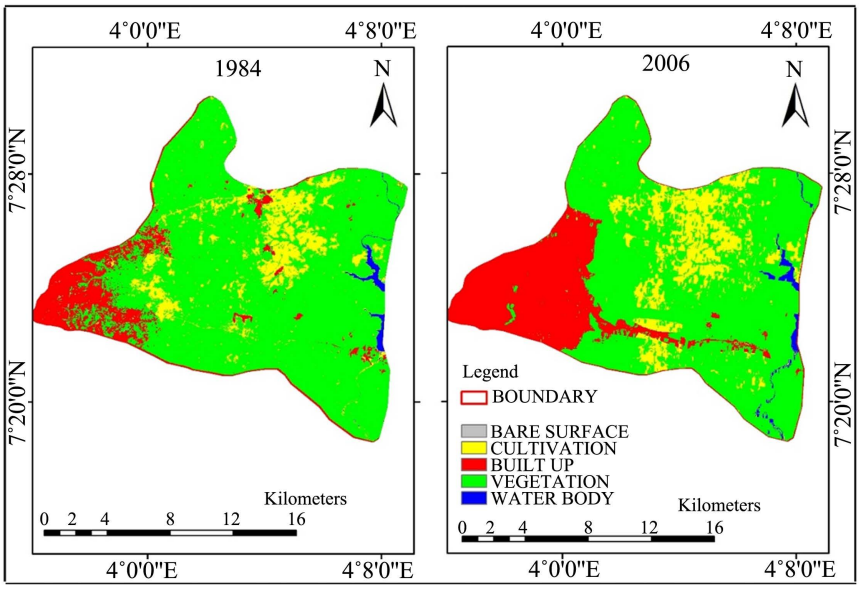

Figure 5. Classified Land use/cover loss and gain map of the study area for 1984 to 2006.

Table 5. Trend showing 1984 to 2006 (km2).

	bare surface	cultivation	built up	vegetation	water body	2006
bare surface	0	0	0	0	0	0
cultivation	0.001	16.694	1.479	16.354	0.047	34.575
built up	0.161	5.297	22.285	27.417	0.012	55.171
vegetation	0.042	5.051	1.610	157.789	0.492	164.984
water body	0	0.269	0.009	0.904	1.738	2.9196
1984	0.204	27.311	25.384	202.463	2.289	

Source: Field work, 2018.

Water Body; 0.1611 (km^2), 5.2965 (km^2), 27.4167 (km^2), 0.0017 (km^2) respectively. It shows that in 1984, Built up area were 25.3836 (km^2), while in 2006, Built up area were 55.1709 (km^2). This shows that from 1984 to 2006, Built-up area gained 29.7873 (km^2) and this shows how the trend of land use and land cover has been over the years.

Figure 6 shows a diagram representing categories of gain, loss and stable change that occurred in the period of 1984 to 2006, whereby stable change has the highest numbers, followed by loss change and lastly gain with the lowest numbers.

Figure 7 and Table 6, show that from the Classified Image of 2006 and 2018, it shows that Built up gained from Bare Surface, Cultivation, Vegetation, and Water Body; 0 (km^2), 8.0307 (km^2), 21.310 (km^2), and 0.0189 (km^2) respectively. In 2006, built up area were 55.1709 while in 2018, built up area were 84.5118. This shows that from 2006 to 2018, built up gained 29.3409 (km^2) and this shows how the land use has been over the years.

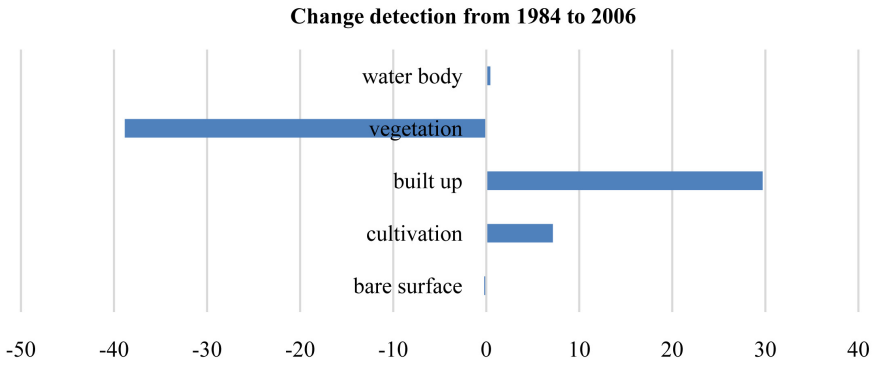

Figure 6. Land use/land cover loss and gain chart in the study area for 1984 to 2006.

