Original Research Article

Conflict of Land Use Types over Geomorphological Space of Anambra State, Southeastern Nigeria: The Analyses and Predictions

Abstract

Geomorphological constraints have led to the scarcity of lands in most urban and newly urbanizing areas by reducing land that would have been available for urban expansion. The study area is Anambra State; the data used for this study include primary and secondary data. A mixed-method approach was applied in the analysis and presentation of data, and ArcGIS 10.2 GIS software was also used for the processing of the satellite imageries to determine the rate of land use cover change (LUCC) in the State. Conclusively, People for long are not living in the active flood plains of Idemili-Niger area and other agriculturally endowed lands, but presently, due to increase in population and pressure on land, people have now started buying and sand filling lands in these areas without considering the danger their actions may cause if there is soil failure. Mixed land use type is visibly observed, especially urban related land use like commercial and other socio-cultural land uses. The land use cover change (LUCC) analysis shows that there is a reduction from 53.26% to 28.75% of vegetated land; reduction from 26.48% to 25.02% of disturbed vegetation and a whopping increase of settlements to 20.51% from 4.69% respectively, within a period of thirty (30) years. Presently, Anambra State is almost attaining equilibrium in all land use types in the State and if nothing is done to check the trend, there may no longer be available space for vegetation or farmland in the State in the next thirty (30) years.

Key words: Conflict, Geomorphological Space, Geomorphological Constraints, Land use, Anambra

1. INTRODUCTION

Geomorphological constraints have led to the scarcity of lands in most urban and newly urbanizing areas by reducing land that would have been available for urban expansion. Thus the benefits that could have accrued to the society socially and economically are lost. The response to this problem is the construction of multi-storey buildings as seen in cities of the world leading recently to the misuse of various land space for purposes other than the ones most suitable. The soil must possess the capacity to carry the weight of a building structure or else failure will be inevitable. This capacity is determined by the strength and structure of the underlying soil which is a geomorphological phenomenon (Ndulue, 2018).

There are geomorphological controls which limit the use of land even at the beginning of human existence that are still present today, despite man's ingenuity and advancement in technology (Ofomata, 1978; Ndulue, 2018). Some of these natural or geomorphological controls are steep slopes, wet valley floors, swampy areas, active flood plains, gully sites, rocky terrains, desert landscape, river troughs, mountains, water bodies etc (Umeuduji, 1988). Man in his attempt to modify and reduce these obstacles created by these controls, has ended up exposing the environment to more hazards such as flooding, erosion among others (Adinna, 2001).

Human beings based on their understanding of the environment must apply sense in placing their houses, roads, markets and other facilities for easy accessibility and sustainability (Ofomata, 2001; Oke, 2002). Science has provided the basis for sustainable use of resources, and its application to the global environment is enormous, cutting across all fields - soil science, engineering, geology, geomorphology, and agricultural science among others. Today, farmlands are suppose to be scientifically assessed, mapped and designated for the best suitable use before any farming activities are carried on them. Housing estates are generally established after the land has been scientifically evaluated and certified for suitability (Ndulue, 2018). Population growth has led to high demand for residential and commercial land use, especially in high cities creating problems for government and city managers in controlling and monitoring land use activities as recommended among others to ensure sanity (Akpomrere and Nymorere, 2012).

In order to make any useful developmental decision, adequate information on many complex yet interrelated aspects are very critical. Land use and its changes over time is one of such critical aspect, the developer or planner must resolve. Because of this, knowledge about land use and land cover is increasingly important if planners in Nigeria seek to overcome the problem of haphazard development that leads to deterioration in environmental quality, loss of prime arable lands, destruction or destabilization of habitats (Olaleye, 2009). With the advances in remote sensing and Geographic information system, satellite imageries have been used to understand the topography, land use and other important characteristics of an area as well as its changes over time (Olaleye, 2009). These data/imageries provide a strong visual portrayal of recognized growth pattern and dramatically convey how the progress of modern development results in profound changes to the landscape.

There are various types of land use controls, they are identified as the primary land use constraints that can limit, and in some cases preclude, development of property and they are (i) Title restrictions, (ii) governmental regulations, (iii) infrastructure limits, (iv) environmental requirements, (v) physical constraints and (vi) market place dynamics. Land use constraints are as a result of the physical characteristic of the property in question, topographic elevation changes, soils conditions (expansive, rock, Proneness to landslides), level of groundwater table among others are but a few examples of physical land use constraints (Castlelyon Corporation, n.d).

Uncontrolled human activities have led to significant modification of the natural landscape and biodiversity in the world over the years (Adefioye, 2013). Consequentially, land use and land cover characteristics are continuously being degraded without adequate consideration for the future. This has led to the depletion and deterioration of the rich ecosystem of various areas. The impact of topography on land use ranges from minor land cover changes and soil modification, to severe desertification, deforestation, erosion, and river encroachment problem. A piece of land can be put to various uses, for example, farming, forestry, construction of building, wild- life etc. however, the topography determines mostly the spatial pattern of land use and its changes (Solaimani et al. 2009; Gobin et al. 2004

Man in his quest for wealth has neglected nature's providence with regard to every tract of land and its suitable use. Vegetated, Crops and farmlands have been cleared for the purpose of erecting building structures in the study area (Figure 1), commercial activities are hostilely taken over spaces meant for residential. This paper therefore looks at the conflict of land use over geomorphological space among various types of economic, social, cultural and religious activities being carried out on land in Anambra State, Southeastern Nigeria.

