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Forest Biodiversity Degradation: Assessment of Deforestation in Ohaji Egbema Forest Reserve, Imo State, Nigeria Using GIS Approach

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ABSTRACT

This research is focused on a spatial analysis of a reserved forest deforestation over a period of time using a GIS approach in Ohaji Egbema Local Government Area Imo state, Nigeria. It aimed at assessing and analyze deforestation in Ohaji Egbema forest reserve and examined the possible effects of deforestation on the forest environment. The assessment concentrated on when and where have forestlands changed in the reserved forest programmed within the period of 1984 - 2040 forecast. The key objectives were to assess the impact of land use and land cover changes on forest cover for the past 36 years, while sub objectives were dedicated to achieve in mapping out different land cover in Ohaji Egbema forest reserve, to assess land cover changes in the forest reserve susceptible to long term degradation from 1984 to 2020 of about 20 years. To evaluate forest loss in the area for the past 36years, and to predict the state of the land cover (forest) for the next 20 years (2040). Primary and secondary data employed using (200 ground truth points) were systematically collected from four different LULC classes in the study area using geographical positioning system (GPS), the secondary data (Satellite Landsat Imageries of 1984, 2002 and 2020) of the study area was acquired. The imageries were processed, enhanced and classified into four LULC classes using supervised classification in Idrisi and ArcGis software Ground truth points were utilized to assess the accuracy of the classifications. The data collected was analyzed in tables and figures and represented with a bar chart and pie chart graphs. Results showed that forest land, built up, grassland and water body were the four LULC classified in the study area. Kappa coefficient values of 91%, 85% and 92% for 1984, 2002 and 2020 respectively shows the accuracy of the classifications. Classifying the land uses into built-up and forest lands revealed that the built-up lands constantly rose while the forest lands kept dropping. The built-up lands increased by 49.30% between 1984 and 2000, 50.00% between 2002 and 2020 and 28.40% between 2020 and 2040 at the expense of the forest portion of the area which fell by 33.88% between 1984 and 2000,46.45% between 2002 and 2020, and 49.22% between 2020 and 2040. Increase in population, per capita income, and land use activities and by extension urban expansion were found to be the major factors causing deforestation in the forest reserve, it is likely that in the nearest future the remaining forest lands would be gradually wiped out and consequently the environmental crisis would be aggravated. Based on the findings of the study, there is need to urgently limit and control the high rate of deforestation going on in Ohaji Egbema forest reserve and embark on tree replanting campaigns without delay. There is need and recommended that a higher quality satellite imagery that offers up to 4m resolution should be used and a forest relic analysis should be conducted.

KEYWORDS: Biodiversity; Forest degradation; GIS; Forest Reserve; LULC; Deforestation and Satellite Imagery

INTRODUCTION

Deforestation constitutes one of the serious threats to forest biodiversity and pose a global development challenges of long-term environmental problem at both regional level and the world at large. According to [1] and [2] the degradation of the forest ecosystem has obvious ecological effects on the immediate environment and forested areas. Deforestation can result in erosion which in turn may lead to desertification. The economic and human consequences of deforestation include loss of potential wood used as fuel wood for cooking and heating among others. The transformation of forested

lands by human actions represents one of the great forces in global environmental change and considered as one of the great drivers of biodiversity loss. Forests are cleared, degraded and fragmented by timber harvest, conversion to agriculture, road-construction, human-caused fire, and in myriad of other ways of degradation. According to [5], deforestation refers to the removal of trees from afforested site and the conversion of land to another use, most often agriculture. There is growing concern over shrinking areas of forests in the recent time [7]. The livelihoods of over two hundred million forest dwellers and poor settlers depend directly on food, fibre, fodder, fuel and other resources taken from the forest or produced on recently cleared forest soils. Furthermore, deforestation has become an issue of global environmental concern, in particular because of the value of forests in biodiversity conservation and in limiting the greenhouse effect [8]. Globally, deforestation by this trend has been described as the major problem facing the forest ecosystem. The extent of deforestation in any particular location or region can be viewed from economic, ecological and human consequences as well as scramble for land. Forest degradation may in many ways be irreversible, because of the extensive nature of forest degradation which the impact of activities altering their condition may not be immediately apparent and as a result they are largely ignored by those who cause them. Forest is often perceived as a stock resource and always and freely available for conversion to other uses without considering the consequences for the production services and environmental roles of the forest. As environmental degradation and its consequences becomes a global issue, the world is faced with the danger that the renewable forest resources may be exhausted and that man stands the risk of destroying his environment if all the impacts of deforestation are allowed to go unchecked. It becomes therefore important to evaluate the level of deforestation and degradation in Ohaji Egbema forest reserve using a GIS application. The effect of deforestation and degradation of the only forest reserve in South east Nigeria has recently become a serious problem. It has been identified that in the area is mostly the quest for fuel wood, grazing and for agricultural use. One of the effects of deforestation is global warming which occurs as a result of deforestation as trees uses carbon dioxide during photosynthesis. Deforestation leads to the increase of carbon dioxide in the environment which traps heat in the atmosphere leading to global warming. I become very objective to assess the impact of land use and land cover changes on forest cover for the past 36 years with further interest to map out different land cover in the Ohaji Egbema forest reserve, assess land cover changes from 1984 to 2020 at 20 years, evaluate forest loss in the area for the past 36 years and make a prediction of the state of the land cover (forest) for the next 20 years (2040). It is known that deforestation and degradation of the forest has posed a serious problem especially at this era of global climatic change.

