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RESEARCH ARTICLE

LAND USE AND LAND CAPABILITY STUDIES IN UYO, NIGERIA, USING GEOSPATIAL TECHNOLOGY

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ABSTRACT

This study investigated Land Use and Land Capability Studies in Uyo, Akwa Ibom State, Nigeria, using geospatial technology. The research employed Geographic Information System (ArcGIS) and remote sensing (Erdas Imagine) techniques, satellite imagery data set of land sat TM, ETM + OLI sensor images of 1986, 2000 and 2018 respectively. Normalized Different Built-up Index (NDBI) was used to extract the built-up areas from the satellite imagery. Land cover maps of the three period were produced using supervised classification methods to place pixels in an image into land use/cover classes to draw useful thematic information. Change detection analysis was used to determine different land use changes between 1986 and 2018. The result showed a generally increased in built-up land by 117.70 square kilometers (50 percent) while bare land/agricultural land use was depleted by 36.93 square kilometers (15.69 percent), primary vegetation decreased by 49.57 square kilometers (21.03 percent), and secondary vegetation decreased by 31.26 square kilometers (13.28 percent) within the period under review. The increase in the built-up land cover is an indication of the growth of the urban area in the study area. From the forgoing, there is need for sustainable land management. Practices which encourages the adoption of sustainable agricultural practices that enhances soil quality and prevent degradation ensuring long-term productivity, integrated land planning which promote a comprehensive land use planning framework that balances urban development with agricultural needs while considering, and policy development which advocate for the formulation of policies that prioritize land capability assessments in decision-making processes for development projects. This will foster ecological balance while meeting the demands of a growing population.

Keywords: Land use, land capability studies, urban growth, geospatial technologies, Uyo.

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INTRODUCTION

Land is the part of the earth which is not covered by oceans or other bodies of water. According to U.S Environmental Protection Agency, 2022, it is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below the surface including those of the near surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps, the near surface).

Land use and land capability are important concepts in the field of land management and planning. The term "land use" is used to describe the human use of land. It represents the economic and cultural activities, (e.g. agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place (US EPA. 2022). Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed Woods (US EPA, 2021). It has been defined also as "the purpose and activities through which people interact with land and terrestrial ecosystems and as "the total of arrangements, activities, and inputs that people undertake in a certain land. Land use is one of the most important drivers of global environment" (Zhang et al, 2020).

Land capability is the ability of a piece of land to sustainably support a specific land use. It is the amount of use a piece of land can withstand before becoming irreversibly damaged. If land is used beyond its capability, degradation is the consequence. Land capability is based on the understanding that every component of land has its own particular capacity to provide ecosystem services. Land use and land capability then becomes a very important tools in the management of land resources. They help us understand the potential uses and limitations of land for various purposes such as agriculture, forestry, urban development, and concentration.

Land capability refers to the inherent potential of the land to support different types of land use. It takes into account factors such as soil conditions, topography, climate, hydrology and vegetation cover, among others. These factors determine the suitability of land for specific uses and help in the decision-making process related to land management (US EPA, 2022).A digital land information system (DLIS) plays a crucial role in providing accurate and up-to-date information about land use and land capability. The background of land use and land capability dates back to the early attempts of human to divide and allocate land for different activities (Li et al, 2022). Overtime, as human population increased and the need for agricultural, industrial and residential land grew, it became necessary to assess the productive capacity and sustainability of land for specific purposes. This led to the development of land capability classification systems. (Liying Zhu, 2003).

Geospatial techniques, such as remote sensing and GIS, have become increasingly important in these studies, as they provide efficient and comprehensive methods for data collection, analysis, and visualization. The application of geospatial techniques in land use and land capability studies has gained significant attention in recent years. Remote sensing data, such as satellite imagery and aerial photographs, can be used to map and monitor land cover and land use changes over time (Nouri et al., 2019; Wulder et al., 2018).

GIS provides a robust platform for integrating and analyzing various spatial and non-spatial data sets, including topographic information, soil characteristics, and socioeconomic data (Shen et al., 2020). These techniques enable researchers and decision-makers to assess land suitability, identify land use conflicts, and plan for suitable land management.

Land use and land capability studies are crucial for effective land management and sustainable development, particularly in rapidly urbanizing areas like Uyo, Akwa Ibom State, Nigeria. The region is experiencing significant changes in land use patterns due to population growth, agricultural expansion and infrastructural development (Udosen et al, 2017). According to Akpan et al, (2018), the rapid population growth and unplanned urbanization in Uyo have resulted in the conversion of agricultural lands and natural ecosystems into residential, commercial and industrial areas leading to a decline in the overall and quality and ecosystem services.

There have been numerous researchers who have conducted studies closely related to this work. Such work include Igbokwe, et al 2011, on application of geographic information systems (GIS) in mapping groundwater quality in Uyo, Spatio-temporal Analysis of Land use change in Uyo, urban, using remote sensing 2019 by Aniekan Eyo, and Detection of urban development in Uyo using remote sensing 2016. Contrarily, Umo Ibanga, and Ike (2018) adopt geospatial technologies in exploring gully erosion in Eniong Offot area of Uyo. The study established that urbanization of other human activities has crept into the area thereby posing ecological threat to the environment (Umo et al, 2018). However, there is a lack or paucity of a comprehensive and systematic assessment that utilize geospatial techniques for various uses in Uyo which are essential for effective land management and sustainable development. Other works may have relied upon generalized land use maps, which do not accurately reflect the dynamic nature of land utilization in the region.

There are indications that comprehensive study on land use and land cover data for the Uyo area, which is essential for understanding the current patterns of land use and their changes are lacking. Also, research efforts to assess of the land capability of the Uyo area, which is crucial for identifying the most suitable land management options, are grossly insufficient. We are confident that addressing the highlighted gaps in this study will contribute to the development of a comprehensive understanding of the land use and land capability of the Uyo area, which can inform sustainable land use planning and decision-making, thereby promoting the long-term well-being of the local community and the environment.