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Fig 1: Vegetated, Crops and Farmland being cleared for Housing Estates in the Study Area
Source: Authors' Fieldwork, (2021)

1.1 Conceptual Framework

This study looks at landscape transition, as lands transit from initial landform to various terminal uses which are studied in later times. The model adopted, applied and discussed for this paper is that of Liu and Long, (2016), Modified by (Ndulue, 2018), and is presented below:

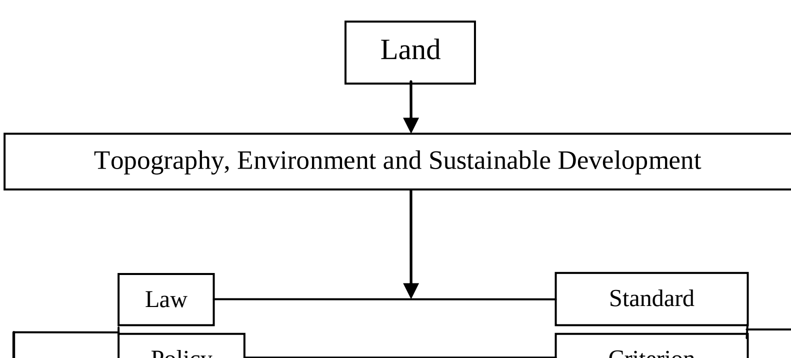

Fig 2: Conceptual framework for dynamic mechanism of land use change transition.
Source: Adopted from Liu and Long, (2016); Modified by (Ndulue, 2018).

The landscape is conceptualized according to the scheme of progression advocated by the German School of modern geomorphology as presented by Ofomata (2008). This concept therefore preserves the land and provides a model that can help a land use planner to measure and identify the sources and causes of master plan failure and occurrences of environmental hazards in any region of the world. That is why it is chosen for this study. The scheme conceives of land as made up of the topographic surface and the substrate on which it is founded. Because of the nature and importance of land to man, the thrust of the model is based on the paradigm of environmental sustainability.

Four factors affect the transition of land from one use or state to another. They are the laws in the area of study, the policies that are derived from the laws on the one hand and from the variables and the criterion for adopting the standards on the other hand. These laws, policies, standards and criteria are used by the legislature to make the laws that govern land uses at various levels and in various quarters. Via these laws land use transition is governed. Land use transition is a function of the physical variables that govern land use which include climate, geology, topography, soils, hydrology, vegetation etc, which decide the physical fitness of land for any type of use. On the other hand, the socio-economic factors exist as the socio-economic driving factors – viz population growth which drives demand for land by need for food and housing; others are economic growth, industrialization, urbanization and transport expansion all of which are socio-economic and can result in severe land degradation and environmental hazards where the dictates of the physical factors are ignored. These socio-economic driving factors are subject to internal and external controls by the natives, external populations, and others operating in the locality of the study area and the larger national space.

Land use transition is always in a state that is governed by and reflects the levels of science, land resource engineering and technology. The state of the engineering science and technology is reflected in the conversion and transition of the land from agriculture to any other non-agricultural uses and it also determines the rate and pace of landscape conversion and degradation in any region subject to control by the legal and administrative authorities which compel obedience to the laws and assure environmental safety or otherwise degradation and environmental hazards.

Land development is done via the processes of land reclamation, land consolidation, land modification and land conservation. Each of these has its part to play in the level of exposure of an inhabiting population to various types of environmental hazards. Land use engineering and technology also directly affects the various uses to which the land can be put, whether agricultural, residential, commercial, institutional, transportation, industrial, socio-cultural, utilitarian, tourism etc, which must be carried out under the operation and land use laws and policies ensured by the relevant agencies of government such that harmony on the landscape is preserved and assured.

2. MATERIALS AND METHODS

2,1 Study Area

Anambra State (Figures 3) has an area of 4844 km^2, located between Latitude 5º 45'N to 6º 46'N and Longitude 6º 38'E to 7º 23'E. It lies within the Koppens Af climatic region (Ayadiuno and Ndulue, 2021). Mean annual temperatures are around 27ºC with a mean rainfall of 1870mm per year. The southwest to western corner of Anambra State is the wettest part while the central to north/northeast section is relatively a drier area (Obetta, et al, 2011; Ayadiuno and Ndulue, 2021).
The rainy season lasts from mid to late April to late October each year the occurrence of little dry season – August Break for which the area is known. The dry season that normally starts in late October started in year 2020 in December as observed by the authors. The harmattan season that normally lasts from late November to February started also in year 2020 in December, may be as a result of climate change.