United Nations Food and Agricultural Organization [12], deforestation can be defined as the permanent destruction of forests in other to make the land available for other uses. Deforestation is said to be taking place when forest is being cut down on a massive scale without making proportionate effort at replanting. Also, deforestation is the conversion of forest to an alternative permanent non-forested land use Such as agriculture, grazing or urban development [5]. Deforestation is primarily a concern for the developing countries of the tropics [6] as it is shrinking areas of the tropical forests [3] causing loss of Biodiversity and enhancing the greenhouse effect [8]. Forest degradation occurs when the ecosystem functions of the forest are degraded but where the area remains forested rather cleared [9]. Available literatures shows that the causes of forest deforestation and degradation are caused by expansion of farming land, logging and fuel wood, overgrazing, fire/fire outbreak, release of greenhouse gases and urbanization/ industrialization as well as infrastructural provisions. More so agents of deforestation in agricultural terms include those of slash and burn farmers, commercial farmers, ranchers, loggers, firewood collectors etc. Generally, the center of biodiversity and conservation (CBC 1998) established the remote sensing and geographic information system (RS/GIS) facilities as technologies that will help to identify potential survey sites, analyze deforestation rates in focal study areas, incorporate spatial and non-spatial databases and create persuasive visual aids to enhance reports and proposals. Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times [11]. Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

Study Area

Ohaji Egbema lies in the southwestern part of Imo state and shares common boundaries with Owerri to the east, Oguta to the north Andogba/Egbema/Ndoni in Rivers state in the southwest. The 2006 census estimated the study area to over 182,500 inhabitants but recently due to industrialization and urbanization, Ohaji/Egbema has witnessed a great deal of population influx. The study area lies within latitudes 50 11'N and 50 35'N and longitudes 6037' ad 6057'. It covers an area of about 890km2.

The study area is largely drained by the Otammiri River

and other Imo river tributaries. The study area belongs to a major physiographic region- the undulating lowland plain which bears a relationship with its geology. The low land areas are largely underlain by the younger and loosely consolidated Benin formation [12]. The vegetation and climate of the study area has been delineated to have 2 distinct seasons both of which are warm, these are the dry and rainy season.

Climate and Vegetation

The dry season occurs between November and March, while the rainy season occurs between April and October. The high temperatures, humidity and precipitation of the area favour quick plant growth and hence vegetation cover of the area that is characterized by trees and shrubs of the rainforest belt of Nigeria.

Geology and Soil

The study area is located in the Eastern Niger delta sedimentary basin, characterized by the three lithostratigrapgic units in the Niger delta. These units are – Akata, Agbada and Benin formation in order of decrease in age [13]. The overall thickness of the tertiary sediments is about 10,000 meters.

Method of Data Collection

Data are based on field observation and from monitoring the real situation, they are collected as fact or evidence that may be processed to give them meaning and turn them into information in line with [14]. Heywood (1988). Geographical Positioning System (GPS) was used to collect fifty (50) coordinate points at each land use land cover, totaling 200 points for the four major land use and land cover identified in the study area. Landsat Imageries of one season (path 188, 189 and row 56) were acquired from United State Geological Survey (USGS) in time series; 1984 Thematic Mapper (Tm), 2002 Enhanced Thematic Mapper (ETM) and 2020 Operational Land Imager (OLI) as shown in the table one below table 3.

Data Analysis and Data Processing

The acquired landsat imageries were pre-processed for geometrical corrections, stripes and cloud removal. Image enhancement was carried out on the acquired imageries employing bands 4, 3, 2 for LANDSAT TM and ETM while bands 5, 4, 3 for LANDSAT OLI/TIRS to get false colour composite using Idrisi and Arcgis softwares. In the resultant false colour composite, built up areas appear in cyan blue, vegetation in shades of red differentiating dense forest and grass or farm lands, water bodies from dark blue to black, bare lands from white to brown [15]. This was necessary to enhance visualization and interpretability of the scenes for classification. The study area was clipped out using administrative map of Nigeria containing Imo State and Local Government shape files in Arc map (Table1 and table 2).

Table: 1. Details of Landsat Imageries Dataset used

Year	Sensor	Scene ID	Path / Row	Date acquired	Resolution
1984	TM	p189r056_4dt19841221_z32_20. p189r056_4dt19841221_z32_30. p189r056_4dt19841221_z32_40. p188r056_5dt19841219_z32_20.tif p188r056_5dt19841219_z32_30.tif p188r056_5dt19841219_z32_40.tif	189/56 188/56	12/21/1984 12/19/1984	30m
2002	ETM	p189r056_7t20020128_z32_nn20.tif p189r056_7t20020128_z32_nn30.tif p189r056_7t20020128_z32_nn40.tif p188r056_7t200201217_z32_nn20.tif p188r056_7t200201217_z32_nn30.tif p188r056_7t200201217_z32_nn40.tif	189/56 188/56	12/8/2002 12/17/2002	30m
2020	OLI	LC08_L2SP_188056_20201221_20201230_02_T1_SR_B3.TIF LC08_L2SP_188056_20201221_20201230_02_T1_SR_B4.TIF LC08_L2SP_188056_20201221_20201230_02_T1_SR_B5.TIF LC08_LITP_189056_20201206_20201214_T1_B3.TIF LC08_LITP_189056_20201206_20201214_T1_B4.TIF LC08_LITP_189056_20201206_20201214_T1_B5.TIF	188/56 189/56	12/21/2020 12/6/2020	30m

Table: 2. Change Observed between (1984 – 2002)

Land Classes	1984	2002	Change Observed	%Change	Remarks
Forest	723.26	699.85	23.41	33.88	Decreased
Built-up	128.4	162.46	-34.06	49.3	Increased
Grass	32.57	21.41	11.16	16.15	Decreased
Water	5.34	5.8	-0.46	0.67	Increased
Total	**890**	**890**		**100**	

