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The Dynamics and Implications of Landuse and Landcover Change in Bayelsa State

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Abstract

This study examines the dynamics and implications of landuse and landcover change in Sagbama LGA of Bayelsa State. Satellite imageries of 1987, 1992, and 2015 were derived from the USGS, Using supervised classification, bare land surfaces reduced significantly from 46km^2 in 1987 to 40km^2 in the year 1992 and 11km^2 in 2015. The built-up areas/developed areas increased from 10km^2 in the year 1987 to 46km^2 in 1992 and 61km^2 in 2015. Area covered by light vegetation increased from 316km^2 in 1987 to 404km^2 in 1992 and 511km^2 in 2015, while heavy vegetation reduced from 526km^2 in 1987 to 408km^2 in 1992 and 315km^2 in 2015. The logistic regression results showed that education, gender, agricultural land use, and logging of trees are (1.0, 1.1, 1.2, and 1.6) times more likely to influence land cover change at a 0.05 significance level. This study recommends government implementation of the policy of controlled logging and the involvement of non-governmental agencies in public enlightenment to protect the environment, and improve the livelihood of residents in the coastal communities ofBayelsa State.

Keywords: *Dynamics, Landuse and landcover change, Spatial analytical research design, Binary logistic regression, Bayelsa State, Nigeria*

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Background to the Study

According to Patel, et.al, (2019), land cover change indicates a change in certain continuous characteristics of the land such as vegetation types, soil properties, and so on, whereas land-use change consist of an alteration in the way certain area of land is being used or managed by humans. Quentin, Andrew and Carole (2006) posited that landuse and landcover change is an inevitable phenomenon occurring both temporary and (or) permanent interest of the inhabitants, this could be either on a small or large scale but the most interesting and fundamental observation is that change occurs over time. Land-use and land-cover change is the change in the physical as well as biological characteristics of land.

Wizor and Eludoyin (2020) stated that the land use and land cover of a region is a reflection of the level of development in that region, hence, LULC changes become essential in monitoring the development of a particular area. Ellis (2018) posited that human populations, and their activities on land have modified most of the terrestrial biosphere into anthropogenic biomes, and these modifications have resulted in the emancipation of a variety of unhealthy ecological patterns and processes. Lariguaderie and Mooney (2010), and Mienmany (2018) stated that scientific literature recognizes demographic, socio-economic, institutional, technological, and biophysical factors are the primary factors shaping land Use and Land Cover Change (LULCC) globally. The prevalence and intensity of these drivers depend on local contexts and specific study areas.

Authors such as Fabiyi and Dami, et.al., (2017) have studied the different dimensions of landcover change and the implications of landcover changes. Bariweni and Andrew (2017) studied Land use/Land cover changes and causes of deforestation in the Wilberforce Island, Bayelsa State, using satellite images of 2002 and 2015 acquired from land sat 7 and 8 respectively. Balogun, Adeyewa, Balogun and Morakinyo (2011) analyzed urban expansion and land use changes in Akure Nigeria. Digha, Imaitor, Ariwadum and Osuji (2018) investigated the influence of population growth on landuse in Calabar Metropolis and observed that due to population growth in Calabar Municipality, there has been increase in traffic congestion, rising cost of land, land conversion, urban sprawl and increasing house rent. Eludoyin, Obafemi and Hardy (2017) assessed effects of urbanization changes on landuse in Yenagoa Metropolis, Bayelsa State, Nigeria (1986-2013). Authors such as Turner II & Butzer, (1992); Foley, et.al., (2005), identified drivers of land-use change at the global level. (Geist & Lambin, (2001); Geist & Lambin, (2002); Geist et al., (2006); Drigo et al., (2009) studied these drivers at the regional level, while Mertens & Lambin, (2000), Serneels & Lambin, (2001); Braimoh, (2004); Kok, (2004); Alo & Pontius, (2008) examined the drivers of landuse change at the local level.

Unanaonwi and Ihimikaiye (2018) stated that in the tropical rainforest zone of Nigeria, tree species diversity and resilience are significantly influenced by human-caused disturbances such as logging, agricultural practice, and urbanization.Sagbama Local Government has witnessed remarkable urban expansion, land cover change and massive deforestation since its inception. These have resulted in increased change and modification of her land cover over time. There is a need for research on the socio-economic implications of landuse and landcover change in Sagbama LGA to understand the factors influencing the changes observed using remotely sensed data from satellite images to detect changes over the years, and their implications on the livelihoods of the residents of Sagbama Local Government Area.