The work thus seeks to accurately assess the current land use patterns and capabilities within the central geographic area using geospatial technology. The two specific objectives of this study are to: (i) accurately assess the current land use patterns and capabilities within the central geographic area using geospatial technology, and (ii) identify area with high agricultural potential based on soil quality, climatic conditions, and other key factors using geospatial technology.

THEORETICAL FRAMEWORK

Geographic Information System (GIS) provides a platform for spatial analysis that allows researchers to overlay multiple layers of data onto a single map. This allows for the visualization of land use patterns, environmental conditions, and socioeconomic factors that can be crucial in understanding how land is currently being utilized. For example, GIS Can be used to map out urban verses rural areas, identify areas of high agricultural activity, and pinpoint locations where deforestation or other environmental degradation may be occurring. These visualizations can provide valuable insights into the current state of land use in the region. Remote sensing technology offers another important tool for studying land use and Capabilities in Uyo. By capturing high resolution imagery of the Earth's surface from satellites or drones, researchers can gain a deeper understanding of how land is being used and how it is changing over time. For example, remove sensing data can be used to track changes in vegetation cover, monitor soil degradation, and detect land use changes such as urban expansion or agricultural intensification.

This information can be valuable for policymakers and land-use planners who need accurate, up-to-date data in order to make informed decisions about land management. Traditional land use analysis techniques, such as field surveys and interviews with local stakeholders, also play a critical role in a comprehensive land use and capability studies. These methods provide qualitative data that can complement and contextualize the quantitative data generated by GIS and remove sensing technologies. By combining the insights gained from these different sources of data, researchers can form a more comprehensive understanding of how land is currently being used in Uyo, and what it's capabilities and limitations are for supporting various types of land use in the future, (unOpen AI (2021).

METHODOLOGY

Study Area

The study area is Uyo, the capital city of Akwa Ibom State. It's highly urbanized virtually all parts of Uyo within the Uyo Capital City Development Area (UCCDA), except Ikono clan. Uyo local government area is bordered to the north by Itu, Ikono and Ibiono Ibom local government Areas, to the south by Etinan, Nsit Ibom and Ibesikpo Asutan local government Areas, to the East by Uruan which stretches from Northeast around Ibiaku Uruan to Ndon Uruan in Southeast corner. Uyo is located between latitudes 4^0 53^1 and 5^0 04^1 North of the equator and longitudes 7^0 48^1 and 8^0 02^1 North of the Greenwich Meridian. The total population based on 2006 population census is 273,000 persons. Uyo being the Capital of Akwa Ibom State has witnessed increased intensity of infrastructural development in recent years.

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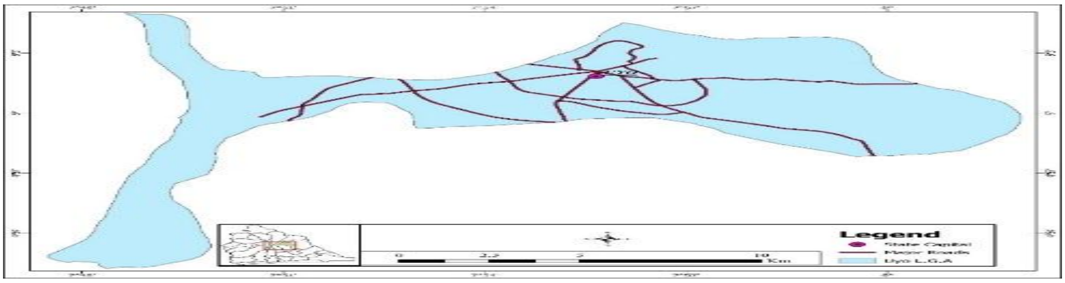

Figure 1: Study Area Map

Latitude and Longitude coordinates are 5.038963, 7.909470. Uyo is the capital of Akwa Ibom State which is the second - largest oil - producing state in the country and is located in South - South Nigeria. It is a famous recreation center and has a total Area of 140 square miles. The residents mainly speak the Ibibio language that is the native language of the people living in Akwa Ibom State. The University of Uyo (UNIUYO) is in the heart of Uyo. The town is very accessible by road, and there is an International Airport too. Victor Attah International Airport is the primary airport in the region and situated 20 Miles South- East of Uyo. The main attraction of the city include local parks, green zones, hotels, restaurants, recreation areas like Ibeno Beach, Le Meridian Golf Resort, Godswill Akpabio International Stadium, Ibom Connection, Ibom Plaza, Unity Park The Amalgamation House, National Museum of Colonial History, Presbyterian Church, Kilimanjaro Restaurant and so on. Uyo has a large Roman Catholic community and a good number of religious establishments.

The Wet season in Uyo usually runs from April to October with the heaviest rainfall occurring between June and September. During this period, Uyo experiences high humidity and frequent rainfall, often accompanied by thunderstorms. The average annual rainfall in Uyo is around 2,700mm (106 inches). The dry season in Uyo lasts from November to March, with relatively lower humidity and minimal rainfall. Temperatures during this period can reach heights of around 32^{o}C (90^{o}F) during the day, while nights are generally cooler, averaging around 18^{o}C (64^{o}F).Overall, Uyo has a warm and humid climate throughout the year with temperatures ranging from 24^{o}C to 32^{o}C (75^{o}F to 90^{o}F).

Uyo is located in the South-South part of Nigeria, specifically in Akwa Ibom State. The city is situated on a relatively flat terrain, which is characteristic of the coastal plains in that region. The elevation of Uyo is generally low, with the city averaging around 49 meters (160 feet) above sea level.The landscape around Uyo is mainly characterized by gently rolling hills and plains. The area is covered with lush vegetation, including forests and grasslands. Uyo is also surrounded by several rivers and streams, which contribute to the region’s agricultural productivity and scenic beauty. Overall, Uyo is located in a relatively low-lying area with gentle hills and fertile plains, offering a mix of urban and natural landscapes.