Land Use Land Cover Classification

The false Colour composite images were subjected to supervised classification which was based on ground-based information. Maximum likelihood was adopted to define areas of Landsat images that represented thematic classes as determined by maximal spectral heterogeneity according to

Table: 3. Change Observed between (2002 – 2020)

Land Classes	2002	2020	Change Observed	%Change	Remarks
Forest	699.85	589.73	110.12	46.45	Decreased
built-up	162.46	280.98	-118.53	50	Increased
Grass	21.41	15.53	5.88	2.48	Decreased
Water	5.8	3.27	2.53	1.07	Decreased
Total	**890**	**890**		**100**	

[16]. Maximum likelihood algorithm considers the average characteristics of the spectral signature of each category and the covariance among all categories, thus allowing for precise discrimination of categories. Hence the land covers were classified into four major land use land cover classes: Built up, forest cover, grass cover and water body. Forest vegetation are the areas dominated by trees and shrubs; grass land are the areas dominated by grasses, including farm lands and gardens; water body are the areas occupied by streams, rivers, inland waters; while built-up areas are the areas occupied by built structures including residential, commercial, schools, churches, tarred roads and those land surface features devoid of any type of vegetation cover or structures including rocks. Four applications (ArcGis 10.5, Idris software, Excel and Microsoft word) were also applied in this study.

Accuracy Assessment of The Classification

The aim of accuracy assessment is to quantitatively assess how effectively the pixels were sampled into the correct land cover classes. Confusion matrix was used for accuracy assessment of the classification procedure in accordance with the training samples and the ground truth points as a reference point. This approach has also been adopted effectively in similar studies by [17]; [18]. The accuracy assessments of the classified maps for 1984, 2002 and 2020 were evaluated using the base error matrix. The base error matrix evaluates accuracy using parameters such as agreement/accuracy, overall accuracy, commission error, omission error and the Kappa coefficient. The agreement/ accuracy is the probability (%) that the classifier has labeled an image pixel into the ground truth class. It is the probability of a reference pixel being correctly classified. The overall accuracy specifies the total correctly classified pixels and is determined by dividing the total number of correctly classified pixels by the total number of pixels in the error matrix. Commission error represent pixels that belong to another class but are labeled as belonging to the class; while the Omission error represent pixels that belong to the truth class but fail to be classified into the proper class. Finally, the Kappa coefficient (Khat) measures the agreement between classification map and reference data, as expressed below:

kappa coefficient t= (Observed Accuracy-Chance agreement)/ (1-Chance agreement)

It is stated that Kappa values of more than 0.80 (80%) indicate good classification performance. Kappa values between 0.40 and 0.80 indicate moderate classification performance and Kappa values of less than 0.40 (40%) indicate poor classification performance [19].

Change Detection Analysis

Spatio-temporal changes in the four classified land use classes for the past 36 years were analyzed through comparison of area coverage of the classified maps. Change detection was carried out in each of the classes to ascertain the changes over time in terms of area and percentage coverage according to [18]. This was done by computing the area coverage for each of the feature class in each epoch from the classified images in idrisi and Arcmap softwares following the expression below:

Area (m2) = (Cell Size x Count)/10,000

Percentage cover (%) = Area/ (Total) x100

Where cell size and count were gotten from the properties of the raster attributes.

The extent of land use land cover over change, land use encroachment as well as gains and losses experienced within the study period were analyzed and presented in maps and charts.

Prediction Analysis

The classified land use imageries were subjected for Land Change Modeling in idrisi software using Cellular Automata and Markov Chain algorithm for prediction. Then land cover scenario under prevailing conditions for the year 2040 was modeled table 6.

RESULTS AND DISCUSSION LAND COVER LAND USE CHANGES CLASSIFICATION FROM 1984-2040

The result of the work is presented starting with the land use and land cover classification in the years 1984,2002,2020 and 2040 presented in Figures 4.1,4.2,4.3 and 4.4 below. Dark green colour represents forest vegetation, light green represents grass lands, blue represent water body, while orange colour represent built-up area. In figure 4.1 which is the LULC classification of 1984 shows that the study area is largely covered with deeply dark green which is forest