This article examined the dynamics and implications of landuse and landcover changes in Sagbama LGA between 1987 – 2015 with a view to determine the livelihoods and anthropogenic factors influencing landuse and landcover changes in the Sagbama LGA with the proposition that landuse and landcover changes are not influenced by the livelihoods (agricultural activites, fishing) uncontrolled logging, residential commercial and institutional landuse activities of the residents of Sagbama, Bayelsa State, Nigeria. Further still, this paper is structured into four sections: Apart from the introductory section, which includes a discussion of agent-based approach model to landuse and landcover change. The decription of the spatial analytical research design, sample size and sampling technique was presented in section two. Discussion of findings on the demographic characteristics, spatial and temporal trends, and dynamics and implications of landuse and landcover change is undertaken in section three, while section four presents the conclusion and recommendations .

The agent-based approach utilized land use decision process in explaining landuse and landcover change models. According to Irwin and Geohegan, (2001), the landuse and landcover change models are classified into two groups of spatially explicit models of landuse/landcover change and non-spatially explicit models.The application of this model in this study reveals that both the spatially explicit models discussed in relation to the disaggregate pattern of landuse, and the non-spatially explicit models which concentrated on the aggregate pattern of landuse of individuals and residents of the study area such as logging of trees, deforestation of primary vegetation due to agricultural activities and development of built-up areas (residential and institutional) land use influence the observed changes in landuse and landcover in Sagbama LGA of Bayelsa State.

Methodology

Location of Study

Sagbama local government is one of the 8 local governments in Bayelsa state, located on latitude $50^{0}10^{1}$ N and longitude $60^{0}12^{1}$E. Sagbama Local Government shares a boundary Opokumor/Kolokumor LGA in the North East, and bounded in the southwest by the Atlantic Ocean. According to National Population Census (NPC, 2006), the population of Sagbama LGA is (187,146). Sagbama LGA experiences heavy rainfall of 2,500mm per annum and a relatively constant temperature between 23^{o}c to 30^{o}c. Although, Bayelsa State experiencesboth the equatorial climate and tropical climate Sagbama LGA is also characterized by low-land equatorial evergreen rainforest or tropical rainforest.

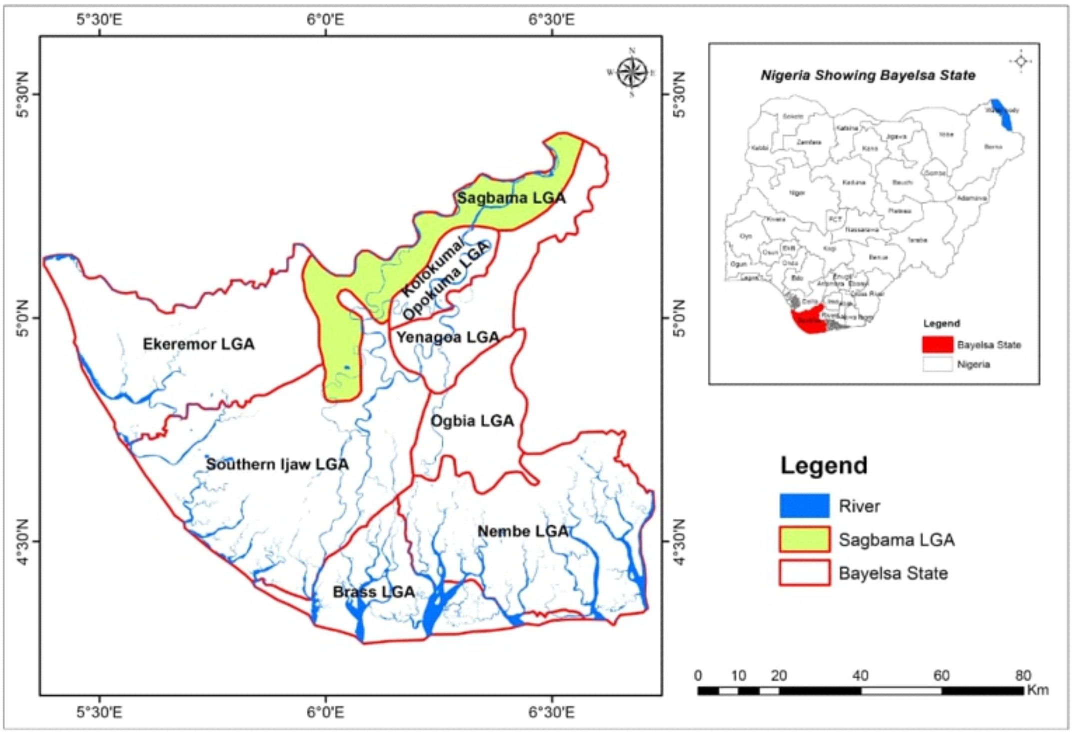

Figure 1: Map of Sagbama Local Government Area
Source: Authors GIS Lab (2025)

