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Remote Sensing Based-Assessment of Land Use and Land Cover Dynamics in Mangrove Vegetation, Akwa Ibom State, Nigeria (1986-2024)

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Abstract

This study was poised to determine the spatial extent and trend of changes in mangrove vegetation in Akwa Ibom State, in the Niger Delta region of Nigeria, for about forty years. Remotely sensed Landsat satellite images were obtained for 1986, 2004, 2014, and 2024 from the United States Geological Survey, Earth Explorer. The study identified, classified, and analysed the various land uses replacing Mangrove vegetation in Akwa Ibom State using the supervised algorithm in Erdas Imagine. The result showed that the mangrove forest declined by about 70% from 1986 to 2024. The decline in the spatial extent of Mangrove vegetation was influenced by several anthropogenic factors, especially in the coastal areas. Notably, there was a steady increase in built-up, and farmland uses through these years. This study suggests the need to monitor Mangrove vegetation exploitation. Furthermore, it recommends the need for an urgent mangrove restoration programme in the area, given the ecological benefits of the mangrove vegetation to the ecosystem.

Keywords: GIS, Remote Sensing, Mangrove Vegetation, Land Use and Cover Change

INTRODUCTION

Ecological zones in Nigeria are classified into mangrove swamp and coastal vegetation, freshwater swamp forest, lowland rain forest, derived savanna, guinea savanna, sudan savanna, and sahel savanna (Keay, 1949). The Mangrove swamp and coastal vegetation are found along the delta and coastal parts of Nigeria (Federal Government of Nigeria (FGN, 2019). Hula and Uwem (2015) explain that Mangroves are found in Lagos, Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom, and Cross River. Mangroves are characterised by stilt roots of Rhizophora spp., with the population dominated by Rhizophora racemosa, Rhizophora mangle, Rhizophora harrisonii, Avicennia Africana, and Laguncularia racemosa (FGN, 2019). Ogbeibu and Oribhabor (2023) reveal that mangrove species in the location consist of six species in three families, classed as Rhizophoraceae (Rhizophora racemosa, R. harrisonii, and R. mangle), Avicenniaceae (Avicennia africana), and Combretaceae (Laguncularia racemosa and Conocarpus erectus). The most dominant species are red (Rhizophora racemosa), black (Laguncularia racemosa), and white (Avicennia germinans) mangroves.

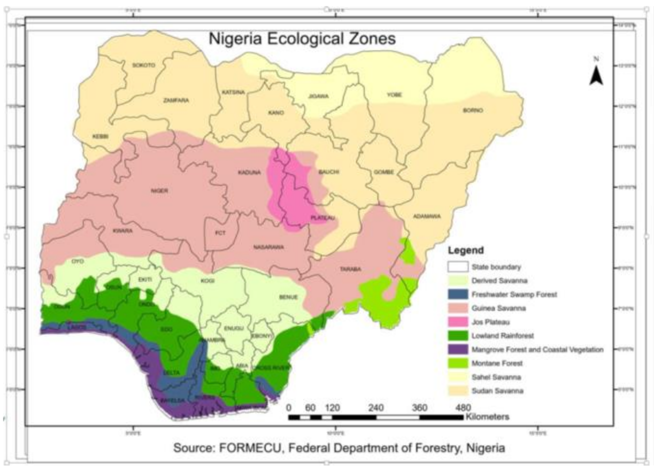

Figure 1: Nigeria Ecological Zones

This study adopts the Ecological Succession Theory in conceptualizing mangrove vegetation dynamics. Fredrick (1916) explains how plant communities change with time as influenced by changes in environmental and anthropogenic disturbances. Mangroves offer coastal protection buffer against flooding, storms, and erosion. Their ecosystems are rich in biodiversity, critical to sustaining local fisheries. United Nations Environmental Program (2024) reveals that, mangrove-derived ecosystem services are estimated to be worth US$33,000–57,000 per hectare per year. UNEP (2024) shows that Mangroves are a significant global carbon store and sink with the largest average carbon stocks per unit of any terrestrial or marine ecosystem. The global average carbon stock of mangroves is around 1000 tonnes of carbon per hectare, including soil carbon (UNEP 2024; UNEP 2023). Gilang Qur'ani *et al.* (2023) explains that instead of long-term carbon stock storage, mangroves can become a significant source of carbon emission if degraded due to land use and cover change and subsequently add to global atmospheric greenhouse-gas concentrations. However, 1996-2020 mangrove forest loss released the equivalent of approximately 4 times the global Co_2 emissions of fossil fuel burning and the manufacture of cement in 2018, even as emissions resulting from mangrove losses make up nearly one-fifth of global emissions from deforestation, resulting in economic damages of US$6-42 billion annually (UNEP, 2024).