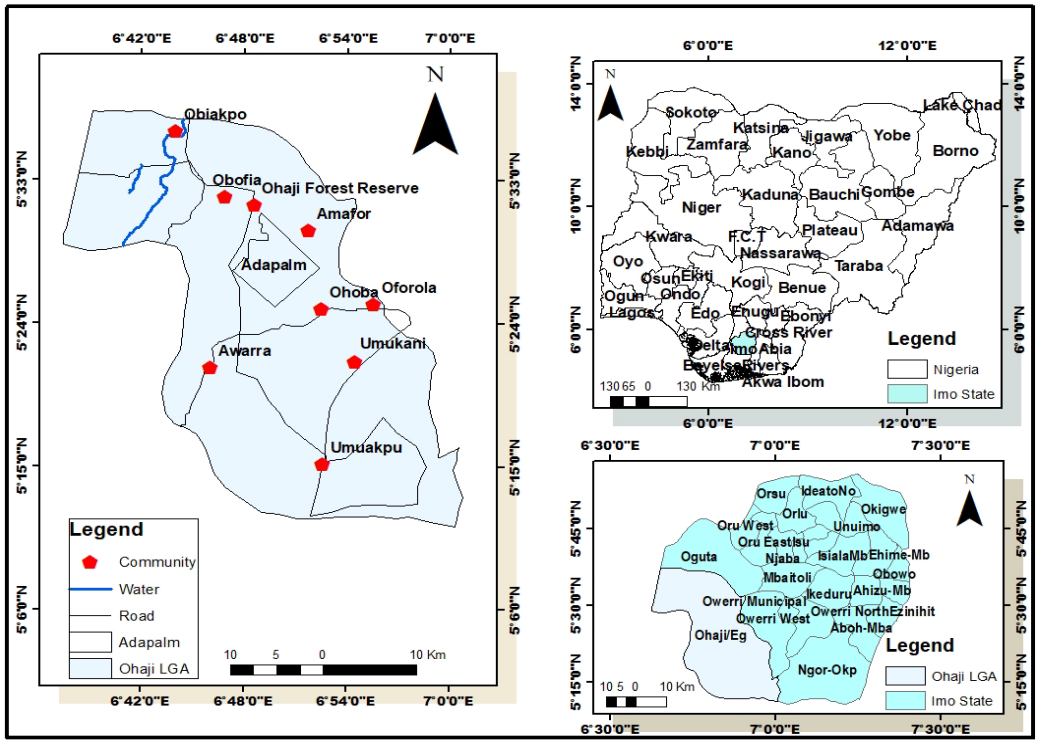

Figure: 1

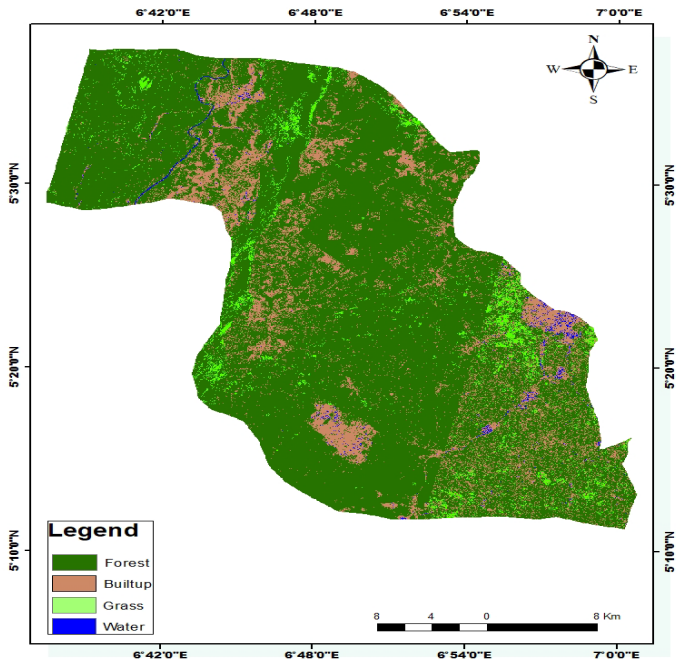

Figure: 2. *The land use land cover classification of the year 1984*

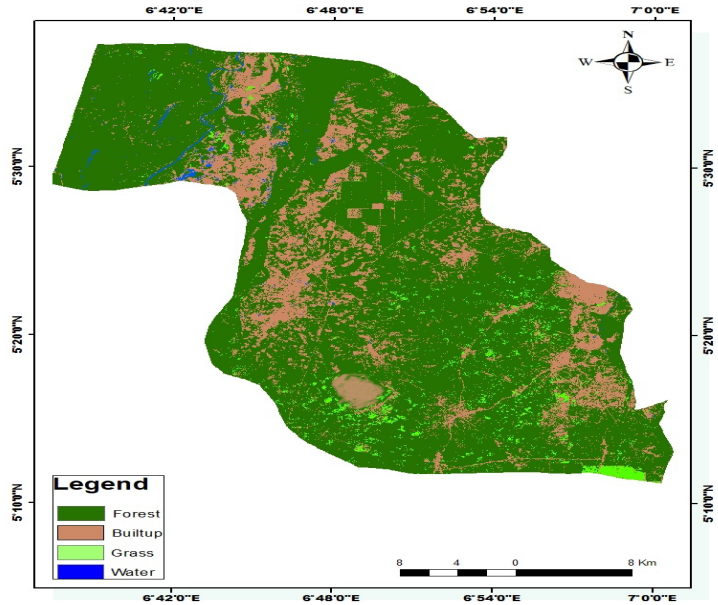

Figure: 3. *The land use land cover classification of the year 2002*

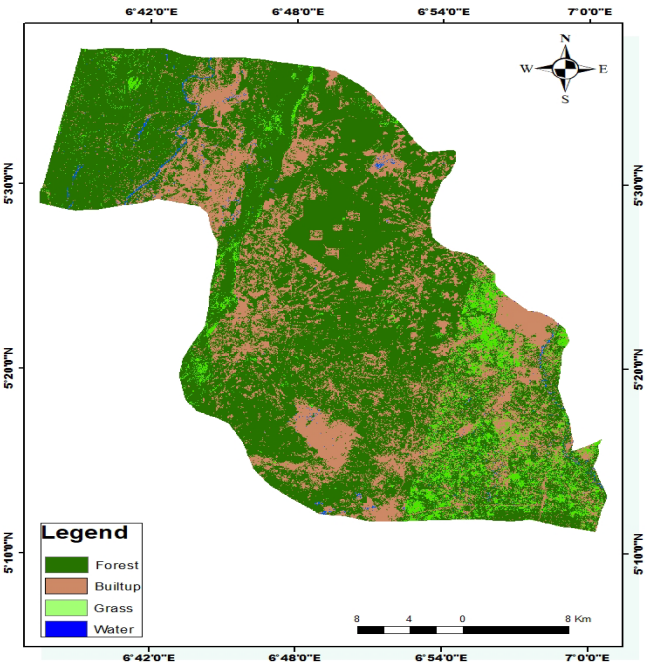

Figure: 4. *Land use land cover classification of 2020*

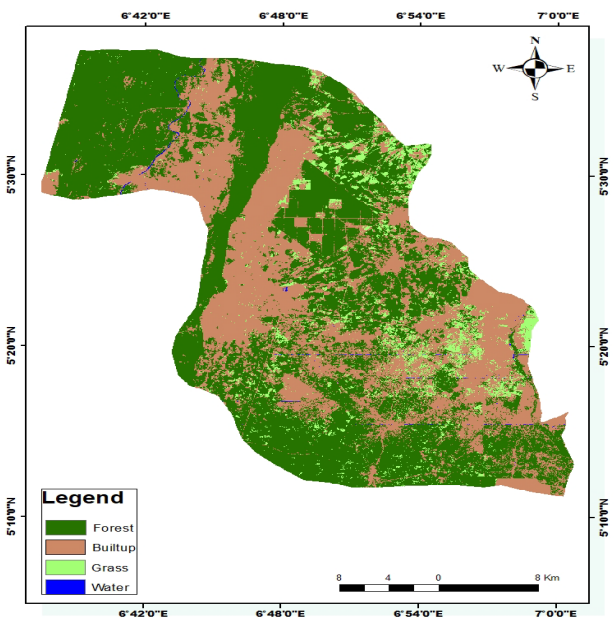

Figure: 5. *The land use land cover classification of 2040*

Table: 4. *Change Observed between (2020 - 2040)*

Land Classes	2020	2040	Change Observed	%Change	Remarks
Forest	589.73	497.67	92.06	49.22	Decreased
built-up	280.98	334.11	-53.12	28.4	Increased
Grass	15.53	55.92	-40.39	21.6	Increased
Water	3.27	1.82	1.45	0.78	Decreased
Total Area (Km2)	**890**	**890**		**100**	

vegetation, patches of scattered light green and orange colour which is grass land and built-up while the blue colour which is the water bodies covers a little part of the study area. This depict that the study area was more of forest vegetation in 1984 table 7.

In figure 4.2, it is observed that dark green colour is reduced, there was a slight increase in blue colour, and there was a slight reduction inlight green colour, while the orange colour was at an increase rate mainly at Obofia, Awarra, Amafor, Ohoba, Umukani, Ohaji Egbema forest reserve and Adapalm axis. This indicated that by the year 2002, reasonable forest lands were deforested and converted to residential, commercial, Agricultural and other land uses, and this could be attributed to infrastructural development, urbanization, industrialization and human population increase in the area which is the causes of deforestation table 4 and table 5.

In fig 4.3, deforestation continued. There were more of orange colours and light green colors were observed more at Umukani and Umuakpu axis in the map, while the dark green colour is gradually decreasing and it's been observed that the blue colour was rarely seen in the map. These indicated that as the years passes by, there are more built ups, and grass lands while the forest land is gradually degraded and used for built-up and agricultural purposes.

In figure 4.4 below, the whole map is mostly covered with orange colour, with scattered patches of light green, and dark green colour being deforested, while the blue colour is hardly seen in the map. This shows that the forest land cover has been on the regular decrease, while built ups, grass lands have been on the regular increase.