Methodology

A spatial analytical research design which involves the use of satellite images of Landsat 7 and 8 (1987, 1992, and 2015) based on a spatial resolution of 30m x 30m due to achieve a high-image resolution at the time of this research. This study utilized a set of structured questionnaires to seek information on landuse and landcover, and the consequences of landcover change in the area studied. The pixel-based supervised classification of satellite imageries identified the following land covers: built-up areas, bare lands, heavy forests, light forests, wetlands, and water bodies. Geometric corrections were used to remove distortions and cloud cover from the images.

Sample Size

The sample size was statistically determined using Taro Yamane (1967) formula.

$$n = \frac{N}{1+N(e)2}$$

Where:
N = Population Frame
1 = Default/Constant
E = Error

$$\frac{85{,}435}{1+85{,}435\,(0.05)^2}$$

$$\frac{85{,}435}{1+85{,}435(0.0025)}$$

$$\frac{85{,}435}{1+213.5875}$$

$$\frac{85{,}435}{214.5875}$$

$$= 398$$

Sampling Technique

A muilti-stage sampling technique involving three stages was utilized for this study. At first, Bayelsa State was purposively selected because of rapid urbanization, and indiscriminate logging. In the second stage, Sagbama Local Government was purposively selected for this study based on the dynamics and implications of landuse and landcover change experienced. In the third stage, 398 copies of the structured questionnaire were randomly administered to residents (household heads) in the major communities of Ofoni, Tungbo, Sagbama, Odoni, Asamabiri, Okumabiri, and Ossiama, while 300 copies of the questionnaire were retrieved with a response rate of (75.0%).

Results and Discussions

Presentation of Demographic Characteristics

The demographic characteristics pertain to the respondent's age, gender, occupation, and income; analysis of livelihoods and land uses (fishing, farming, logging, residential, commercial, institutional), while land cover change includes changes in the (bare surfaces, built-up areas, heavy forests, light forests, wetlands, and water bodies). The socioeconomic and demographic profile of the respondents revealed that 161 representing 53.7% are males, while 139 representing 46.3% are females.

Table 1: Gender Distribution

Variable	Frequency	Percentage (%)
Male	161	53.7
Female	139	46.3
Total	300	100

Source: Authors Fieldwork, (2025)

The age categories of the respondents revealed that 8.7% are less than 20 years, and 34.1% are within 21-30 years and 31-40 years respectively. Hence, most of the persons involved in this uncontrolled logging in this study are between 21-40 years, a youthful and economically active populationsee Figure 2.

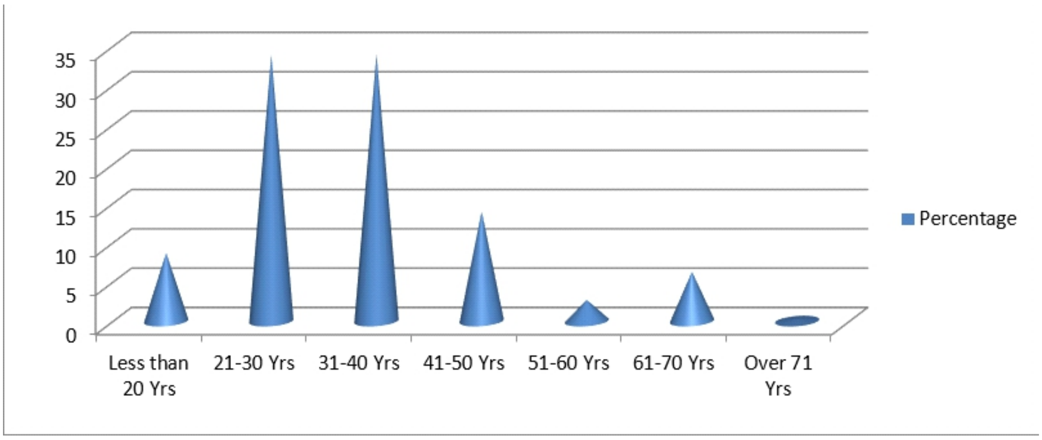

Fig. 2: Age Categories of Respondents
Source: Authors Fieldwork, (2025)

Table 2 presents information on the occupation of respondents surveyed, and revealed that 126 respondents representing (42.0%) are unemployed, 74(24.7%) are self-employed, 57(19.0%) are civil servants, 34(11.3%) are students, while 9(3.0%) are retired from active service.