Uyo has been making efforts to improve its drainage system in recent years to address the issue of flooding that can occur during the heavy rainy season. The city has implemented various projects to enhance its drainage infrastructure and mitigate the impact of heavy rainfall. One notable project is the Uyo Urban Stormwater Management and Flood control Project, which was initiated by the State Government. This project aims to improve the city’s

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drainage system by constructing and rehabilitating drains channels, culverts, and canals to enhance the flow of storm water.

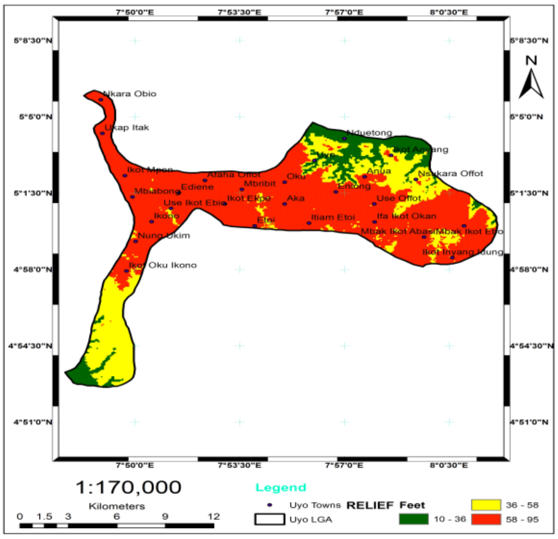

Fig. 2: Relief Map of the Study Area

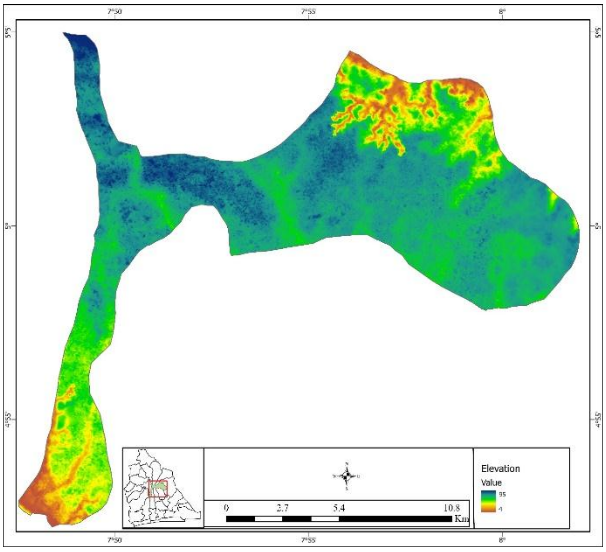

Fig. 3: Elevation Map of the Study Area

Additionally, the State Government has been investing in the construction of retention ponds, and reservoirs to help manage excess rainwater during periods of heavy rainfall. These retention systems are designed to temporarily store excessive water and release it gradually to prevent flooding. Furthermore, Uyo has been implementing proper waste management practices to prevent blockage in the drainage system caused by indiscriminate waste disposal. This includes public awareness campaigns, waste collection systems, and the construction of waste treatment facilities.

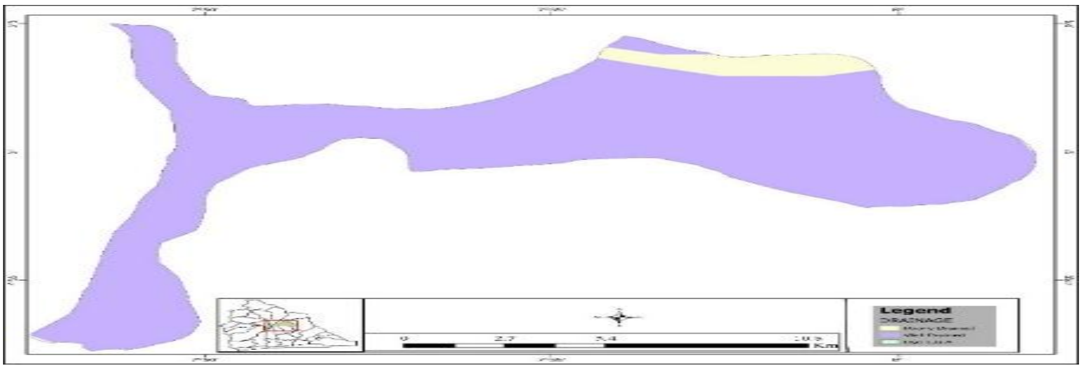

Figure 4: Drainage Map of the Study Area

The vegetation of Uyo, South -South Nigeria consists mainly of tropical rainforest, characterized by lush greenery, tall trees, various plants species, and dense vegetation. This region is known for its high biodiversity, with a mix of both evergreen and deciduous trees, as well as a variety of shrubs, Palms, and ferns. The area also features vibrant undergrowth and thick vegetation due to the humid and rainy climate typical of the region. Uyo's vegetation is essential for local communities, providing resources for food, medicine, and traditional practices. The lush green landscape and dense forests not only contributes to the region's natural beauty, but also play a vital role in maintain ecological balance and biodiversity in the area, making it a significant part of Nigeria's natural heritage.