Land use and cover in the Niger Delta region of Africa are in a state of constant flux. Succession occurs in these Mangrove ecosystems due to anthropogenic activities like urban development (e.g. dredging and sand filling for swamp reclamation, urban settlements, road construction, industrial development in coastal areas, coastal resorts among others), coastal erosion, oil exploration and pollution, gas flaring, and subsidence of the coastal geosynclines aggravated by fluid withdrawal (oil and gas) from porous reservoirs in subsurface Niger Delta change (Hula and Uwem, 2015). Several studies utilized unique methodologies and classifications to define this succession. Archibong *et al.* (2024) assessed the land use change of two coastal local government areas of Oron and Eastern Obolo in Akwa Ibom State, showing a progressive succession of Nipa palm (Nypa fruticans) over the mangroves within a period of three decades (1986-2018). Their results show that in 1986, mangroves occupied a large area of 6.8 km^2 using a pixel count methodology, representing 12.7% of the entire forest, with nipa palm covering an area of 3.1 km^2, representing 5.7% of the area. They explain that in 2000, mangrove forest reduced from 6.8 km^2 to 6.0 km^2

and 4.9 km^2 in 2018, with nipa palm increasing from 3.1 km^2 to 4.2 km^2 and 5.6 km^2 in 2018.

Hula and Uwem (2015) show that mangrove forest distribution changed for 17 years (1986-2003) using the Landsat TM and ETM imageries, respectively. They covered more local government areas of Oron, Udunguko, Urue Offong Oruko, Opobo, Uruan, Ikot Abasi, Esit Eket, Ibeno, and Eastern Obolo in Akwa Ibom State. Their results using the unsupervised classification method of the clustering algorithm in Erdas Imagine revealed changes in mangrove forests from 114103.8ha, representing 17.2% in 1986, to 107669.7ha (15.3%) in 2003. Anthropogenic activities of oil companies, increasing rate of mangrove removal by timber logging, local usage of mangroves, and the invasion of Nypa palm, causing the loss of 96434.1ha of mangroves. Ekpenyong (2015) carried out land cover mapping and change analysis in Akwa Ibom State from 1986 to 2007. The 28.5 m orthorectified Landsat TM satellite data for 1986, and NIGERSAT-1 imagery for 2007 were used, where cluster analysis and a supervised classification algorithm were applied. Results revealed that swamp forests possessed 290,540ha, representing 42% of the total area in 1986. Swamp forest declined to 191,750ha, representing 28% of the total area in 2007. This study is novel as it integrates the 2024 datasets to provide new insights into land use and land cover dynamics beyond earlier studies. The succession transitions will be discussed in detail, showing the patterns of succession dynamics.

This research determined the spatial extent and trend of changes in Mangrove vegetation for the years 1986, 2004, 2014, and 2024 in the Niger-delta region. It focused on Akwa Ibom State in Nigeria. It achieved this with the following objectives. To identify the land uses that replace mangrove vegetation in Akwa Ibom State. To show the level of land cover change in Mangrove vegetation in Akwa Ibom State.

This research identified and classified the various land uses that replaced mangrove vegetation in Akwa Ibom State. It revealed the spatial extent of Mangrove vegetation cover dynamics in Akwa Ibom State. It focused on the years 1986, 2004, 2014, and 2024. This showed the current spatial extent and trend of mangrove vegetation change in Akwa Ibom State within the 30-year study. This study was necessitated by the need to monitor the mangrove forest. In order to create a base to guide conservation and inform mangrove management decisions.

Materials and Methods

Study Area

Akwa Ibom State is located in the Niger delta region of Nigeria. It lies between latitudes 4°30" and 5°30" N and longitudes 7°30" and 8°30" E (As seen in Figure 2).

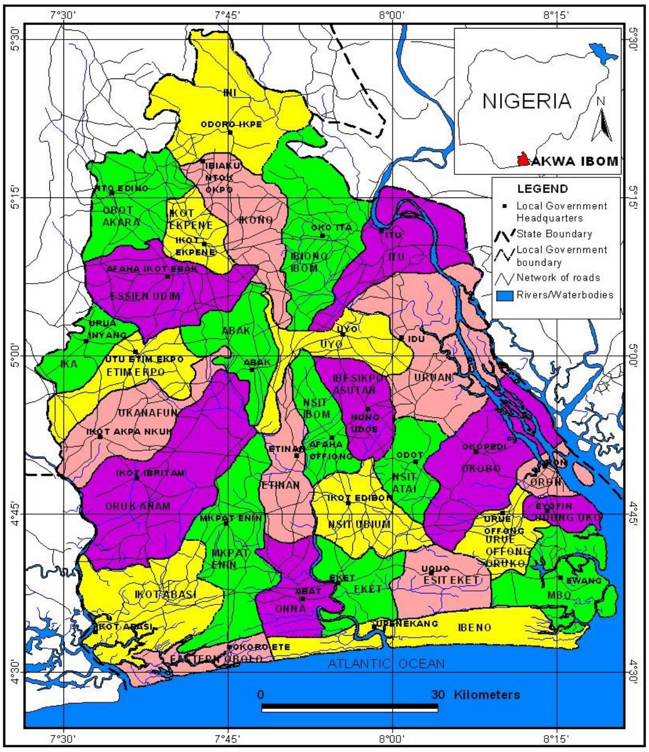

Figure 2: Location of study area: Akwa Ibom State, Nigeria
Source: Akwa Ibom State Surveys, 1997, extracted from Etim *et al.* (2025)

Usoro (2010) shows the State's major physiography. This includes sandstone hills and ridges with steep-sided valleys, level to slightly undulating sandy plains, level floodplains with recent alluvial accumulations, and mangrove swamps. The Qua Iboe and Cross rivers are major river systems draining the area. They source two sub-basins. The eastern basin comprises the Ikpa River and Enyong River. The western basin has the Qua Iboe River's main trunk, which flows from the hinterland to the Atlantic coastal swampland. Its drainage pattern on the whole is dendritic (Usoro, 2010).