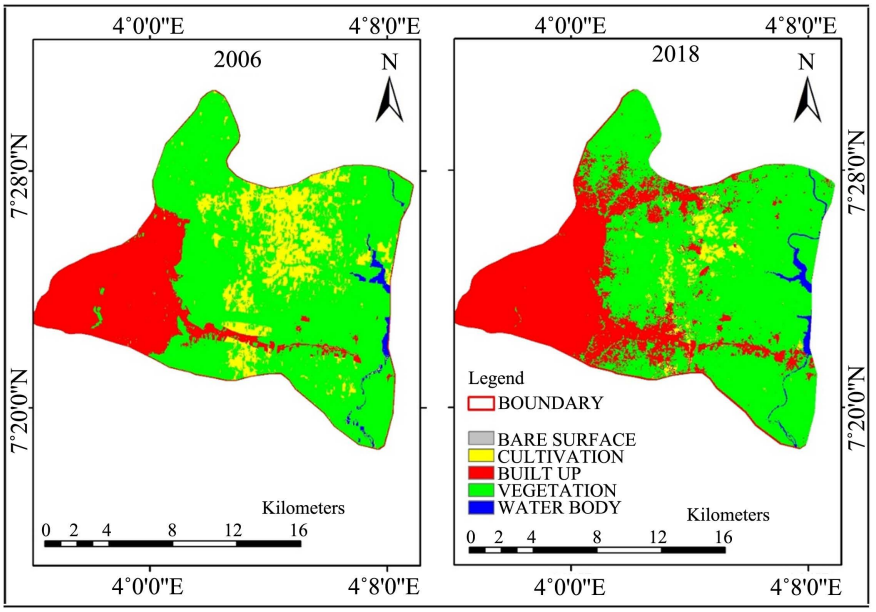

Figure 7. Classified land use/land cover loss and gain map of the study area for 2006 to 2018.

Table 6. Trend showing 2006 to 2018 (km^2).

	bare surface	cultivation	built up	vegetation	water body	2018
bare surface	0	0	0	0	0	0
cultivation	0	6.979	0	2.191	0.007	9.177
built up	0	8.031	55.152	21.310	0.019	84.512
vegetation	0	19.419	0.011	140.695	0.679	160.804
water body	0	0.146	0.008	0.788	2.215	3.157
2006	0	34.575	55.171	164.984	2.919	

Figure 8 shows a diagram representing categories of gain, loss and stable change that occurred in the period of 2006 to 2018, whereby stable change has the highest numbers, followed by loss change and lastly gain with the lowest numbers.

Figure 9 shows the three years tend pattern from 1984 to 2018. In 1984, bare surface, cultivation, built up, vegetation and water body measures 0.0788%, 10.5660%, 9.8148%, 78.5841%, and 0.9563%, respectively. In 2006, bare surface lost from 0% to 0%, cultivation gained from 10.5660% to 13.4195%, built up also gained from 9.8148% to 21.4131%, vegetation lost from 78.5841% to 64.0343% while water body also gained from 0.9563% to 1.1331%. In 2018, bare surface remains the same, cultivation and vegetation lost from 13.42% to 3.6%, and 64.03% to 62.41% respectively, while built up and water body all gained from 21.41% to 35.80% and 1.13% to 1.23 % respectively.

It shows that there is a continuous increase in built up area from 25.4565 Km^2 in 1984 to 84.5118 Km^2 in 2018. This shows that land use from 1984 to 2018 with an increase of 59.0553 Km^2, this shows that there is an increase of more than 50% within those years.