Area coverage, percentage cover and change detection land use and land cover 1984 - 2040

The area coverage and percentage cover of different land use classes are represented below. It is observed that the forest land covers about 723.26km2 with a percentage cover of 81.31% which was the major land cover of the study area in 1984. This implies that more than half of the study area was under forest cover in 1984, In the areas of built-up, it covers about 128.40km2 in 1984 with a percentage cover of 14.43%. Areas covered by grass land (either by sparse vegetation, farmland or grasses) was at minimal in 1984 with an area cover of 32.57km2 and percentage cover of 3.66%, while the water bodies cover an area of 5.34km2 and a percentage cover of 0.6%.

Table: 5. *1984 Land use land cover classification accuracy*

LULC Classes	Forest	Grass	Water	Built up	Ground Truth	Commission error	User's accuracy
Forest	44	5	0	0	49	0.1	0.9
Grass	0	45	0	1	46	0.02	0.98
Water	0	0	50	1	51	0.02	0.98
Built up	6	0	0	48	54	0.11	0.89
Total	**50**	**50**	**50**	**50**	**200**		
Omission error	0.12	0.1	0	0.04			
Producer's accuracy	0.88	0.9	1	0.96			
Over all accuracy	**0.94**						
P(r)	0.25						
Kappa Coefficient							
	0.91						
Kappa (%)							
	91						

Table: 6. *2002 Land use land cover Classification Accuracy*

LULC Classes	Forest	Grass	Water	Built up	Ground truth	Commision error
Forest	47	1	3	2	53	0.11
Grass	1	47	7	1	56	0.16
Water	3	0	37	0	40	0.08
Built up	0	2	3	47	52	0.1
Total	**51**	**50**	**50**	**50**	**201**	
Omission error	0.08	0.06	0.26	0.06		
Producer's accuracy	0.92	0.94	0.74	0.94		
Over all accuracy	**0.89**					
P(r)	0.25					
Kappa Coefficient						
	0.85					
Kappa (%)	**85**					

Table: 7. *2020 Land use land cover classification accuracy*

LULC Classes	Forest	Grass	Built up	Water	Ground truth	Commision error	User's accuracy
Forest	47	0	0	4	51	0.08	0.92
Grass	0	49	3	0	52	0.06	0.94
Built-up	1	0	49	0	50	0.02	0.98
Water	2	2	0	49	53	0.08	0.92
Total	**50**	**51**	**52**	**53**	**206**		
Omission error	0.06	0.04	0.06	0.08			
producer's accuracy	0.94	0.96	0.94	0.92			
Over all accuracy	**0.94**						
p(r)	0.25						
Kappa Coefficient							
	0.92						
Kappa (%)							
	92						