Table 2: Occupation of Respondents

Variable	Frequency	Percentage
Unemployed	126	42.0
Self Employed	74	24.7
Employed	57	19.0
Student	34	11.3
Retired	09	3.0
Total	300	100.0

Source: Authors Fieldwork, (2025)

Information on income distribution of respondents in Table 3 revealed, 84(28.0%) earned less than fifty thousand naira (₦50,000), while 130(43.3%) earned between fifty thousand and one naira and one hundred thousand naira (₦50,001- ₦100, 000), and 56(18.7%) earned between one hundred thousand and one naira (₦100,001 – ₦150,000) and one hundred and fifty thousand naira.

Table 3: Income Levels

Income	Frequency	Percentage
> ₦ 50, 000	84	28.0
₦50,001-₦100,000	130	43.3
₦100,001-₦150,000	56	18.7
₦150,001-₦200,000	26	8.7
> ₦200,001	4	1.3
Total	300	100

Source: Authors Fieldwork, (2025)

Landuse and Landcover Classification

The landcover classification scheme utilized showed that bare lands are open land surfaces that are mainly non-vegetated lands. The built-up areas are the industrial, residential, and educational lands. The heavy forests and light forests are vegetation with a high density of trees and arable lands, while the wetlands are swampy and water-logged areas see Table 4.

Table 4: Land cover Classification Scheme

Bare Lands	Open land, Non-vegetated lands
Built-up areas	Industrial, Residential, and Educational
Heavy Forests/Vegetation	Thick Forests, Higher Density of Trees
Lights Forests/Vegetation	Light Forests/Arable lands
Wetlands	Swamps
Water Bodies	Ponds, Rivers, Streams, Dams

Source: Adapted from Anderson, et.al., (2001); and Chukwudi Nwaogu, et.al., (2017).

Spatial and Temporal Trend of Landuse and Landcover change

The analysis of satellite images of the vegetation cover of Sagbama LGA derived from USGS showed that the dense forest vegetation is changing to light vegetation at the northern fringe, which implies a gradual increase in the built-up areas from 1987 to 2015 see Figure 3.