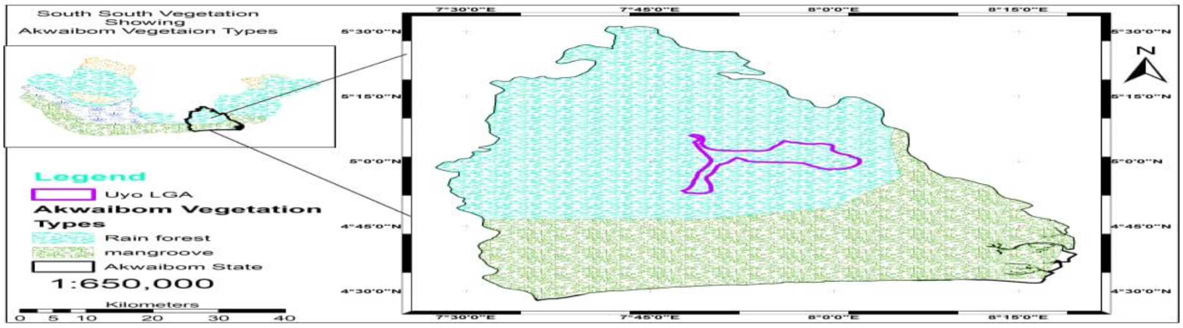

Figure 5: Vegetation Map of the Study Area

Uyo, located in South- South Nigeria predominantly features sedimentary geology. The region is characterized by its presence within the Nigeria Delta Basin, consisting mainly of sandy soils, alluvial deposit, clay rich materials. The sedimentary composition is typically associated with the Tertiary and Quaternary periods with significant fluvial and deltaic influences shaping its structure. The area is generally flat, with some undulating terrains due to the deposits and erosional processes. In addition to its sedimentary geology, Uyo exhibits formations such as sandstones, shales, and minor limestone deposit. Tectonic activity in the past has also contributed to the shaping of the landscape in Uyo. Overall, the Geology of Uyo reflects a complex interplay of geological processes that have shaped its current physical characteristics and landforms.

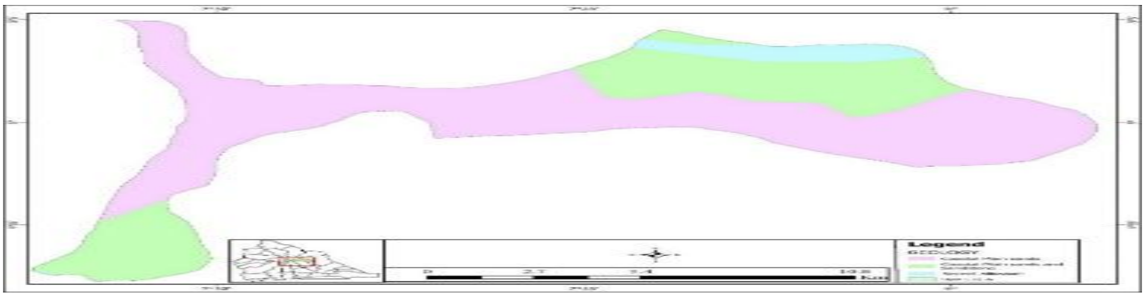

Figure 6: Geology Map of the Study Area

Data Acquisition and Sources

Data for this work were from two sources: The primary and secondary data. Primary data includes cloud free imageries of path 188 Rows 56 and 57 of Landsat 7. Enhanced Thermatic Mapper Plus (ETM +) of 10th December, 2000 and Landsat 8 Operational Land Image (OLI) of 13th January, 2018. These were downloaded from the USGS website at Earth Explorer USGS.gov. The TM, ETM (+), and OLI sensor records electromagnetic energy in the visible, reflective infrared, middle infra-red and thermal infrared regions of the electromagnetic spectrum. Landsat has a spatial resolution of 30 x 30m. The downloaded images were radiometrically corrected by USGS (4) and projected to Universal Traverse Mercator (UTM) Zone 32 North Coordinate System on World Geodetic System (WGS) 1984 ellipsoid.

Secondary data include administrative maps, land use maps and topographic maps of Uyo metropolis acquired from Uyo Capital City Development Authority (UCCDA), Akwa Ibom State Google Earth was used to obtain images of the study area at higher resolution to support satellite image interpretation, classification, accuracy assessment and as a reference to different Landsat images used. The administrative map was used to create a shape file of the study area used to subset the Landsat images. The essence was to reduce data sizes and increased computer storage space, and also reduced the run time of the different processes.

During the field trip, different land cover types were identified, and photographs and coordinates points were taken at each location. Information on land use types in the area was gathered by interviewing native leaders who had worked or live in Uyo since it was established as a state capital, using their local language. Structure questionnaire was used on some professionals who are into environmental science land related areas such as geographers, environmental scientists, surveyors, and town planners. Information obtained from them led to the land cover types being classified into four classes: built-up land, primary vegetation, secondary vegetation, and bare land/ agricultural land.

Data Processing

Multiple processing procedures were used in this study include image compositioning, classification scheme design, image classification, accuracy assessment, analysis of the land-use/land cover dynamics as well as the comparison of the changes that occurred within the year under consideration. Soil analysis was also carried out. Land-use maps of the period was gotten from the knowledge of GIS and remote sensing for 1986-2018. Calculation of the area in square kilometer of each land-use in each year in order to determine the changes and percentage of change in the total area covered in the land-use and types.

As mentioned earlier, Landsat TM and ETM + of 1986, 2000 and 2018 and Nigerian copy of her Local Government Area map. Uyo Local Government were imported to the ArcGIS environment using add data from the Nigeria copy of the Local Government Areas and Towns. This was to enable the boundaries of the map to be well defined. The Satellite imageries were also imported to the ENVI environment, composited and exported to the ArcGIS where they were clipped with the study area in the ArcGIS environment. The output of this operation was an extract to the study area fully geo-referenced in the coordinate systems in the tree image bands.

The extracted image of the study area was then exported to ENVI environment from the ArcGIS environment in TIFF format. Colour separation on the imageries was done and repeated for the remaining 2 Landsat imageries. This was followed by building the colour composites of the images using combination of different band until the combination which was closer to the true colour was achieved. The combination which was closer to the true colour was the combination of the band 4-3-2. Having assigned commensurate number of pixels to various land-use/land-cover classes, the classification images were processed in the

ENVI using image processing operation called classification (supervise maximum likelihood method).