Ekanem (2010) reveals that the average annual rainfall is about 2500mm. It has a low rainfall variability of -2 with a mean daily maximum temperature of 27 °C (Ekanem, 2010). Its highest temperatures are normally recorded between February and April, and do not exceed 37 °C. Rainfall surpasses 80 inches per year (200 cm). Relative humidity exceeds 75 percent throughout the year (Ekanem, 2010). The temperatures are warm, enabling the rapid growth of vegetation. The state is divided into 31 local government administrative areas. The area is populated by people with diverse cultures and behaviors. This impacts on vegetation exploitation and conservation.

Data Acquisition

This study was concerned with enhancing appropriate accuracy in data collection and analysis. The methodology was structured into three stages. Image pre-processing and classification, Area calculation and Analysis of Change.

Remote Sensing Data

The high spatial and temporal resolution satellite data was collected in the 30m resolution range. Remotely sensed Landsat satellite imagery of 1986, 2004, 2014, and 2024 were downloaded from the United States Geological Survey.

Classification Scheme

This technique was utilized to reveal natural grouping and hidden patterns that might not be anticipated. This classification scheme was developed for the study after National center for Remote Sensing classification scheme (NRSC, 2011; ISRO, 2011). Six land cover and use classes were classified based on their spectral signatures. The modified classes were done keeping in view the area under investigation, and the land use and land cover was segmented into six groups, namely: Water bodies, Mangrove, Forest, Disturbed Forests, Farmland, and Built-up Areas.

Image Analysis

The following methods and GIS techniques were adopted in analysing satellite data. Image pre-processing and enhancement; Image classification; Calculation of the Area in hectares of the resulting land cover types for each study year; and Analysis of changes that have taken place.

i. Image pre-processing: The 1986, 2004, 2014 and 2024 images were layer stacked, mosaic, and subset. After which the images were enhanced in Erdas imagine 9.2.
ii. Image classification: The images were processed using the supervised image processing technique. This was done through the classifier menu by training the signature first according to and cover categories developed and then classified using the trained signature
iii. Area Generation: The calculation of the Area in hectares of the resulting land cover types for each study year was obtained from the add area column of the raster attribute of the image.
iv. Change analyses: Analysis of changes that have taken place in the study area were obtained by comparing the land use land cover statistics. This aided in identifying the changes in hectares and percentage between 1986 to 2004, 2004 to 2014 and 2014 to 2024. In achieving this, a table showing the area in hectares and the percentage change measured against each land use land cover type was generated. Percentage change to determine the trend of change was calculated by dividing observed change by sum of change and multiplied by 100.

$$\text{Percentage change} = \frac{\text{Observed change X 100}}{\text{Sum of change}}$$

To obtain the annual rate of change, the percentage change will be divided by 100 and multiplied by the number of study years (that is 1986 – 2024, 38 years), among others.

$$\text{(rate) annual rate of change} = \frac{\text{percentage change X 38 years}}{100}$$

The Tables 1, 2, 3, and 4 shows the accuracy assessment for the classified maps of 1986, 2004, 2014, and 2024 respectively. The tables show each land use and land cover, the number of correctly classified test pixels, number of incorrectly classified test pixels, number of total classified test pixels, producer's accuracy and user's accuracy.

Table 1: Accuracy Assessment for classified map of 1986

LULC Classes	Number of Correctly Classified Test Pixels	Number of Classified Test Pixels	Number of Total Classified Test Pixels	Producers Accuracy (%)	Users Accuracy (%)
Forest	80	5	85	93.02326	94.1176
Disturbed Forest	75	5	80	91.46341	93.845
Mangrove	65	3	68	92.85714	95.5882
Farmland	45	3	48	91.83673	93.7525
Built up	15	5	20	54.94737	57.3203
Water Body	10	8	18	66.66667	55.5556

Overall accuracy = 89.6%; Kappa Coefficient = 0.858

Table 2: Accuracy Assessment for classified map of 2004

LULC Classes	Number of Correctly Classified Test Pixels	Number of Incorrectly Classified Test Pixels	Number of Total Classified Test Pixels	Producers Accuracy (%)	Users Accuracy (%)
Forest	74	4	84	94.11765	95.2381
Disturbed Forest	72	8	80	92.4418	91.758
Mangrove	60	6	66	91. 7145	92. 8342
Farmland	56	5	61	90.27361	89.1772
Built up	51	4	55	80.64135	78.2386
Water Body	14	5	19	67.57723	58.7265