The Geology of Anambra State consists of cretaceous sedimentary rocks, Shale formations underlie the State and are exposed in the Mamu basin and the Anambra basin and the Niger basin (Umeji, 2002). On the shale are deposits of the Eocene – Miocene consisting of the Bende-Ameke, Nanka Sands, Ebenebe Sandstones, etc (Offodile, 2002; Igwe & Egbueri 2018) (Figures 4).

2.2 Research Design

The design is reliance on empirical data, supported by secondary data sources. The data used in this study include primary and secondary data. Primary data used were obtained from direct field observation, measurements, photographs and oral interviews. Secondary data that were used include images and raster files collected from United States Geological Surveys (USGS) Earth Explorer imageries, Library data, online data, published and unpublished articles and books. The forecasting of the possible outcome of the conflict of land use over geomorphological space was done using Microsoft Excel.

Mixed-method approach was applied in the analysis and presentation of data for this study and the results are rendered in charts, tables and maps.

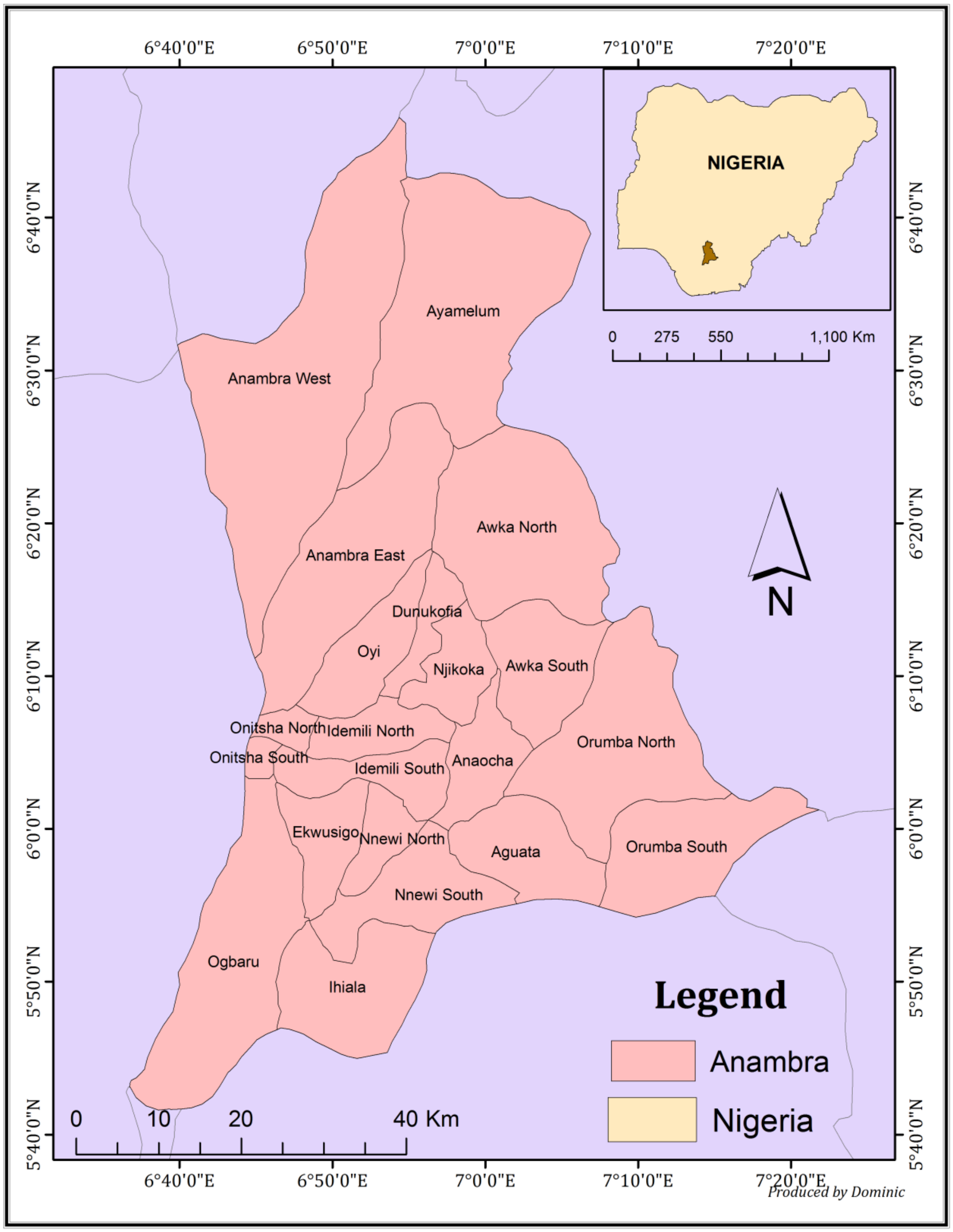

Fig 3: Anambra State

Source: DIVA GIS, Modified by the Authors, (2021)