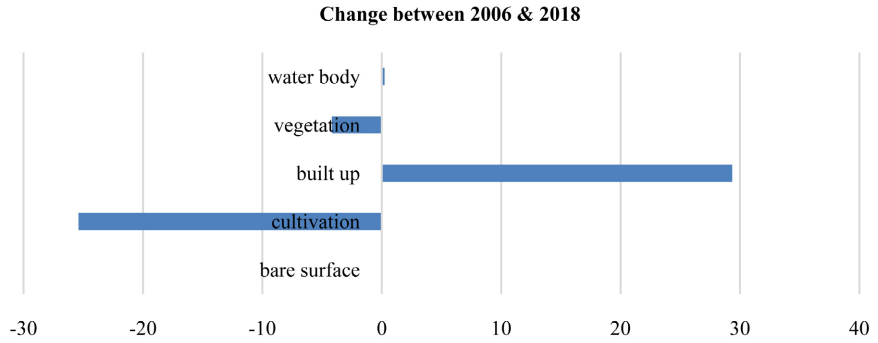

Figure 8. Land use/land cover loss and gain chart in the study area for 2006 to 2018.

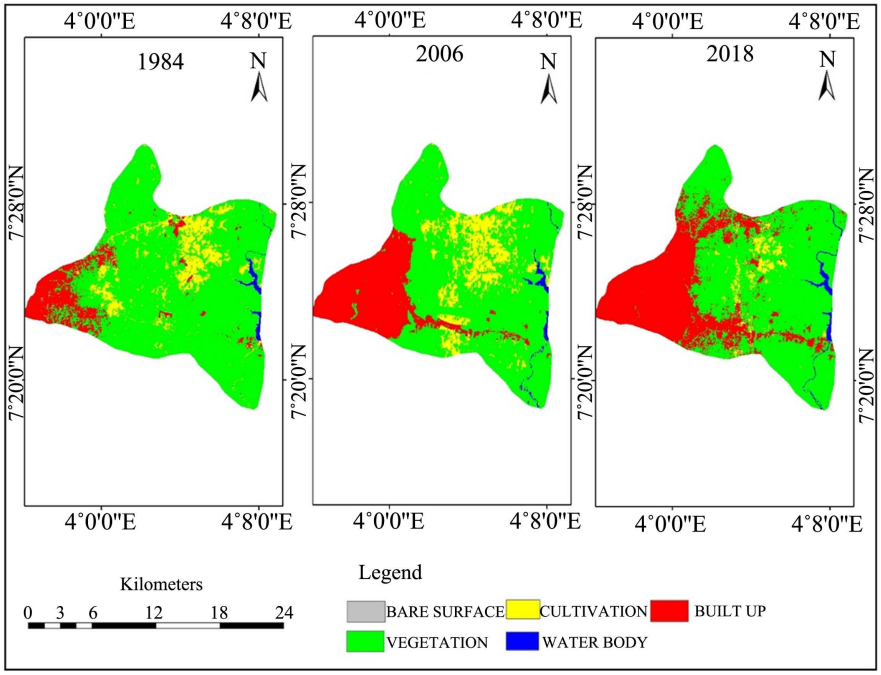

Figure 9. Classified Land use/cover loss and gain map of the study area for 1984, 2006 and 2018.