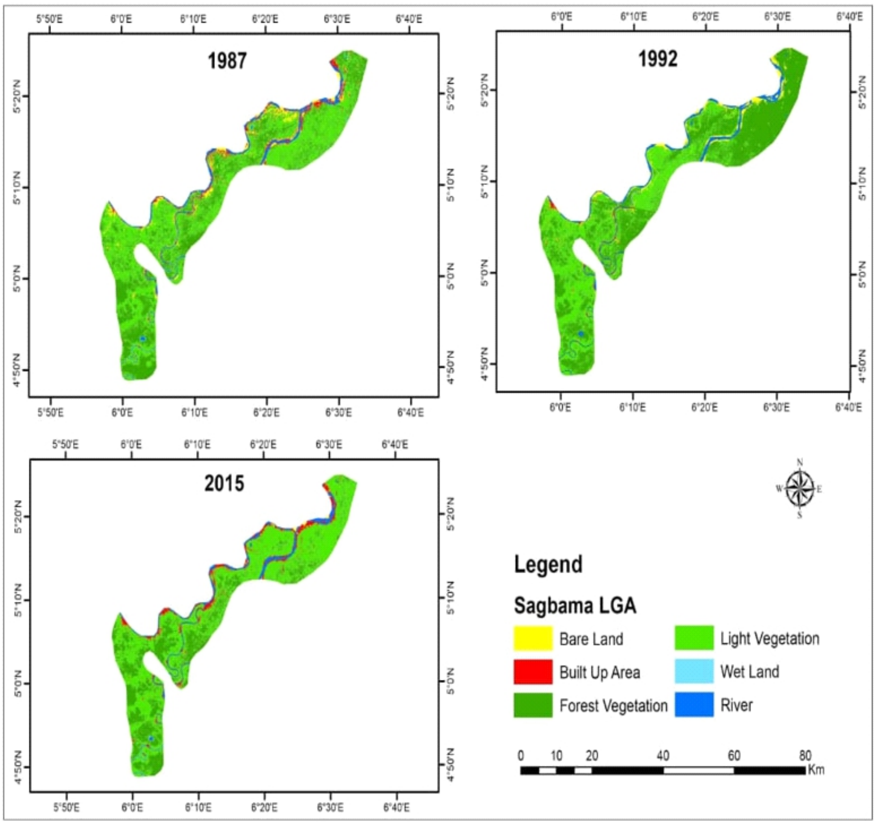

Figure 3: Spatial-Temporal Analysis of Land Cover Change
Source: USGS, 2025

Table 5 presents a discussion of land cover change. In 1987, bare land surfaces covered 46km^2, and bare land surfaces reduced significantly to 40km^2 in the year 1992 and 11km^2 in the year 2015 as a result of increased landuse activities such as logging and urbanization. There was an expansion of the built-up area to 10km^2 in 1987, 46km^2 in 1992 and 61km^2 in 2015 respectively as a result of increased urbanization, while area covered by light vegetation also increased to 316km^2 in 1987, 404km^2 in 1992 and 511km^2 in 2015, whereas the area covered by forest vegetation reduced from 526km^2 in 1987, 408km^2 in 1992 and 315km^2 in 2015.

Table 5: Land Cover Change

S/N	Classification	1987 (km^2)	1992 (km^2)	2015 (km^2)
1	Bare land surfaces	46	40	11
2	Built-up areas	10	46	61
3	Light vegetations	316	404	511
4	Forests	526	408	315
5	Wetlands	4	4	3
6	Waterbodies	51	51	52
Total	Total land cover	953	953	953

Source: USGS, 2025

Dynamics of landuse and landcover change

A discussion of landuse and landcover change cannot be well understood without the knowledge of the dynamics which are important for continuous planning, development, and improving environmental quality (Madugundu, Al-Gaadi, Patil&Tola, 2014; Tilahun&Teferi, 2015). The distribution of land use activities in Sagbama LGA presented in Table 6 showed that agricultural activities dominate with 150(50.0%) of all land uses, followed by fishing 36(12.0%), while logging of trees 24(8.0%), residential land use 58(19.3%), commercial land use 30(10.0%), while institutional land use represents 2(0.7%) of all land use activities. This result specified agricultural activities as the main dynamics of landuse and land cover change.

Table 6: Land-Use Activities

Landuse	Frequency	Percentage
Farming	150	50.0
Fishing	36	12.0
Logging	24	8.0
Residential	58	19.3
Commercial	30	10.0
Institutional	2	0.7
Total	300	100

Source: Authors Fieldwork, (2025)

Table 7 presents the proportion of trees fell by loggers and farmers in the area surveyed. The information revealed that 31 respondents representing (10.3%) had fallen less than five hundred trees, 38(12.7%) had fallen between five hundred trees and one thousand trees, 27(9.0%) had fallen between one thousand trees and one thousand five hundred trees, 108(36.0%) had fallen over one thousand five hundred trees, while 96(32.0) had lost count of the numbers of trees logged.

Table 7: Number of Trees Fell within the Year

Trees Fell	Frequency	Percentage
Lost Count	96	32.0
<500 trees	31	10.3
501-1000 trees	38	12.7
1001-1500 trees	27	9.0
>1500 trees	108	36.0
Total	300	100.0

Source: Authors Fieldwork, (2025)

The immediate causes of land cover change presented in Table 8 showed that uncontrolled lumbering represents 69(23.0%), population pressure 136(45.3%), bush burning 57(19.0%), and farming/agricultural activities 38(12.7%) with adverse effects on livelihoods of the people in the area studied.

Table 8: Immediate Causes of land cover Change

Causes	Frequency	Percentage
Uncontrolled lumbering	69	23.0
Population pressure	136	45.3
Bush burning	57	19.0
Farming	38	12.7
Total	300	100.0

Source: Authors Fieldwork, (2025)

The landuse and landcoverin Sagbama LGA have changed greatly because of uncontrolled lumbering, agricultural activities, and overpopulation/population pressure with adverse effects. There are diverse effects of landcover change presented in Table 9. Landcover change accelerates soil erosion 64(21.3%)and flooding 96(32.0%), land cover change accelerates climate change 44(14.7%), land cover change increased direct radiation from the sun 52(17.3%), land cover change also reduces soil fertility 44(14.7%). This result corroborates the findings of (Brandon, 1998 & Molla, 2014) who discovered that the complex and dynamic landuse and landcover change at various scales has socio-economic effects. In addition, Unanaonwi and Ihimikaiye (2018) stated that in the tropical rainforest zone, tree species diversity and resilience are mostly influenced by human-caused disturbance; logging, agricultural practice, and urbanization.