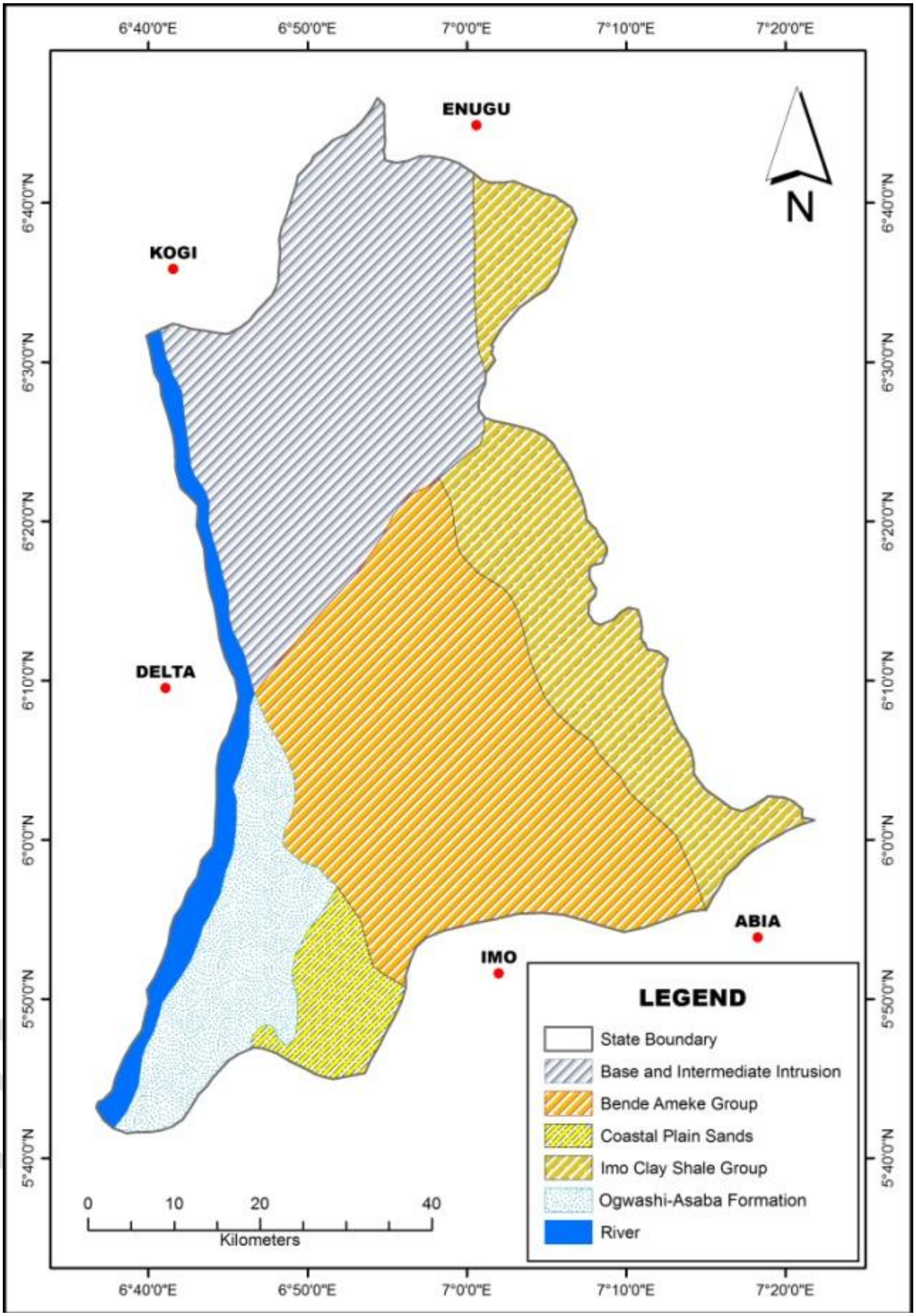

Fig 4: Geology of the Study Area

Source: USGS, Modified by the Authors, (2021)

2.3 Data Collection

Data for this study was collected through primary and secondary sources. They involved the use of Global Positioning System (GPS Extrex 10) for identifying point location of areas of significance, direct field observations, interviews to obtain peoples view and perception of land use pattern in the study area, focus group discussions to get the general knowledge of the residence of the study area with regards to the land and land use pattern. The use of satellite imageries to examine the relationship between the attributes of the land and land use change. Soil data was obtained through observation and extraction of soil specimen samples from twenty (20) randomly selected locations and were analyzed for engineering parameters. The specimen were extracted by first excavating the ground to about 0.5m of dept and a metal core was driven into the ground at the bottom of the pit using hammer and bar to extract undisturbed soil sample, while disturbed soil sample was collected using shovel after the metal core was removed from the pit (figures 5*a* and 5*b).*

Fig 5*a*: Extracting Soil Sample with Core

Source: Authors' Fieldwork, (2021)

Fig 5*b*: Arrow showing Core in the Soil

Source: Authors' Fieldwork, (2021)

2.4 Data analysis

In order to achieve the result of the objective of this study, the results of the soil analysis were subjected to statistical test using the Statistical Package for Social Sciences (SPSS) version 20. Principal Component Analysis (PCA) was carried out in order to identify the underlying factors of the soil variables in the study area. ArcGIS 10.2 soft ware was also used for the processing of the satellite imageries to determine the rate of land use cover change in the State.