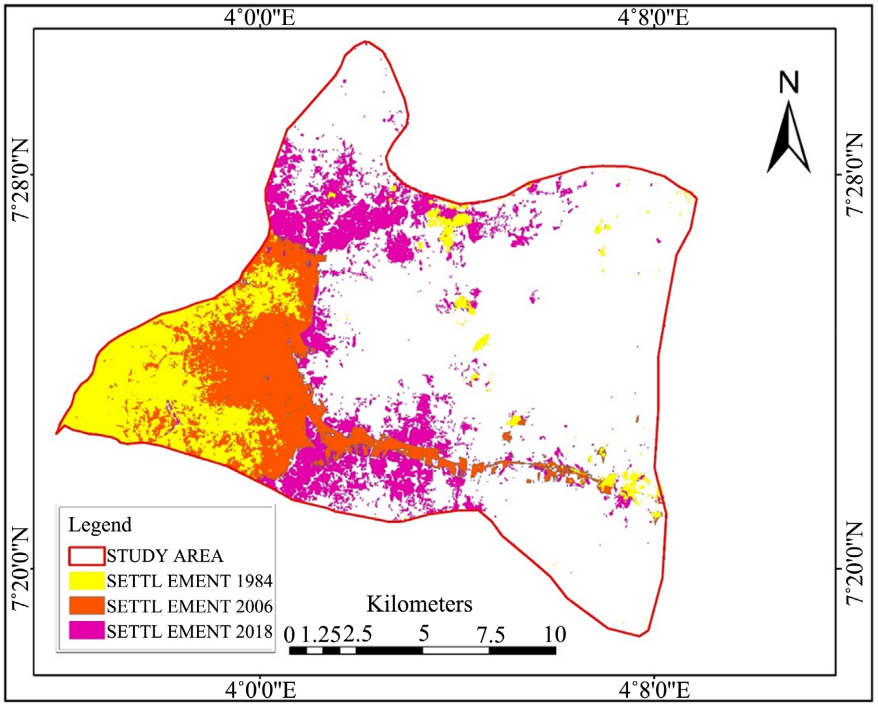

Figure 10. Classified Image showing the Overlaying of three years built up area in Egbeda Local Government Area.

Figure 10 shows the future land use and land cover change prediction. It shows the direction and pattern at which the land use is taking. The overlay of the classification results provided the actual change detection analysis and direction of the landuse and land cover which is along the two (2) major roads towards the North and South of Egbeda Local Government area, Oyo State.

5. Conclusion and Recommendations

The study has been able to determine land use and land cover changes for the past 34 years in the study area. The study employed the use of remote sensing and Geographical Information Systems (GIS) to study the land use and land cover change of Egbeda Local Government, Oyo State, Nigeria. Landsat TM and Enhanced Thematic Mapping (ETM+) imageries of 1984, 2006 and 2018 were used to analyze the landuse and land cover change of Egbeda Local Government Area, Oyo State. The results of the built-up area increase from 25.4565 areas Km^2 (9.8%) in 1984 to 55.1709 areas Km^2 (21.4%) and 84.5118 areas Km^2 (32.8%) in 2006 and 2018 respectively. It is clearly seen that vegetation decreased from 203.823 areas Km^2 (78%) in 1984 to 164.98644 areas Km^2 and 160.8039 areas Km^2 in 2006 and 2018 respectively. Also the analysis shows that the change in the land use and land cover was noticed as the encroachment of the built-up areas into cultivation area due to demand for shelter and cultivation replacing the vegetation due to farming activities. The study therefore recommends that there should be regular monitoring of urban area using dynamic method such as Remote Sensing and Geographic Information System so as to provide current

and accurate data for the urban managers. This will help to forestall the development of slums, and squatter settlement. Information and consultation programs should be established in order to improve awareness to the public and government about the implications of land use and land cover changes in an area. Government should explore and experiment private-public participation in the provision of urban services and infrastructure.

Authors' Contributions

All authors of this work performed substantial contributions to conception, design, analysis and writing and design of this article. All authors have read the manuscript for important intellectual and approved the final version for publication.

Acknowledgments

We acknowledge Olatunji Sharafdeen Bolaji our M.Tech. student, in the Department of Remote Sensing and GIS, Federal University of Technology, Akure whose final project provided data and information for this paper.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Adebayejo, A. T., & Abolade, O. (2006). Analysis of Spatial Changes in Ogbomoso City. *Journal of the NITP, 19,* 35-47.

Andrej, L., Rosemarie, S., & Tim, B. (2015). Sustainability in Land Management: An Analysis of Stakeholder Perceptions in Rural Northern Germany. *Sustainability, 7,* 683-704. https://doi.org/10.3390/su7010683

Bala, I. F. (2017). *Geographical Implications of Land Use Change in Fagge Local Government Area, Kano State, Nigeria.* Master's Thesis, Federal University of Technology Akure.

Balayneh, B., & Eyasu, E. (2021). Land Use/Land Cover Change and Its Driving Forces in Shenkolla Watershed, South Central Ethiopia. *The Scientific World Journal, 2021,* Article ID: 9470918. https://doi.org/10.1155/2021/9470918

Balogun, T. F. (2009). *An Integrated Remote Sensing and GIS Approach in Monitoring Urban Expansion: A Case Study of Benin City, Nigeria.* M.Sc. Thesis, Department of Geography and Planning Science, Faculty of Social and Management Science, Adekunle Ajasin University.