The accuracy of the images was assessed through crossing the sample sets and the classified images and the level of accuracies were established using the confusion matrix operation in the ENVI environment. Post classification method was used to analyze land-use and land-cover changes which have taken place in the successive years. This method involve the cross matrix (confusion matrix & change detection statistics). The crossing of the images of year 1986 and 2000, years 2000 and 2018 were undertaken. This resulted in the histograms in the Microsoft excel environment to reveal the percentage changes which have taken place between the successive imageries. At the completion of the operations, the land-use and land-cover classification output and raster images of the detected changes were vectorized and exported back to ArcGIS and clipped with the study area boundary. All these results were sent to view layout on the ArcGIS environment where the relational database was generated for each land-use type.

Determination of the Normalized Difference Built-up Index (NDBI)

This was done using raster calculator in ArcGIS 10:4 software. The Normalized Difference Built-up Index (NDBI) technique was used to extract the built-up areas automatically from the satellite imagery. The index highlighted urban areas where there was typically a higher reflectance in the Shortwave – Infrared (SWIR) region, compared to the Wear-Infrared (NIR) region. The equations of NDBI are given thus:

$$NDBI = \frac{SWIR - NIr}{SWIR + NIR} \qquad (1)$$

$$\text{That is } NDBI = \frac{Band\ 5 - Band\ 4}{Band\ 5 + Band\ 4} \text{(TM \& ETM + Sensor)} \qquad (2)$$

$$NDBI = \frac{Band\ 6 - Band\ 5}{Band\ 6 + Band\ 5} \text{OLI (Sensor)} \qquad (3)$$

Bands 4 & 5 of the TM and ETM+ sensors had wavelengths of 0.76μm to 0.90μm and 1.55μm to 1.75μm respectively, while the Band 5 and Band 6 of OLI sensor had wavelength of 0.86μm to 0.88μm (NIR) and 1.57μm to 1.66μm (SWIR) respectively. NDBI was originally developed for use with Landsat TM Bands 5 and 4. However, it works with any multispectral sensor with a SWIR band between 1.55-1.75μm and NIR band between 0.76 – 0.9μm.

Image Classification

Land cover maps of the three periods were produced using supervised classification methods. The main objective of image classification is to place pixels in an image into land use/land cover classes in order to draw out useful thematic information. This was done on the basis of reflectance characteristics of the LULC types. Standard ‘false’ colour composite comprising of bands 5,4 and 3 for Landsat TM and ETM+ sensor and ands 6, 5 and 4 for Landsat OLI sensor were used. The delineated classes were: Build-up land, primary vegetation, secondary vegetation and bareland/agricultural land, table 3.2 shows the Major land use/land cover types and description. Similarly, information collected, during the field surveys were combined with digital base map of the study area and was used to assess the accuracy of the classification.

Change Detection Analysis

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different time (Singh, 1989). This study observed the LULC change process in the periods of 1986 – 2000, & 2000 – 2009 and determined by applying the post-classification comparism method – This method is simple and has the capability to compare two images from different times and sensor (Rahdary et al, 2008). These methods allow two images from different dates to be classified and labelled independently. The area of change is then calculated through direct comparism of the classified images using ENVI software. The results were presented in the form of a change matrix.

Image Interpretation

Software used to carry out this research included Arc GIS 10.4, and ERDAS Imagine 14.0. ERDAS imagine was used to perform layer stacking to produce false colour composites, image co-registration, sub-setting, and image classification; supervised and unsupervised. These processes could also be done in ArcGIS but ERDAS was chosen since it was more convenient for these analyses. ArcGIS software was used for adding images, adding attributes to data, mosaicking different scenes of Landsat data, performing image overlay, and calculating the Normalised Difference Built-up Index (NDBI).

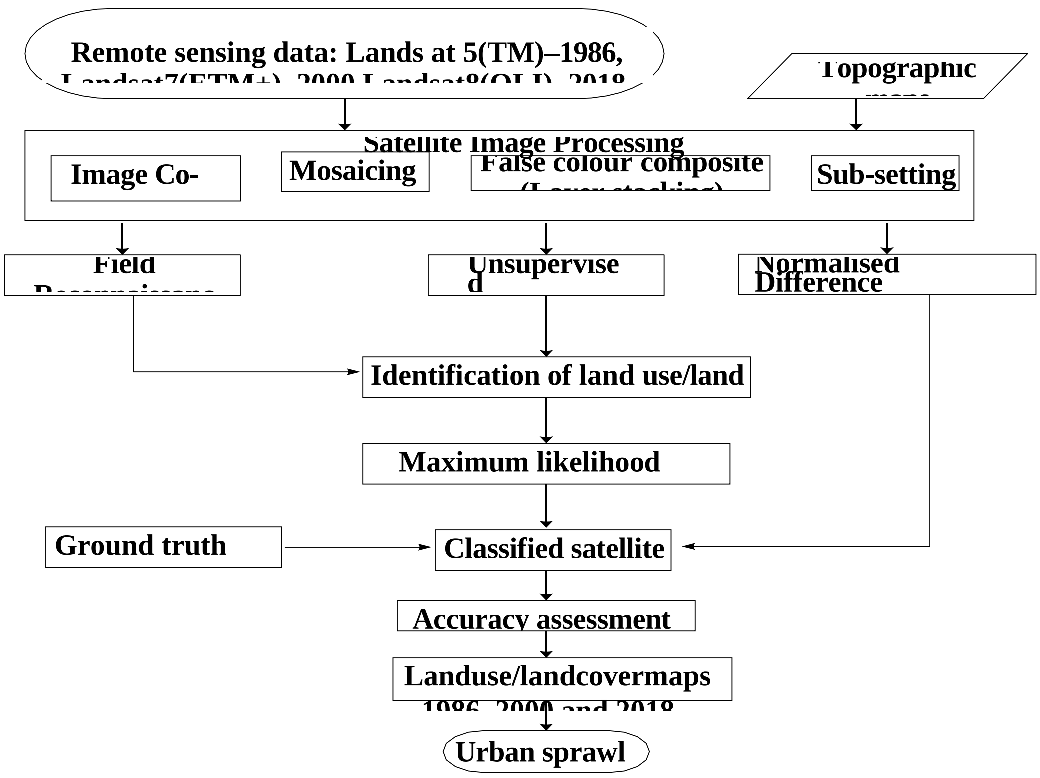

Fig 7: Methodology flow chart

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PRESENTATION OF RESULTS AND DISCUSSION

The outcome of the data processing and analysis were presented in figures and tables. The area covered by LULC types were obtained by multiplying the pixel counts by the pixel size which was 30 x 30m. accuracy assessment of the image classification was assessed in terms of user's accuracy, producer's accuracy and overall accuracy, results of the image differencing were interpreted and the percentage change, trend, and rate of change in land use patterns and capabilities within the central geographical area with more attention to built-up land were analyzed by comparison of the land use cover statistics.