Overall accuracy = 90.52%; Kappa Coefficient = 0.892

Table 3: Accuracy Assessment for classified map of 2014

LULC Classes	Number of Correctly Classified Test Pixels	Number of Incorrectly Classified Test Pixels	Number of Total Classified Test Pixels	Producers Accuracy (%)	Users Accuracy (%)
Forest	60	3	66	92.47826	93.7272
Disturbed Forest	65	5	70	90.52714	95.5886
Mangrove	56	2	58	83.79154	81. 8643
Farmland	80	4	84	94.11765	95.2381
Built up	110	8	118	78.94737	78.9473
Water Body	16	4	20	68.57723	57.165

Overall accuracy = 91.88%; Kappa Coefficient = 0.879

Table 4: Accuracy Assessment for classified map of 2024

LULC Classes	Number of Correctly Classified Test Pixels	Number of Incorrectly Classified Test Pixels	Number of Total Classified Test Pixels	Producers Accuracy (%)	Users Accuracy (%)
Forest	54	2	54	86.3276	82.2381
Disturbed Forest	67	3	70	91.2128	90.529
Mangrove	42	3	45	89.47826	87.7277
Farmland	50	4	54	82.64135	78.2382
Built up	121	7	128	94.61435	89.8612
Water Body	12	11	23	67.57723	52.1635

Overall accuracy = 92.82%; Kappa Coefficient = 0.904

Note: LULC represents Land use and land cover. Number of correctly classified test pixels represents frequency counts of correctly classified pixels. Number of classified test pixels represents frequency counts of other pixels. Number of total classified test pixels is the sum total correctly classified and classified test pixels. This representation is across the Tables 1, 2, 3, and 4.

RESULTS AND DISCUSSION

Distribution of land use and cover types

The land use and cover types in Akwa Ibom State for the year 1986 showed Mangrove vegetation spanning across 107,570.74 hectares. This ranked it as the fourth most prominent land cover in the state. The most prominent land cover and land use class was the Disturbed forest (241,734.15 hectares). Others: Farmland (122,804.19 hectares), Forest (161,553.24 hectares), Built-up (51,020.61 hectares), and Water body (20,367.62 hectares) as shown in Table 5.

Table 5: Land use and Land cover classification for Akwa Ibom State -1986

LULC Class	1986 area in Hectares
Water Body	20,367.62
Mangrove	107,570.74
Forest	161,553.24
Disturbed Forest	241,734.15
Farmland	122,804.19
Built-up	51,020.61
Total	**705,050.55**

Source: Author's analysis, 2025

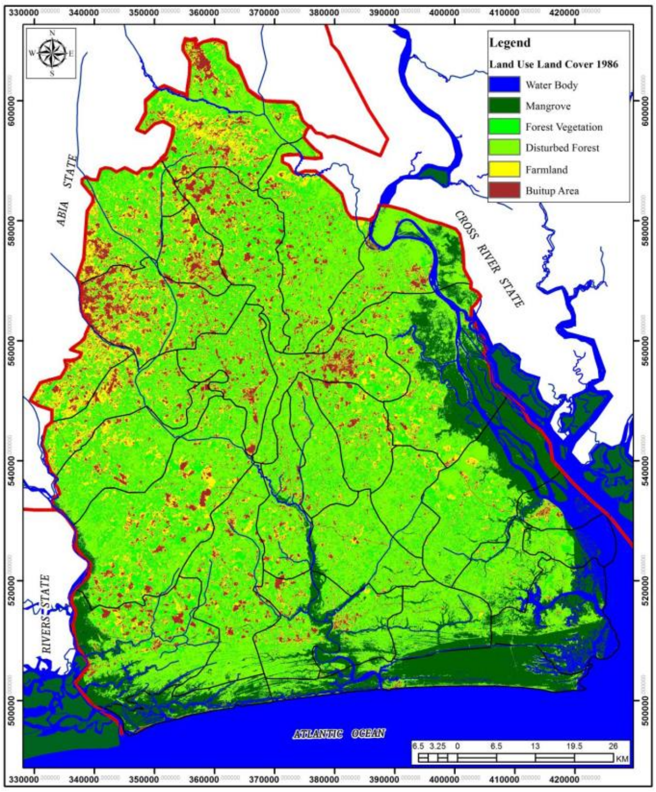

Figure 3: Land use and land cover change of Akwa Ibom State for the year 1986
Source: Author's analysis, 2025

The map in Figure 3 shows the distribution of land use and land cover in Akwa Ibom State. It reveals the cluster of mangrove vegetation around the coastal areas of the state. The disturbed forest and forest vegetation spreads widely across the state with built-up and farmland randomly distributed where settlements were developing.

Figure 4 shows of the land use and land cover of the year 2004. The figure shows a level of divergence from the year 1986. The map reveals an increase in Built-up land use as cities develop replacing important vegetation. Farmlands also significantly increase.