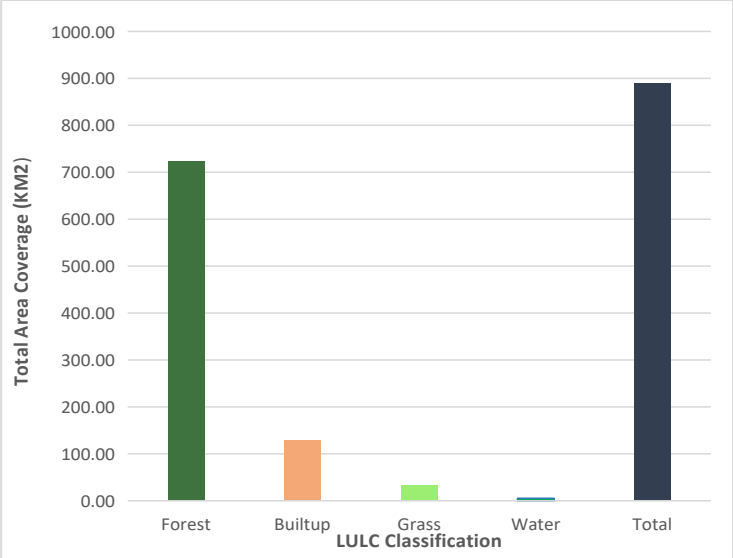

Figure: 5. *1984 Area coverage of different land use classes*

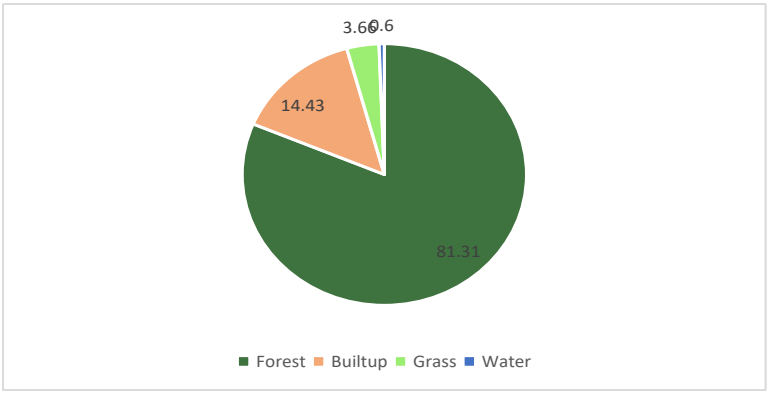

Figure: 6. *Percentage cover of 1984 LULC Classification*

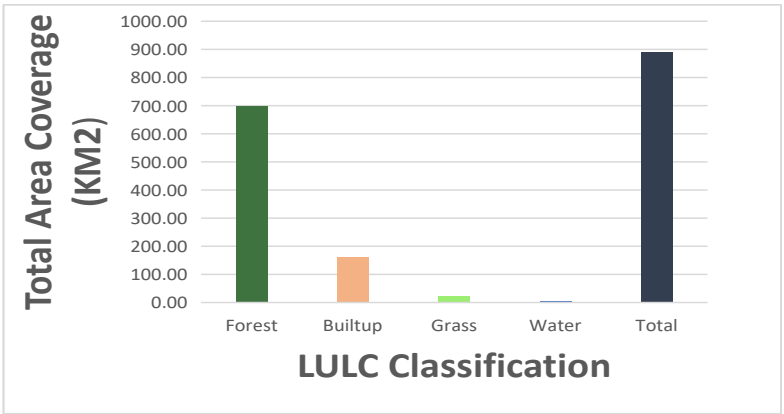

Figure: 7. *2002 Area coverage of different land use classes*

Figure 4.7 and 4.8 below show the area coverage and percentage coverage of the year 2002. As time goes on, the forest land decrease from area coverage of 723.26km2 in 1984 to 699.68km2 in 2002, with a percentage cover of 81.31% in 1984 to 78.68% in 2002 which depict that the forest cover was at a loss while the built–up was at increase from 128.40km2 to162.46km2 and a percentage cover of 18.26%. Areas covered by grass land gradually decrease to