Brandt, J., Primdahl, J., & Reenberg, A. (1999). Rural Land Use and Landscape Dynamics-Analysis of Driving Forces in Apace and Time. In R. Krönert, J. Baudry, I. R. Bowler, & A. Reenberg (Eds.), *Land-Use Changes and Their Environmental Impact in Rural Areas in Europe* (pp. 81-102). UNESCO.

Czech, B., Krausman, P. R., & Devers, P. K. (2000). Economics Associations among Causes of Spices Endangerment in the United State. *Bioscience, 50,* 593-601. https://doi.org/10.1641/0006-3568(2000)050[0593:EAACOS]2.0.CO;2

Eiter, S., & Potthoff, K. (2007). Improving the Factual Knowledge of Landscapes. *Norwegian Journal of Geography, 61,* 145-156. https://doi.org/10.1080/00291950701709127

Geist, H. J., & Lambin, E. F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *Bioscience, 52,* 143-150. https://doi.org/10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2

Hundu, W. T., Anuele, P. T., Kwanga, G. M., & Dam, D. P. (2021). Assessment of Land Use and Land Cover Change Using GIS and Remote Sensing Techniques in Kastina-Ala Local Government Area of Benue State, Nigeria. *Journal of Research in Forestry, Wildlife and Environment, 13,* 195-204.

Lepers, E., Lambin, E. F., Jaretos, A. C., Defries, J. Achard, F., Ramankutty, N. et al. (2004). A Synthesis of Information on Rapid Landcover Changes for Period 1981-2000. *Bioscience, 55,* 115-124. https://doi.org/10.1641/0006-3568(2005)055[0115:ASOIOR]2.0.CO;2

Loft, S. (2001). Remote Sensing for Urban Growth in Northern Iran. In: *The 22nd Asian Conference on Remote Sensing* (pp. 1-3). Asian Association on Remote Sensing (AARS).

Martin, L. R. G., & Howart, P. J. (1989). Change-Detection Accuracy Assessment using SPOT Multispectral Imagery of the Rural-Urban Fringe. *Remote Sensing of Environment, 30,* 55-66. https://doi.org/10.1016/0034-4257(89)90047-3

National Population Commission (2006). *Population of the Federal Republic of Nigeria: Analytical Report at the National Level.*

Olatunji, S. B. (2022). *Urban Speawl and Its Implication on Health Facilities in Egbeda Local Government Area, Oyo State.* Unpublished Master's Thesis, Federal University of Technology Akure.

Ramadan, E., Feng, X. Z., & Cheng, Z. (2004). Satellite Remote Sensing for Urban Growth Assessment in Shaoxing City, Zhejiang Province. *Journal of Zhejiang University-Science A, 5,* 1095-1101. https://doi.org/10.1631/jzus.2004.1095

Rudel, T. K., Coomes, O. T., Moran, E., Achard, F., Angelsen, A., Xu, J. C., & Lambin, E. (2005). Forest Transitions: Towards a Global Understanding of Land Use Change. *Global Environmental Change, 15,* 23-31. https://doi.org/10.1016/j.gloenvcha.2004.11.001

Treitz, P., Howarth, P., & Gong, P. (1992). Application of Satellite and GIS Technologies for Land Use Mapping at the Rural-Urban Fringe: A Case Study. *Photogrammetric Engineering and Remote Sensing, 58,* 439-448.

Trotter, C. M. (1991). Remote-Sensed Data as an Information Source for Geographical Information Systems in Natural Resources Management: A Review. *International Journal of Geographical Information Systems, 5,* 225-239. https://doi.org/10.1080/02693799108927845

Wu, J. (2008). Land Use Changes: Economic, Social and Environmental Impacts. *CHOICES: The Magazine of Food, Farm, and Resource Issues, 23,* 6-10.

Yang, X. J., & Liu, Z. (2005). Use of Satellite-Derived Landscape Imperviousness Index to Characterize Urban Spatial Growth. *Computer, Environment and Urban Systems, 29,* 524-540. https://doi.org/10.1016/j.compenvurbsys.2005.01.005

Yeh, A. G. O., & Li, X. (1996). Urban Growth Management in Pearl River Delta: An Integrated Remote Sensing and GIS Approach. *ITC Journal, 1,* 77-86.