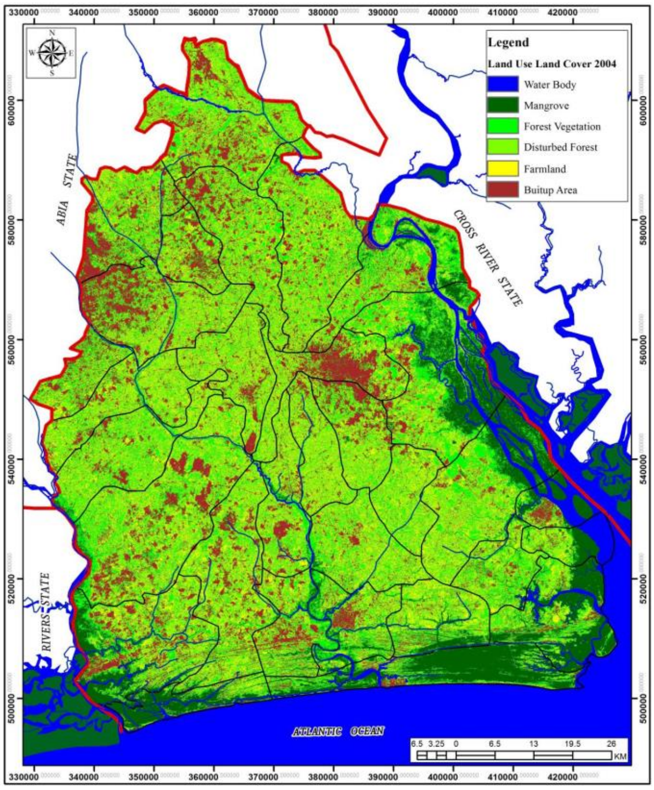

Figure 4: Land use and land cover change of Akwa Ibom State for the year 2004
Source: Author's analysis, 2025

The year 2004 revealed a decline in the Mangrove vegetation. It covered 84,964.02 hectares. There was an increase in the Disturbed forest cover as it spread 226,557.23 hectares. This ranked the highest land use and cover in 2004. Forest vegetation followed with 159,050.80 hectares. Farmlands increased to 129,414.95 hectares. Built-up areas also marked an increase of 85,007.61 hectares. There was a limited decline in Water body cover revealing 20,055.93 hectares. This is as shown in Table 6.

Table 6: Land use and Land cover classification for Akwa Ibom State -2004

LULC Class	2004 area in Hectares
Water Body	20,055.93
Mangrove	84,964.02
Forest	159,050.80
Disturbed Forest	226,557.23
Farmland	129,414.95
Built-up	85,007.61
Total	**705,050.55**

Source: Author's analysis, 2025

The year 2014 showed a steady decline in the Mangrove vegetation as compared to the previous year. Its spread was 73,904.85 hectares. There was also a decrease in the Disturbed forest cover. It was still the major land cover with the spread of 213,723.66 hectares. The disturbed forest still maintained its rank as the largest land use and cover in 2014. Forest vegetation followed with 146,130.17 hectares, marking a decline as well. Farmlands declined to 122,104.71 hectares. Built-up land use was the largest gainer, as it increased to 130,414.15 hectares. The decline in Water body cover continued with 18,773.01 hectares. This is as shown in Table 7.

Table 7: Land use and Land cover classification for Akwa Ibom State -2014

LULC Class	2014 area in Hectares
Water Body	18,773.01
Mangrove	73,904.85
Forest	146,130.17
Disturbed Forest	213,723.66
Farmland	122,104.71
Built-up	130,414.15
Total	705,050.55

Source: Author's analysis, 2025

Figure 4 shows the increase in the spatial distribution of Built-up land use and farmlands replacing the original vegetation as influenced by the rapid socio-economic development of the State.

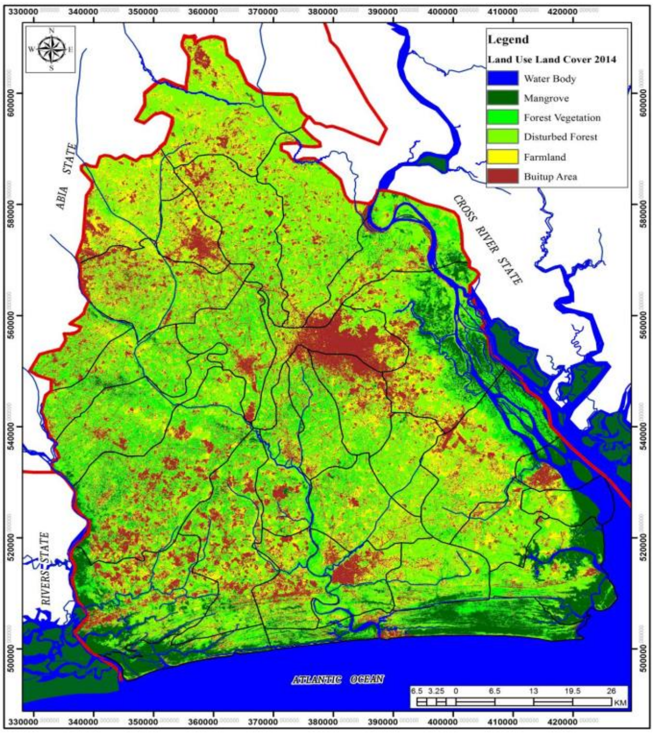

Figure 5: Land use and land cover change of Akwa Ibom State for the year 2014
Source: Author's analysis, 2025