Table 4.1: Area in square/kilometers & percentage cover for 1986-2000, and 2018

LULC types	Area Km^2	1986 Percentage cover (%)	Area km^2	2000 Percentage cover (%)	Area Km^2	2018 Percentage cover (%)
Total land mass	7,081.12		7,081.12		7,081.12	
Build upland	21.36	6.76	35.63	11.29	139.06	44.04
Bare land/ Agricultural land	80.44	25.48	61.8	19.57	43.51	13.78
Primary vegetation	153.3	48.55	136.2	43.13	103.8	32.86
Secondary vegetation	60.66	19.21	82.14	26.02	29.40	9.31

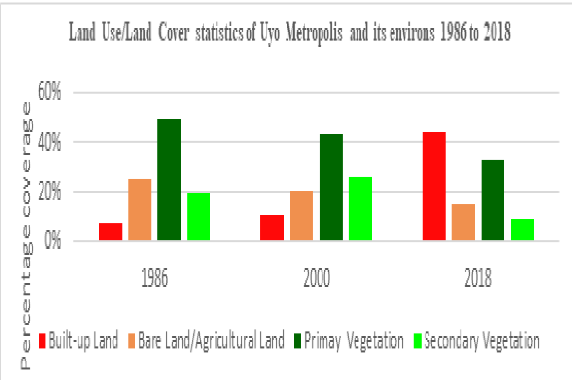

Figure 8: Histogram Showing Land Use/ Land Cover Statistics of Uyo Metropolis and Environs for 1986, 2000 and 2018

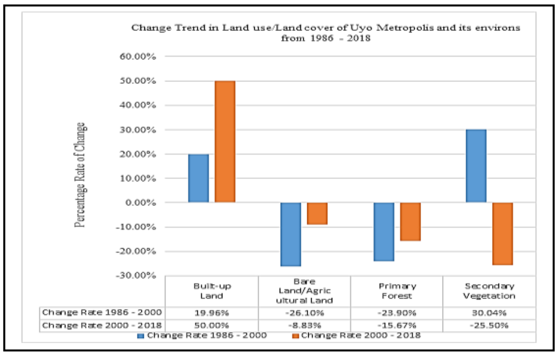

Figure 9: Histogram showing percentage change (trend) in land use/land cover in Uyo from 1986 to 2018.

The graph above shows the increase in the built up land between 1996 to 2000 21.36 square kilometers to 35.63 square kilometres (19.96%) increase. It also shows an increase on the secondary vegetation with an approximate expansion of 21.48 square kilometres (30.04%). The graph showed that other land use/ land cover were decreasing. However, between 2000 and 2018, there was a decrease in secondary vegetation i.e from 82.14 square kilometres to 29.49 square kilometers showing a negative percentage of (-25.50%). This implies that built-up land increases from 35.63 square kilometres in 2000 to 139.06 square kilometres in 2018 (50.00%).The result showed a patterns of increase in built up land by 19.96% between 1986 to 2000 (14 years) and 50.00% between 2000 to 2018 (18 years) respectively. This also results in the decrease on all other land use types which may be attributed to expansion of urbanization in Uyo metropolis and its environs.

The result is further supported by a total of 99.9% who agreed that the current land use patterns and capabilities show built-up/land cover being on the increase.

The temporal analysis of land use/land cover change of Uyo showed that there was increased in Built-up land of 19.96% between 1986 to 2000 (14 year) by 14.28 square kilometres. Bare land/agricultural land decreased by 18.67 square kilometres (26.10%), primary vegetation decreased by 17.09 square kilometres (23.90%) and secondary vegetation increased by 21.48 square kilometres (30.04%). See Table 4.1, Fig. 4.5 & 4.6. Also, in 2000 to 2018 (18 years), Built-land increase by 103.43 square kilometres (50.00%). Bare land/agricultural land depleted by 18.26 square kilometres (8.83%). Primary vegetation decreased by 32.42 square kilometres (15.67%) and secondary vegetation also decreased by 52.74 square kilometres (25.50%) as seen in Fig. 4.1. The results contradict Umo et al. (2018) report of 41.6 percent for built-up area, 22 percent for scattered farmland, and 8.4 percent for bare land respectively in Etim Umanna axis of Uyo metropolis.

From 1986 to 2018 (31 years), Built-up land showed a generally increased by 117.70 square kilometres (50.00%), while barre land/agricultural land was depleted by 36.93 square kilometres (15.69%), primary vegetation decreased by 49.51 square kilometres (21.03%) and secondary vegetation decreased by 31.26 kilometres (13.28%). This is seen in Table 4.1.

The increased in the Built-up land cover is an indication of the growth of the urban area. There are a number of factors that are in support of this growth, this include infrastructural developments such construction/dualization of roads by government between the period under review i.e 2000 to 2018. It is common knowledge that these developments attracts socio-economic activities to the state capital which also result in increase in population through rural-urban migration. The increase in this rural-urban migration leads to a corresponding increase in residential, commercial and other urban land uses. See Fig. 4.3.