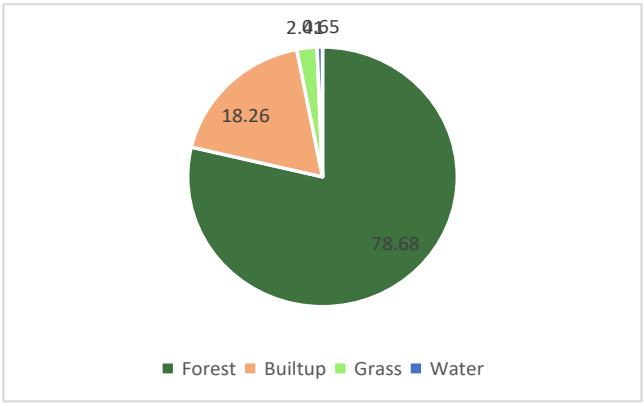

Figure: 8. *Percentage covers of 2002 LULC Classification*

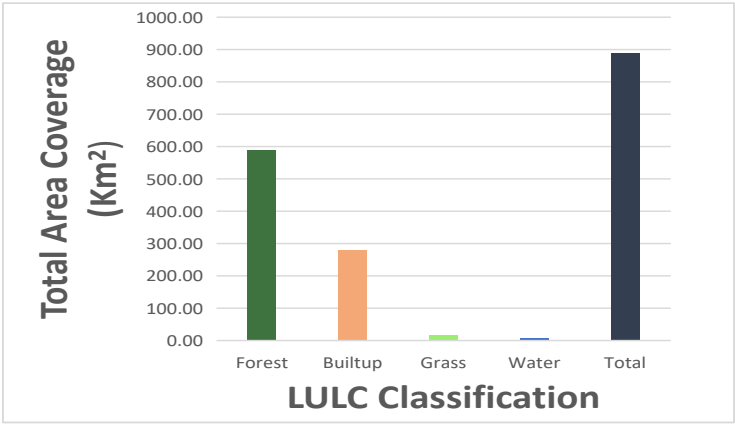

Figure: 9. *2020 Area coverage of different land use classes*

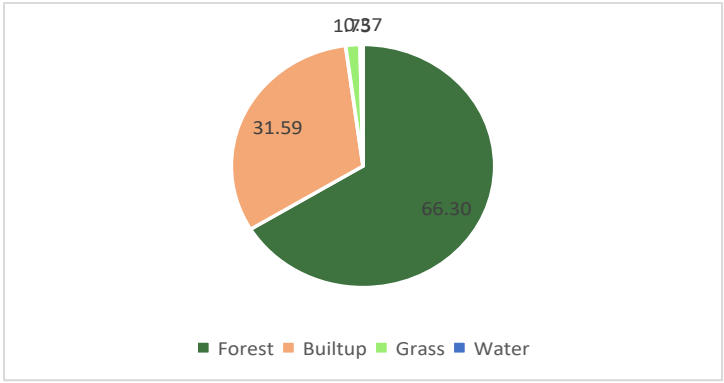

Figure: 10. *Percentage cover of 2020 LULC Classification.*

21.41km2 with a percentage cover of 2.41% in 2002, and a slight increase of the water bodies from an area cover of 5.34km2 to 5.80km2 with a percentage cover of 0.65%.

In the year 2020, it is shown that the forest land covers about 589.73km2 with a percentage cover of 66.30% which shows that there was a decrease within 2002 to 2020 while in the area of built up it increased to an area cover of 280.98km2 with a percentage cover 31.59%. An area covered by grass land covers about 15.53km2 with a percentage cover of 1.75% and the water bodies cover about 3.27km2 and a percentage cover of 0.37%. This shows that the built-up area which is at increase were initially forest

lands and water bodies in the past years.

In 2040 it was predicted that the forest cover about 497.67km2 with a percentage cover of 55.95%, the built up was predicted to be on the increase with an area cover of 334.11km2 and a percentage cover of 37.56%. Area covered by grassland was at predicted to be on increase with an area cover of 55.92km2 and a percentage cover 6.29% and this grass land was formally forest land in the past years and this change occurred mainly at Ohoba, Awarra, Umuakpu, Umukani and Ohaji Egbema forest reserve the only forest reserve in the south east of Nigeria which has been deforested and use for agricultural purposes. The water bodies cover about 1.82km2 with a percentage cover of 0.20%. This implies that the forest land has been deforested and degraded to other land uses in the study area within the study periods. All this are shown in figure 4.11 and figure 4.12.

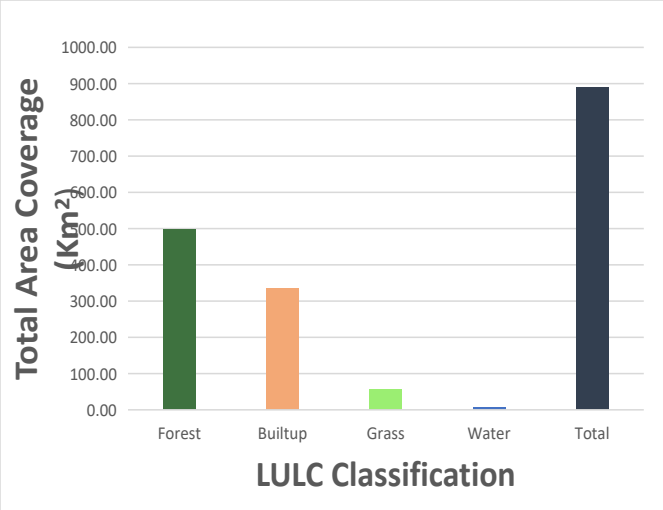

Figure: 11. *Predicted 2040 Area coverage of different land use classes*

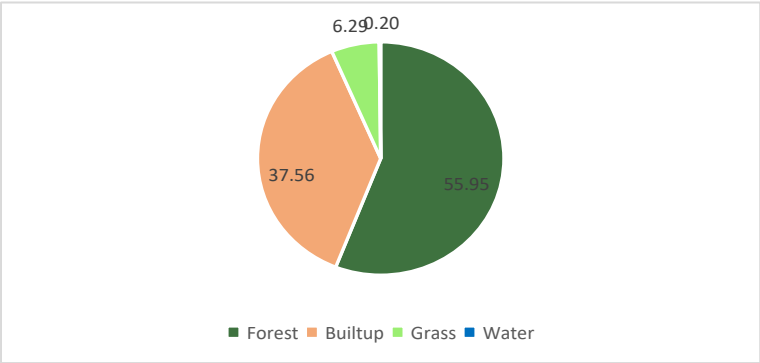

Figure: 12. *Predicted Percentage cover of 2040 LULC Classification*

Change Detection Observed Between (1984-2040)

Approximately the change detected in the forest land from 1984 to 2002 in the area coverage is 23.41km2 with a percentage change of 33.88% which shows it was at decrease, the built up from 1984 to 2002 the change detected in area is -34.06km2 with a percentage change of 49.30% which is at increase while in the area of grassland, the change observed is 11.16km2 with a percentage change of 16.15%. The change detected in the area coverage of water bodies from 1984 to 2002 is -0.46km2 with a percentage coverage of 0.67% which was at increase.