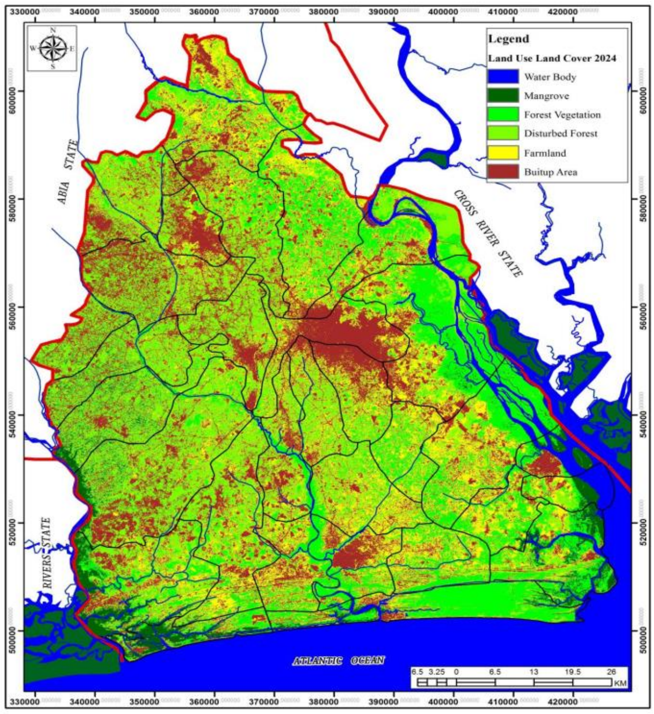

Figure 6: Land use and land cover change of Akwa Ibom State for the year 2024
Source: Author's analysis, 2025

The year 2024 revealed a steeper decline in the Mangrove vegetation with its land cover of 32,377.32 hectares. The Built-up land use became the largest land cover as it showed 196,879.40 hectares. The disturbed forest cover declined due to the spread of 190,308.43 hectares. Farmlands showed an increase to 139,108.59 hectares. Forest vegetation declined to 127,168.02 hectares. The water body showed limited gains of 19,208.79 hectares. Figure 5 shows the change in land use and cover as Built-up land and Farmlands appreciated widely across the State. Figure 6 shows a predominant increase in the Built-up land use. Farmland use also shows a serious increase.

Table 8: Land use and Land cover classification for Akwa Ibom State -2024

LULC Class	2024 area in Hectares
Water Body	19,208.79
Mangrove	32,377.32
Forest	127,168.02
Disturbed Forest	190,308.43
Farmland	139,108.59
Built-up	196,879.40
Total	705,050.55

Source: Author's analysis, 2025

Mangrove Distribution in Akwa Ibom State

Spatial Distribution

This research shows the trend of mangrove vegetation from 1986 (107,570.74a), 2004 (84,964.02ha), 2014 (73,904.85ha), and 2024 (32377.32ha). This trend reveals a steady decline in the size of mangrove vegetation in Akwa Ibom State. Disturbed Forests and Forests also exhibit the same trend of decline. Water body cover shows a different trend as it gradually declines for the years 1986, 2004, and 2014. In 2024, Water body cover showed a slight increase in its area in Akwa Ibom State. However, built-up land use and Farmland use have shown a steady increase throughout the years of the study. This trend is shown in Figure 7.

Mangrove vegetation was 15.26% of the total land mass in Akwa Ibom State in 1986. It reduced in 2004 to 12.05%. Mangrove vegetation in Akwa Ibom State continued to decline as compared with other land uses, to 10.49% of the total land cover. In 2024, the area of Mangrove vegetation reduced to 4.59% of the total land mass in Akwa Ibom State.

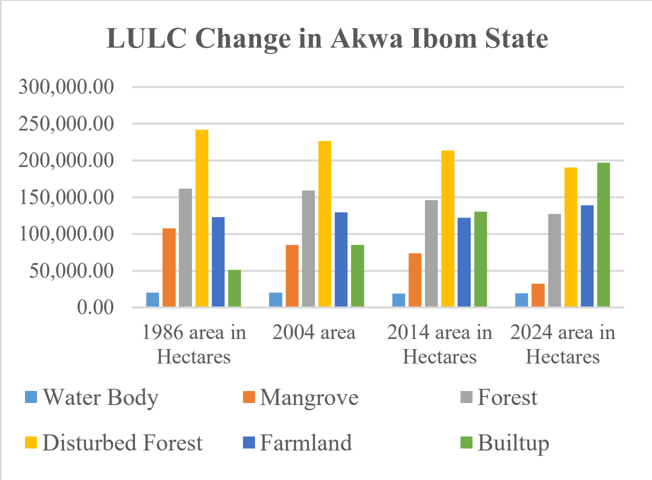

Figure 7: Land use and land cover change in Akwa Ibom State for the study years.
Source: Author's analysis, 2025

This change has been noticed particularly in Eastern Obolo, Ibeno, Mbo, Udung Uko, Oron, and Mbo local government areas where mangrove vegetation, are predominantly located. The percentage area of other land use and cover are revealed in Table 9.