3. RESULTS ANALYSIS AND DISCUSSIONS

The soil analysis test was carried out at Soil Science Department, University of Nigeria Nsukka and the summary of the result is presented thus:

The parameters that were tested in the soil samples are soil particle sizes - Clay, Silt, Fine sand and Coarse sand on average are 28.06%, 11.78%, 18.07% and 32.01% respectively. The percentage of porosity (42.92%) was also determined which shows the level of infiltration or permeability in the area. The land that drains water easily is more suitable for construction and other land use purposes than the waterlogged areas. The test for Atterberg limit was also carried out to determine the liquid limit (25.86%), plastic limit (27.62%) and the plastic index (2.06%). Liquid limit implies limit at which any additional moisture will cause the soil to fail or break. Plastic limit is the level at which a tread of the soil specimen begins to break, that is losing elasticity, while plastic index is the difference between the liquid limit and plastic limit. Atterberg limit is a function of the amount of clay present in a soil sample, the more the clay content of soil the more plasticity and water retaining capacity of the soil (Ayadiuno and Ndulue, 2021). Maximum Dry Density (M.D.D) (186.4 Kg/m^{-3}), measured in Kilogram per cubic meter (Kg/m^{-3}) is used to determine the strength of the soil and its carrying capacity in terms of placing structures on it. Percentage Optimum/Natural Moisture Content

(16.09%) is the percentage level of moisture found in a soil specimen, which is the difference between excess and lack of moisture in the soil. Natural Moisture Content is the volume of water required to maintain Maximum Dry Density (M.D.D) during natural or mechanical compaction. Percentage shrinkage level (8.98%), is the level at which the removal of water from the soil does not cause the soil to shrink or compress further. It is used to determine the level at which a tract of land will compress when moisture is removed. It is important especially in soils made up of mainly clay soil. Percentage Void Ratio (0.36%) shows the percentage of void (space) in the soil in relation to other particles that made up the soil samples. The level of void in the soil determines the level of moisture, air content that is present in the soil. It also determines the level of infiltration in a tract of land. Percentage California Bearing Ratio (C.B.R) (20.4%) is used to determine the strength of the soil of the sub-grade in wet and dry conditions. The test for California Bearing Ratio (C.B.R) is carried out in the laboratory or in the field, either on natural or compacted soil, water soaked soil or dry soil samples and the results are used to determine modification measures. Slope angle which is measured in degree shows the level of the steepness of the slopes in the study area and it ranged from 1^0 to 45^0, while elevation also ranged from 24m to 345m.

Conclusively, Anambra State geomorphological space consists of the top most accepted Klingebiel, and Montgomery land use suitability class of I to V (Klingebiel, and Montgomery, 1962). About 80% of the State land mass is suitable for agriculture, while about 35% is suitable for any engineering construction without remedial modifications. About 40% of the agricultural space can also be used for other purposes like building structures upon fortification (Figure 6), as has been observed at the site of second River Niger bridge road. The appreciable level of M.D.D and C.B.R of 186.4 Kg/m^{-3} and 20.4% respectively, together with the position of the State as the gate way to the entire Eastern zone and her commercial bouyance status attracts high population, hence the rapidity in urban expansion that is being experience in the State.