Table 9: Implications of Land Cover Change

Implications	Frequency	Percentage
Accelerates Soil erosion	64	21.3
Accelerates climate change	44	14.7
Flooding	96	32.0
Increased radiation	52	17.3
Reduced soil fertility	44	14.7

Source: Authors Fieldwork, (2025)

Logistic Regression of the Dynamics of LULC

The binary logistic regression is made up of values (0 and 1). The binary dependent variable takes the value of '1' if the response is 'yes' and takes a value of '0' if the response is 'No'. The logistic regression is ideal for binary dependent variables, while the explanatory variables or predictors which could be categorical variables or continuous variables are measured as coefficients of independent contribution to the variation in the independent variable.

This logistic regression model is utilized in this study. The exponential beta (Exp.B) or odd ratio or likelihood of landuse and landcover change is expressed thus:

$$\frac{P(y)}{1-p(y)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \ldots\ldots\ldots\ldots \beta nxn$$

Where:

$\frac{p(y)}{1-p(y)}$ is the odd ratio

Y being binary variable
X being the independent variable,
β being the exponential beta/regression coefficient
$\beta_0$being the intercept of the model.

Y = Binary dependent variable (1= Landuse/landcover change, 0 = No Landuse/landcover change). X= Independent variables (x_1 = gender, x_2 = education, x_3 = occupation, x_4 = agriculture, x_5= logging and x_6= residential/built-up area).

Landuse and livelihoods of respondents

The hypothesisthat land-use/landcover change does not significantly influenced livelihoods and anthropogenic activities of residents. Result of the hypothesis tested using binary logistic regression analysis revealed that logging of trees was 1.6 times more likely to influence land cover change, followed by agricultural land use which was 1.2 times more likely to influence land cover change, gender was 1.1 times more likely to influence land cover change, while level of education, occupation, residential land use and urbanization were 1.0 times more likely to influence landuse and landcover changes due to the economy and livelihoods of respondents of the area who are mainlyinvolved in primary economic activities of subsistence agricultural practices. In some cases, logging of trees is done to increase and expand agricultural lands in addition to selling of the logs. The result of the model of fit using chi-square 2-log likelihood revealed that logging activity is more likely to influence land cover change at a 0.05 significance level (Table 10 and Table 11).

Table 10: Binary Regression Model

	B	S.E	Wald	df	Sig	Exp(β)
Gender	.124	.263	.221	1	.638	1.132
Education	.030	.144	.043	1	.836	1.030
Occupation	.037	.135	.075	1	.785	1.038
Agriculture	.202	.314	.412	1	.521	1.224
Logging	.530	.285	3.456	1	.063	1.699
Residential	.014	.087	.027	1	.869	1.014
Constant	-.637	.909	.492	1	.483	.529

Source: Authors Fieldwork, (2025)

Table 11: Model of Fit

	ModelLog-likelihood	Change in 2 log-likelihood	df	Sig.
Logging	-178.826	3.938	1	0.047

Source: Authors Fieldwork, (2025)

Conclusion

This section presents the dynamics and implications of landuse and landcover change in Bayelsa State. Using supervised classification, satellite imageries of 1987, 1992, and 2015 were derived from the USGS. The result revealed that in 1987 the area covered by bare land surfaces was 46km^2 reduced significantly to 40km^2 in the year 1992 and further reduced to 11km^2 in the year 2015 as a result of increased land use activities resulting from increased population and urbanization. The built-up areas expanded from 10km^2 in 1987 to 46km^2 in 1992 and 61km^2 in 2015 respectively, while areas covered by heavy and light vegetation reduced significantly within this period of study. Result of the dynamics of landuse and landcover changes showed that education, gender, agricultural land use, and logging of trees are (1.0, 1.1, 1.2, and 1.6) times more likely to influence land cover change at 0.05 significance level. Hence, this study recommends public enlightenment on the implications of uncontrolled logging of trees, population pressure, and subsistence agriculture on land cover change, vegetation, and livelihood loss in Sagbama LGA of Bayelsa State, Nigeria.

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