Table 9: Land use land cover status for 1986, 2004, 2014, and 2024

LULC Class	1986 area in Hectares	%	2004 area in Hectares	%	2014 area in Hectares	%	2024 area in Hectares	%
Water Body	20,367.62	2.89	20,055.93	2.84	18773.01	2.66	19208.79	2.72
Mangrove	107,570.74	15.26	84,964.02	12.05	73904.85	10.49	32377.32	4.59
Forest	161,553.24	22.91	159,050.80	22.56	146130.17	20.72	127168.02	18.04
Disturbed Forest	241,734.15	34.29	226,557.23	32.13	213723.66	30.31	190308.43	26.99
Farmland	122,804.19	17.42	129,414.95	18.36	122104.71	17.32	139108.59	19.73
Built-up	51,020.61	7.23	85,007.61	12.06	130414.15	18.5	196879.4	27.93
Total	705,050.55	100	705,050.55	100	705050.55	100	705050.55	100

Source: Author's analysis, 2025

The percentage change in Mangrove vegetation between the years 2004 and 1986 was 27.84%. The annual rate of change between 2004 and 1986 was 5.01%. The percentage change in Mangrove vegetation between the years 2014 and 2004 was 12.18%. The annual rate of change Mangrove vegetation further showed a percentage change of 24.75 for the years 2024 and 2014. The percentage change of other land use and land cover are revealed in Table 9.

Drivers of Change

Several factors play a prominent role in dynamics of land use and land cover in Akwa Ibom State. This study classifies these factors into Political, Economic, Physical and Socio-Cultural, Politically the state was created as an administrative unit in September, 1987. The State was initially structured into ten local government areas of Abak, Eket, Etinan, Ikot Abasi, Ikot Ekpene, Itu, Oron, Oruk Anam, Uyo and Ukanafun. Development and population grew gradually as shown in the slow increase of urban land use from these locations currently lead with high rate of urban transformation thereby increasing demand for resources like all forms of sand, timber, food, energy among others. This impact on the diverse locations where these resources are situated changing the cover at its wake.

Economically, the above local government administrative units especially in Ikot Ekpene, Uyo, Eket, Oron and Ikot Abasi, attract commerce which pulls human population from the other localities to these settlements. This impacts on the conversion of the ecology of mangroves to farmlands, forests to disturbed forest, disturbed forest to farmlands, and farmlands to built-up areas.

Physically, the state is rich in diverse resources prominent amongst being crude oil, timber, clay and all forms of fishery, among others. These resources attract demand from within and outside of the state. However, crude oil mining exerts the highest influence as incidences of oil spills, oil exploration and exploitation exerts changes in the ecology. The Figure 8 show mangrove decimation by oil exploration activities as alleged by community guides. Furthermore, the inversion of the nippa palm, sand mining, and communal conflicts, among others disrupt existing mangrove stands, initiating secondary succession and regression in Mangrove vegetation.

Figure 8: Cross Section of decimated Mangrove Vegetation in Eastern Obolo Local Government Area
Source: Field work, 2024

Socio-culturally, the state comprises of major ethnic nationalities situated with centralized capitals at Ikot Ekpene, Uyo, Oron, Eket and Ikot Abasi (See Figure 2). There has been rapid urban development in these locations transforming them into rapidly growing Cities. These cultures attract commerce as they often pull businesses to their pole capitals which are often presumed as the political hub of Ananng, Ibibio, Oro, Ekid and Obolo nationalities respectively.

Table 10: Percentage change in Land use and land cover status for 1986, 2004, 2014, and 2024

LULC Class	2004 (ha)	1986 (ha)	Change b/w 2004 & 1986	% Change	2014 (ha)	2004 (ha)	Change b/w 2014 & 2004	% Change	2024	2014	Change b/w 2024 & 2014	% Change
Water Body	20,055.93	20,367.62	-311.69	0.38	18,773.01	20,055.93	-1,282.92	1.41	19,208.79	18,773.01	435.78	0.26
Mangrove	84,964.02	107,570.74	-22,606.72	27.84	73,904.85	84,964.02	-11,059.17	12.18	32,377.32	73,904.85	-41,527.53	24.75
Forest	159,050.80	161,553.24	-2,502.44	3.08	146,130.17	159,050.80	-12,920.63	14.23	127,168.02	146,130.17	-18,962.15	11.3
Disturbed Forest	226,557.23	241,734.15	-15,176.92	18.70	213,723.66	226,557.23	-12,833.57	14.13	190,308.43	213,723.66	-23,415.23	13.95
Farmland	129,414.95	122,804.19	6,610.76	8.14	122,104.71	129,414.95	-7,310.24	8.05	139,108.59	122,104.71	17,003.88	10.13
Built-up	85,007.61	51,020.61	33,987.00	41.86	130,414.15	85,007.61	45,406.54	50	196,879.4	130,414.15	66,465.25	39.61
Total	705,050.55	705,050.55	81,195.53	100.00	705,050.55	705,050.55	0.01	100	705,050.55	705,050.55	167,809.82	100