The change detection observed in table 2 below shows that between 2002 to 2020 the forest cover was at a high decrease with about 110.12km2 of change observed and a percentage change of 46.45% and the built up was about -118.53km2 and a percentage change of 50.00% which shows there was an increase in the area. The change observed in the grass was at 5.88km2 with a percentage cover of 2.48% which is at a decrease while for the water bodies the change observed is 2.53km2 with a percentage change of 1.07% which implies that the area of built up has been on the high increase over other land classes.

In the 2020 to 2040 change detection table shows that there was more of built up in the study area which is observed to cover about -53.12km2 with a percentage change of 28.40% which shows that the built up was at increase, and the forest cover was at decrease with the change observed at 92.06km2 and a percentage change of 49.22%.Also the grassland was detected to be on a increased with about -40.39km2 with a percentage change of 21.60% and the water bodies was at a decrease with the change detected at the study period to be about 1.45km2 and a percentage change of 0.78% which implies that the water body has been lost to other land uses.

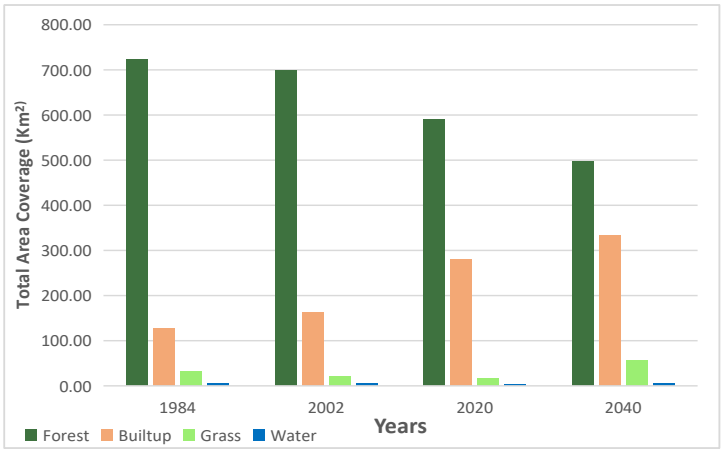

Figure: 13. *General view of Area Coverage 1984 – 2040*

Land Use Land Cover Classification Accuracy

The result of the accuracy assessment for 1984, 2002 and 2020 were presented in table 4 to table 6below. The overall accuracy for 1984 classification was 0.94%, with overall kappa accuracy of 91%, in 2002 classification,

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overall accuracy 0.89%, kappa accuracy was 85%, in 2020 classification, overall accuracy was 0.94%, kappa accuracy was 92%.

DISCUSSION

Findings from the study showed that land cover of the study area has been heavily deforested and degraded within the study period 1984, 2002 and 2020, which will continue if control measures are not taken into consideration. Forest land was on the decrease while built ups and grass lands were on the increase. This is in line with other findings of [16] and [23] and [30]. These outrageous changes in the origin all and cover in the study area could be linked to human population, unsustainable human activities in the study area as well as unsustainable environmental management practices and weak environmental policies. As the human population increases, more lands were needed for settlements and many other commercial activities, which gradually led to rapid industrialization, infrastructural development and urbanization. Increase in human population could also increase the levels of anthropogenic activities such as deforestation, intensive farming and sand mining. In other words, the large spread of forest land in 1984 could be linked to low population and productivity, less socio-economic activity. The forest lands have been drastically reduced to build-ups and other land uses in the study area, without consideration to the many environmental needs that forest provides. Hence loss of biodiversity, land degradation, noise pollution, air pollution and climate change could be rooted to changes in the land cover. It can observe that in the past two centuries the impact of human activities on the land has grown enormously, altering entire landscapes, and ultimately impacting the earth's nutrient and hydrological cycles as well as climate. The classification accuracy for the 3 years represents strong agreement. According to [31] values between 0.4 and 0.8 represent moderate agreement, values below 0.4 represent poor agreement and values above 0.81 represent strong agreement.

CONCLUSION AND RECOMMENDATION

In this study, four land use land cover classes were identified as they change through time. However, the result shows a rapid change in the vegetation cover of the study area between 1984 to 2040. Within this period, 225.59km2 of forest land areas and 3.52km2 of water body were lost and converted to other land uses in the study area. Whereas built up and grassland was at increase covering part of the forest and water body. However, if these patterns of degradation continue in the study area, it is likely that in the nearest future the remaining forest land would be wiped out and environmental crisis would be aggravated. Therefore, the assessment of the level of deforestation in Ohaji Egbema using GIS is thus a vital tool for sustainability of the forest management and environmental planning of the area especially at the only forest reserve in the South east, Nigeria.

Based on the findings, there is need to urgently limit and control the high rate of deforestation going on in Ohaji Egbema and embark on tree planting campaigns without delay. It is also recommended that an Environmental Impact statement (EIS) should be carried out. Furthermore, policy makers should ensure that the existing/future polices with regard to environmental and forest degradation is utmost implemented. There is need to create an awareness programme for all stakeholders on the issues at hand and the need to adopt sustainable use of natural resources, sustainable living habits and minimizing impact on the environmental. Finally, [2] having conducted species relics in this forest reserve further research should be conducted on higher quality satellite imagery that offers up to 4m resolution within as well as forest relic analysis.

CONFlICT OF INTEREST

The authors hereby declare no form of interest either of economic interest or any other form of conflict interest exists.

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