In Uyo, the use of digital land information systems has significantly improved land use and capability studies by providing valuable insights and data for decision-making. The integration of geographical information systems (GIS) and other digital tools has enhanced the accuracy and efficiency of mapping land use patterns and assessing land capabilities in the region. The results of this work are in agreement with previous related studies such as "Assessment of change in built-up index of Uyo using Remote Sensing by Eyo et al, 2019. Through digital land information systems, experts can identify suitable areas for agriculture, urban development, conservation, and other land uses based on land capabilities and constraints. Uyo as the capital city has attracted several government institutions. The land sat images of the study area for 1986, 2003 and 2017 clearly explain this effect. The areas of vegetation cover show a drastic decrease. See Figure 4.1.

Additionally, with the newly built structures such as five-star hotel with a modern golf resort, international airport, these new structures have opened new links and development directions. The socio-economic interviews conducted in the area show that investors tend to acquire more land than public workers and community people are willing to sell their land because the investors are thriving in their businesses and usually purchase the land at high prices. Moreso, it shows that there was intense need for land development due to rural-urban

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migration and labour mobility during the recent industrialization and urbanization, and this encouraged excessive land use in Uyo and stimulated the growth of built-up lands.

Geospatial Interpretation

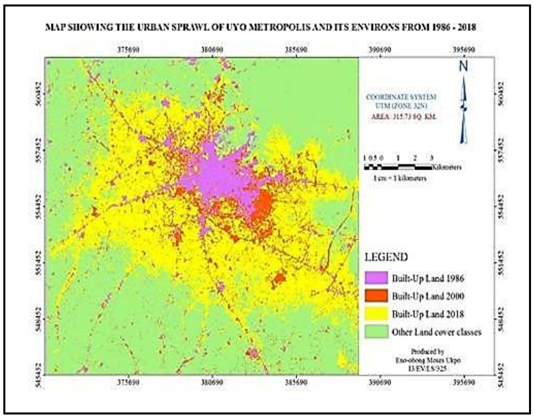

Fig. 10: Urban Sprawl Map of Uyo and its Environs from 1986 to 2018

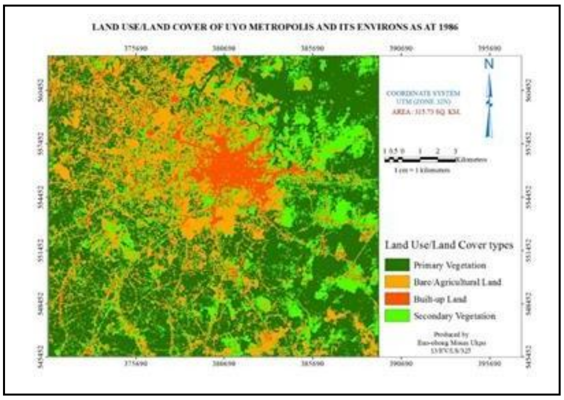

Fig. 11: Land Use/Land Cover Map of Uyo and its Environs as at 1986

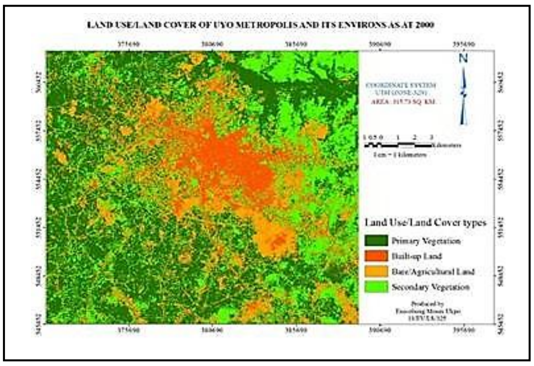

Fig. 12: Land Use/Land Cover Map of Uyo and its Environs as at 2000

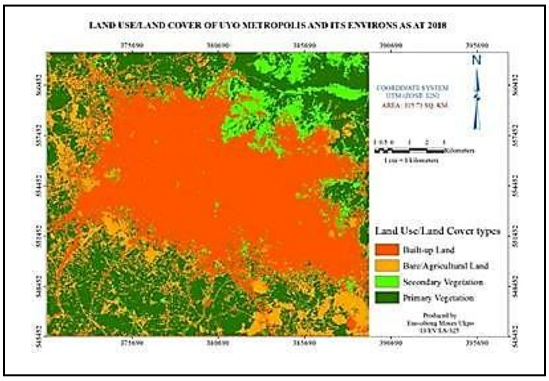

Fig. 13: Land Use/Land Cover Map of Uyo and its Environs as at 2018

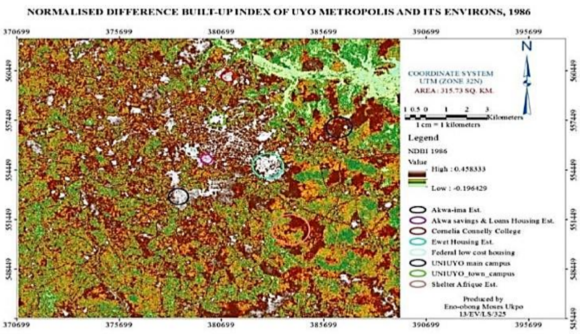

Fig. 14: Result of NDBI for1986 (TMsensor), reflectance value +0.45 to -0.20

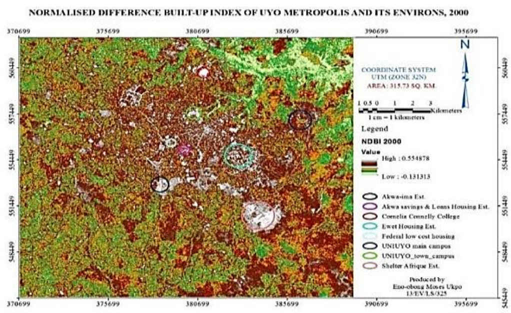

Fig. 15: Result of NDBI for 2000(ETM+sensor) reflectance value +0.55 to -0.13

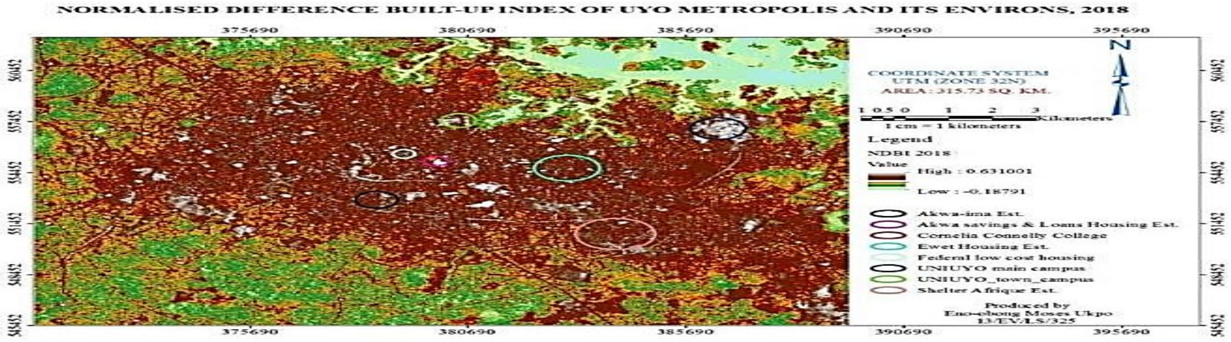

Figure 16: Result of NDBI 2018 (OLIsensor) reflectance value from +0.63 to -0.19

The results of the Normalized Difference Built-up Index(NDBI) gave better distinction between the built-up land features in white and grey colours while older urban surfaces were shown in dark brown and lighter brown colours. The index highlighted changes in Urban surfaces with time. The variability in the bright tones indicated the differences in built-up density appear the brightest and vice versa.

Table 4.2: Accuracy Assessment for the Classification

LULC types	No. of correctly classified test pixels	No. of incorrectly classified test pixels	Total No. of test pixels	Producer's Accuracy or class Accuracies (%)	User's Accuracy (%)
		1986 Classification			
Built-up Land	50	1	51	100	98
Bare Land/Agricultural Land	46	3	49	98	94
Primary Vegetation	46	9	55	92	84
Secondary Vegetation	24	1	25	72	96
	Overall Classification Accuracy	**92.2%**			
	Overall Kappa statistics	**0.894**			
		2000Classification			
Built-up Land	40	1	41	100	98
Bare Land/Agricultural Land	41	0	41	98	100
Primary Vegetation	49	1	50	98	98
Secondary Vegetation	39	1	40	98	98
	Overall Classification Accuracy	**98.2%**			
	Overall Kappa statistics	**0.977**			
		2018Classification			
Built-up Land	50	1	51	100	98
Bare Land/ Agricultural Land	40	1	39	98	100