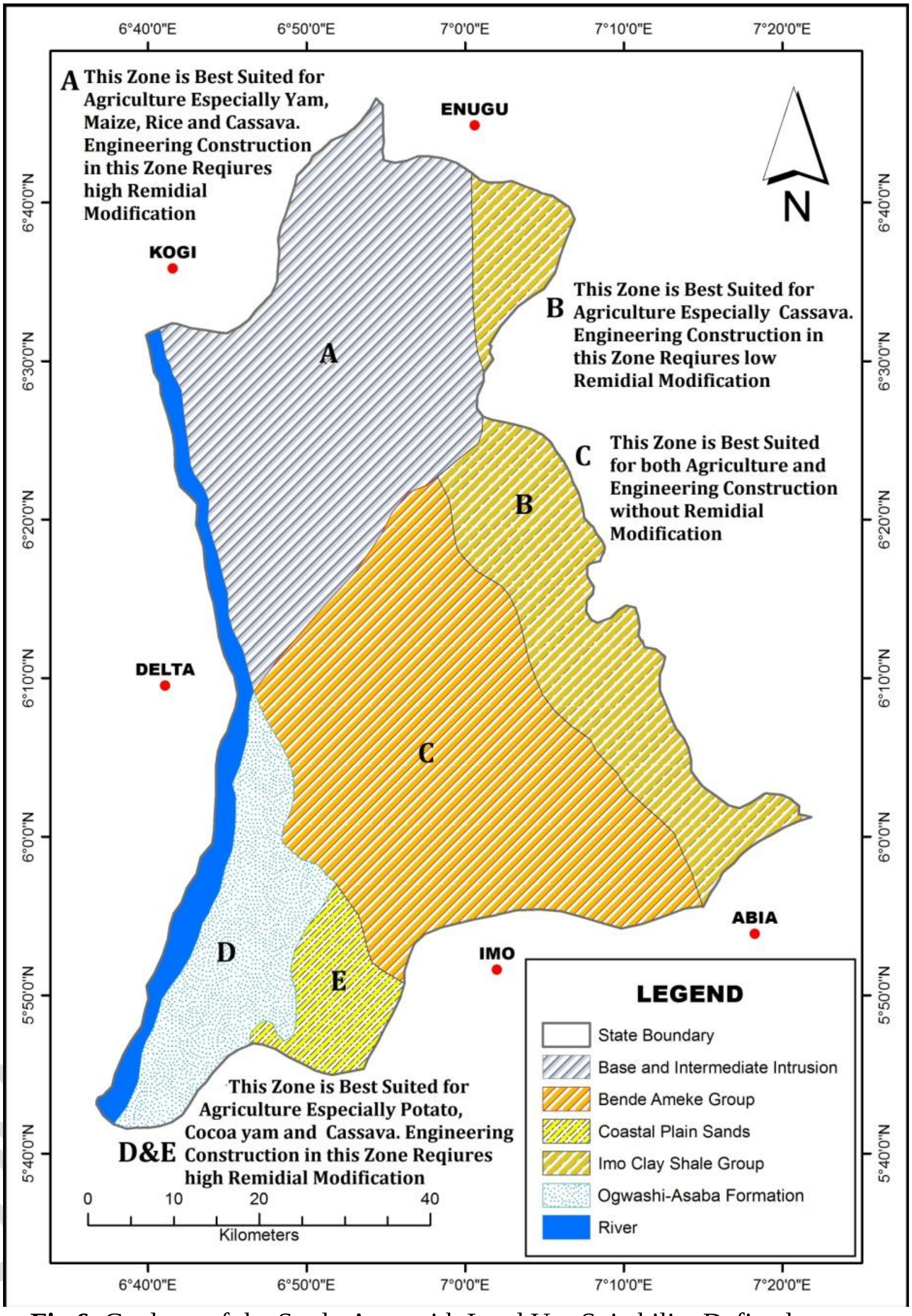

Fig 6: Geology of the Study Area with Land Use Suitability Defined
Source: USGS, Modified by the Authors, (2021)

The result of the soil analysis was subjected to Principal Component Analysis and the results are shown in the tables below:

3.1 Principal Component Analysis

Table 1: Correlation Matrix of the Principal Component Analysis

Correlation Matrix																
		Clay	Silt	Fine Sand	Coarse Sand	Porosity	Plastic Limit	Liquid Limit	Plastic Index	M.D Density	N.M.C	Shrinkage	Void Ratio	C.B.R	Slope Angle	Elevation
Correlation	Clay	1.000	.538	.467	-.938	-.784	.603	.626	.428	-.513	.795	.812	.858	-.729	-.606	-.539
	Silt	.538	1.000	.206	-.645	-.793	.111	.138	.255	-.144	.404	.526	.384	-.257	-.309	-.636
	Fine Sand	.467	.206	1.000	-.697	-.527	.211	.196	.546	-.460	.710	.613	.376	-.666	-.370	-.272
	Coarse Sand	-.938	-.645	-.697	1.000	.873	-.494	-.510	-.526	.530	-.858	-.861	-.781	.768	.596	.587
	Porosity	-.784	-.793	-.527	.873	1.000	-.190	-.205	-.485	.315	-.750	-.770	-.621	.520	.577	.707
	Plastic Limit	.603	.111	.211	-.494	-.190	1.000	.997	.257	-.435	.366	.438	.421	-.427	-.352	.013
	Liquid Limit	.626	.138	.196	-.510	-.205	.997	1.000	.231	-.447	.376	.459	.462	-.449	-.361	-.016
	Plastic Index	.428	.255	.546	-.526	-.485	.257	.231	1.000	-.188	.524	.549	.306	-.455	-.357	-.378
	M.D Density	-.513	-.144	-.460	.530	.315	-.435	-.447	-.188	1.000	-.708	-.281	-.597	.684	.290	-.107
	N.M.C	.795	.404	.710	-.858	-.750	.366	.376	.524	-.708	1.000	.748	.803	-.850	-.615	-.524
	Shrinkage	.812	.526	.613	-.861	-.770	.438	.459	.549	-.281	.748	1.000	.668	-.654	-.695	-.732
	Void Ratio	.858	.384	.376	-.781	-.621	.421	.462	.306	-.597	.803	.668	1.000	-.808	-.448	-.511
	C.B.R	-.729	-.257	-.666	.768	.520	-.427	-.449	-.455	.684	-.850	-.654	-.808	1.000	.390	.421
	Slope Angle	-.606	-.309	-.370	.596	.577	-.352	-.361	-.357	.290	-.615	-.695	-.448	.390	1.000	.407
	Elevation	-.539	-.636	-.272	.587	.707	.013	-.016	-.378	-.107	-.524	-.732	-.511	.421	.407	1.000
a. Determinant = 4.583E-015																

Source: SPSS Output, (2021)

The table above shows all the variables, their relationships and level of correlation. Values above 0.5 shows high correlation, below shows low correlation, values with minus signs shows negative relationships while plus signs show values with positive relationships.