Source: Author's analysis, 2025

Table 11: Annual rate of change in Land use and land cover status for 1986, 2004, 2014 and 2024

LULC Class	2004(ha)	1986(ha)	%Change b/w 1986 & 2004	% Annual rate of Change	2014(ha)	2004 (ha)	% Change b/w 2004 & 2014	% Annual rate of Change	2014(ha)	2024(ha)	Change b/w 2014 & 2024	% Annual rate of Change
Water Body	20,055.93	20,367.62	0.38	0.07	18773.01	20,055.93	1.41	0.14	18773.01	19208.79	0.26	0.02
Mangrove	84,964.02	107,570.74	27.84	5.01	73904.85	84,964.02	12.18	0.12	73904.85	32377.32	24.75	2.48
Forest	159,050.80	161,553.24	3.08	0.55	146130.17	159,050.80	14.23	0.14	146130.17	127168.02	11.3	1.13
Disturbed Forest	226,557.23	241,734.15	18.70	3.37	213723.66	226,557.23	14.13	0.14	213723.66	190308.43	13.95	1.40
Farmland	129,414.95	122,804.19	8.14	1.47	122104.71	129,414.95	8.05	0.81	122104.71	139108.59	10.13	1.01
Builtup	85,007.61	51,020.61	41.86	7.54	130414.15	85,007.61	50	0.50	130414.15	196879.4	39.61	3.96
Total	705,050.55	705,050.55	100.00	18.01	705050.55	705,050.55	100	1.85	705050.55	705050.55	100	10

Source: Author's analysis, 2025

The annual rate of change of Mangrove vegetation across the years of study was analysed. The annual rate of change between 2004 and 1986 was 5.01%. The annual rate of change between 2014 and 2004 for Mangrove vegetation was 0.12%. The annual rate of change between 2024 and 2014 for Mangrove vegetation was 2.48%. The sum total change per hectare in mangrove vegetation from 1986 to 2024 was -75,193.42 revealing a percentage change of -64.77 which is approximated to 70% loss. The annual rate of change in other land use and cover classes in Akwa Ibom State from the years 1986, 2004, 2014, and 2024 are presented in Table 11.

CONCLUSION

Data for this empirical study were remotely sensed, and the Geographic Information System application was used to determine the trend and change in mangrove vegetation for the years 1986, 2004, 2014, and 2024. This study determined the spatial extent and trend of changes in mangrove vegetation cover in Akwa Ibom State. It shows that this cover is in a continuous state of decline. The images analysed showed that mangrove vegetation has changed from 107,570.74ha, 15.26% of the total land mass in Akwa Ibom State in 1986, to 84,964.02ha representing, and 12.05% in 2004.

This showed a 22,606.72ha loss in mangrove, representing a 3.21% decline for the years 1986 to 2004. The 12.05% of mangrove vegetation cover in 2004 continued to diminish to 10.49% in 2014. This represented a 1.56% loss in the mangrove cover between the years 2004 to 2014. This change was further exacerbated in 2014, 73,904.85ha of mangrove vegetation, representing 10.49% of the land mass in Akwa Ibom State reduced to 32377.32ha in 2024, representing only 4.59% of the land mass in the study area. The change in mangrove vegetation for the years 2014 to 2024 showed a deficit of 5.9% in mangrove vegetation cover.

This loss was mainly due to the growth of other land use and cover types, especially built-up areas, farmland, forest, and disturbed forest. The study also showed a gradual decline in the forest and disturbed forest cover. However, the built-up area and farmland use experience a consistent increase across the study years in Akwa Ibom State. The other anthropogenic drivers of mangrove vegetation change include activities of oil companies, which increase the rate of loss in mangrove vegetation. Local use of mangroves for herbal medicine and firewood by the local communities, mangrove timber logging pressured by the build-up growth, are also factors in the decline of vegetation. Several studies around this area had recommended creating mangrove forest reserves, State government involvement in mangrove restoration projects, and protection through its local governments, among others. These recommendations had limited or no effect on the diminishing rates of mangrove in the study area through the years of study.

There is a growing need for urgent mangrove restoration and reclamation actions. This study recommends a different perspective on mangrove vegetation conservation. More studies to be carried out in the local communities of Eastern Obolo, Ibeno, Mbo, Oron, Udung Uko, Okobo, where mangroves are on decline, to determine the right approach to use in their restoration. This study also suggests a bottom-up structure where the local communities, through their youths, women leaders, and chiefs, will provide indigenous mangrove restoration processes. This may be established through training on the appropriate techniques to be adopted.

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Data Availability: The datasets generated during and /or analysed during the current study are available from the corresponding author on reasonable request.

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