Primary Vegetation	25	1	26	100	100
Secondary Vegetation	40	1	39	98	96
	Overall Classification Accuracy	**98.2**			
	Overall Kappa statistics	**0.987**			

Source: Authors' Analysis (2024).

Prior to the creation of Akwa Ibom State in 23rd September,1987 from cross river state and adoption of Uyo local government area as the state capital, several developmental activities took place within the study area in 1986, radiating from the city centre. Some of these were the creation of elitist estates, examples, the Federal low cost housing estate and Ewet housing estate.

In 2000, the NDBI indicated more of such housing estates, which includes Shelter Afrique Estate, Akwa-ima Estate and many other housing estates which were as a result of the transition from military rule to civilian rule in 1999. Also, in 2018, the NDBI indicated developmental activities within the University of Uyo main campus at Nsukara Offot. The variability of total number of test pixels selected for each class is due to the most dominating land cover type present within the years under study. This is shown in table 4.2

CONCLUSION AND RECOMMENDATIONS

Geospatial technology has proven to be a very useful tool in providing archival data for spatial temporal analysis of land use/land cover. This study has successfully explored the use of geospatial technology in assessing land use and land capability studies of Uyo metropolis and environs. The result obtained indicated that from 1986 to 2018, Built-up land increased by 117.70 square kilometres (50.00%) increase, Bare land/Agricultural land was depleted by 36.93 square kilometres (15.69%), primary vegetation decreased by 49.51 square kilometres (21.03% decrease) and secondary vegetation also decreased by 31.26 square kilometres (13.28% decrease).

The downward growth in every other land cover type aside from Built-up land is an indicator of urbanization growth in Uyo. The main observed land cover change trends occurred after 2000, mainly from forest to crop land and sparse built-up. The changes is as a result of increasing economic and political decisions combined with poor governance, leading to population growth and unplanned urban development. This is evidenced in the master plan of Uyo being continuously change because of infrastructure development by different governments, and this directly affects the unstable land cover change. The result of this work will serve as a rallying point for government functionaries and policy makers in planning Uyo especially now that urbanization growth, climate change is affecting every city, with all other environmental and its attendant affects.

Based on the findings and conclusion of this study, the following recommendations will be of great assistance to stakeholders, environmental scientists, government, and decision-makers.

(1) Implementation of Remote Sensing technologies and GIS for efficient mapping of land cover, land use changes, and soil characteristics. This will help in visualizing spatial relationships and patterns.

(2) Adopt Land Capability Models: Use existing land capability classification models (e.g. USDA classification) adjusted for local conditions to assess the suitability of difficult land types for various uses (agriculture, forestry, urban development).

(3) Prioritize Sustainable Practices: Zones should be designated for high, moderate, and low capability lands to prioritize practices, limiting intensive agriculture to high capability areas.

(4) Implement Zoning Regulations: Establish zoning laws that clearly define land use types (residential, commercial, agricultural, industrial) based on land capability assessment. This is critical degradation.

Competing Interest

The authors declare that no conflicting interest exist in this manuscript.

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