Table 2: Total Variance Explained of the Principal Component Analysis

Total Variance Explained									
Component	Initial Eigen-values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.420	56.136	56.136	8.420	56.136	56.136	4.621	30.804	30.804
2	2.132	14.215	70.352	2.132	14.215	70.352	4.302	28.680	59.483
3	1.293	8.623	78.975	1.293	8.623	78.975	2.924	19.492	78.975
4	.964	6.424	85.399						
5	.651	4.338	89.737						
6	.606	4.042	93.780						
7	.406	2.706	96.485						
8	.216	1.439	97.924						
9	.110	.735	98.659						
10	.093	.621	99.281						
11	.058	.385	99.666						
12	.038	.251	99.917						
13	.012	.080	99.997						
14	.000	.003	100.000						
15	4.711E-005	.000	100.000						
Extraction Method: Principal Component Analysis.									

Source: SPSS Output, (2021)

The table above shows that all the variables were collapsed into three components. It used the component to extract total variance explained with Eigen-value above 1. This means that the component with Eigen-value above 1 explained the majority of the variance. The first component explained 56.136% of the total variance, the second component, explained 14.215% of the total variance, while the third component explained 8.623% of the total variance. In all, the three components explained 78.975% of all the total variables analyzed.

The table of Component Correlation Matrix shows the relationships among all the variables which are significant and therefore cannot alter the information in making explanation and predictions.

Table 3: Component Matrix

Component Matrix			
	Component		
	1	2	3
Coarse Sand	-.972	.061	-.015
Clay	.933	.079	.191
N.M.C	.918	.013	-.299
Shrinkage	.893	-.183	.140
Porosity	-.837	.423	-.076
Void Ratio	.833	.103	-.035
C.B.R	-.830	-.192	.340
Fine Sand	.668	-.020	-.527
Slope Angle	-.668	.057	-.162
M.D Density	-.584	-.508	.405
Plastic Index	.577	-.132	-.184
Silt	.575	-.490	.331
Plastic Limit	.543	.687	.424
Liquid Limit	.561	.676	.440
Elevation	-.613	.643	-.201
Extraction Method: Principal Component Analysis.			
a. 3 components extracted.			

Source: SPSS Output, (2021)

The table above shows the unrotated loading of each variable to the three components. In the first component, most of the parameters have high loading value of more than .5 and include Clay (.933), Natural Moisture Content (.918), Shrinkage (.893), Void Ratio (.833), Fine Sand (.668), Silt (.575), Plastic Limit (.543), Liquid Limit (.561) and Plastic Index (.577); suggesting an underlying factor of a depositional plain. In other words, it is evident from the soil analysis result that low lands (areas of deposit) exist in the State. Coarse Sand (-.972), Porosity (-.837), C.B.R (-.830), Slope Angle (-.668), M.D.D. (-.584) and Elevation (-.613) also have high loading value of more than .5 but in negative correlation to the underlying factor. This means that there are parameters in support of engineering constructions in the soil analysis of the State and are far away (negatively correlated) from the underlying factor in the tune of their various loadings. In the second component, Plastic Limit (.687), Liquid Limit (.676) and Elevation (.643) suggest an underlying factor of an upland suspended by the remains of consolidated duricrust that are resistant to erosion and the loading of M.D.D (-.584) shows a negative correlation of a little above .5. This means that in this part of the State, engineering construction with minimal modification is applicable. In the third component, even though all the variables contributed 8.623% of the total variance explained, none made a significant contribution individually.

Table 4: Rotated Component Matrix

Rotated Component Matrix			
	Component		
	1	2	3
Elevation	-.896	-.123	.108
Porosity	-.847	-.403	-.075
Silt	.822	.032	.059
Shrinkage	.751	.438	.308
Coarse Sand	-.673	-.605	-.360
Clay	.625	.478	.543
Slope Angle	-.531	-.301	-.320
C.B.R	-.276	-.825	-.291
N.M.C	.466	.817	.219
Fine Sand	.238	.817	-.032
M.D Density	.115	-.775	-.386
Void Ratio	.456	.584	.395
Plastic Index	.386	.483	.038
Liquid Limit	.090	.170	.963
Plastic Limit	.065	.172	.955
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

Source: SPSS Output, (2021)

The table above shows the rotated loading of each variable to the three components. In the first component, most of the parameters have high loading value of more than .5, and they include Silt (.822), Shrinkage (.751), and Clay (.625). This depicts an area that is water logged which can swell when wet and shrinks when dry and is also flat. This explains the negative correlation of Elevation (-.896), Porosity (-.847) and Coarse Sand (-.673). In other words these parameters are not available in the areas where soil characteristics represented in component one are strong and positively correlated. The area with this characteristic is found in the North and Northwestern part of the State. In the second component; Natural Moisture Content (.817), Fine Sand (.817) and Void Ratio (.584) have high loading value and depict of Alluvium soil. Coarse Sand (-.605), C.B.R (-.825) and M.D.D. (-.775), have negative correlation. The implication is that soils in the area require high remedial modifications for engineering construction to be carried out in these areas. The area with this characteristic is found in the West and Southwestern part of the State. In the third component, Liquid Limit (.963), Plastic Limit (.955) and Clay (.543) have high loading value, depicting a high Atterberg limit. The implication here is that engineering construction requires high remedial modifications and the area with this characteristic is found in the Eastern part of the State.

Table 5: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.654
Bartlett's Test of Sphericity	Approx. Chi-Square	467.734
	Df	105
	Sig.	.000

Source: SPSS Output, (2021)

The table above shows the Kaiser-Meyer-Olkin Measure of Sampling Adequacy which is above 0.6 and Bartlett's test of Sphericity of Significance level of 0.00. These values are statistically significance and therefore confirm the acceptability of the Correlation Matrix in tables above to be appropriate.

3.2 Categories of Land Use in the Study Area

3.2.1 Mixed land use

This is a type of urban development that consists of residential, commercial, cultural, institutional, or entertainment land uses, where those functions are physically and functionally integrated, and that provide pedestrian connections (Ndulue, 2018). Mixed land use development can take the form of a single building, a city block, or entire neighbourhoods. The term may also be used to refer to a mixed land use as in real estate project, a building, complex of buildings, district of a city that is developed for mixed use by a private developer, quasi governmental agency among others (Ndulue, 2018).

3.2.2 Residential land use

Most of the areas that have well drained terrain and favourable weather are suitable for residential purposes. However, the presence of Universities, Markets, among others has led to the development of residential buildings around these facilities, creating a choked up environment for other land users especially motorists and commuters around them. The other types of land use include recreational, transport, institutional, agricultural, industrial and commercial.

3.2.3 Agricultural land use

This is use of land for growing of crops and rearing of animals in a commercial or subsistence level and is the oldest human use of land. Lands suitable for agriculture should be mapped and protected by the government using the instrumentality of the law. However lands in this category are being attacked today by estate developers.

3.2.4 Commercial land use

This type of land use is for economic activities in the study area. For example, wholesales, retails and other service. Commercial land use is now dominating as the study area is becoming urbanized. This kind of land use is basically areas mapped out for markets and there is about sixty three (63) major markets in Anambra State (Anambra State Government, 2020; Ayadiuno and Ndulue, 2020). Other commercial land uses are for Petrol/Cooking Gas filling stations which are now sited everywhere in the State. Banks are also struggling for spaces in most residential allocated places (Figures 7, 8 and 9).

Fig 7: Traders taken over the Road

Source: Authors' Fieldwork, (2021)

Fig 8: A Filling Station around a high populated residential area

Source: Authors' Fieldwork, (2021)

3.2.5 Institutional land use

This covers major public and semi-public land uses like educational (Universities. primary and secondary schools in the study area), Cultural land use like civic centres, religious worship centres, Shrines (including all indigenous shrines in the study area), Healthcare facilities, Protective and Government Service facilities (Local Government Area Headquarters, Police Stations, Courts, Post Office, etc). Shops now surround these facilities, causing them to lose the serenity that is required or attributed to them

3.2.6 Transportation land use

This is the portion of land that is mapped out for transportation route like roads, railways, subways, or airports: anything that transports people or goods. These are like the circulatory system of the modern cities, and necessary for all the other land uses to operate effectively. These specified land use type has been encroached upon by other players of land related activities.

3.2.7 Industrial land use

This is the use of a piece of land for industrial purposes like manufacturing. This includes heavy and light industries. Normally heavy industrial uses are located where large pieces of land are required and pollution (like air & sound pollution) is likely to be high. Light industrial uses which may include smaller, cleaner industries like small processing plants. Industries are normally placed away from urban residential areas, however their locations is within the resident population in the study area.

3.2.8 Recreational land use

This is land used for Tourism and Hospitality industry for human relaxation and pleasure. This mostly includes parks, museums, sports grounds, and the sites of other activities that are not essential to life but are pleasurable. Hotels and recreational centres are displacing residents in most cities and take over agricultural lands in the study area.

Fig 9: A Hotel built on once existed Farmland

Source: Authors' Fieldwork, (2021)

3.3 Land Use Cover Change (LUCC) Analysis of the Study Area

Land use cover change (LUCC) maps are used to show case the spatial information on different types and variations of geomorphological space on the earth's surface of the area in study such as Vegetation (forest), Disturbed vegetation (cropland), Water body, Bare land and

Built-up area (Settlements). A suitable Land use cover change (LUCC) map or model should be able to capture the dynamism and changing feature characteristics of the earth surface in the study area (Njoku, et al. 2018; Ihinegbu and Ogunwumi, 2021).The land use cover change (LUCC) of the study area was carried out from 1990 to 2020, that is for a period of thirty (30) years at an interval of ten (10) years and the resultant maps, tables and charts are presented thus:

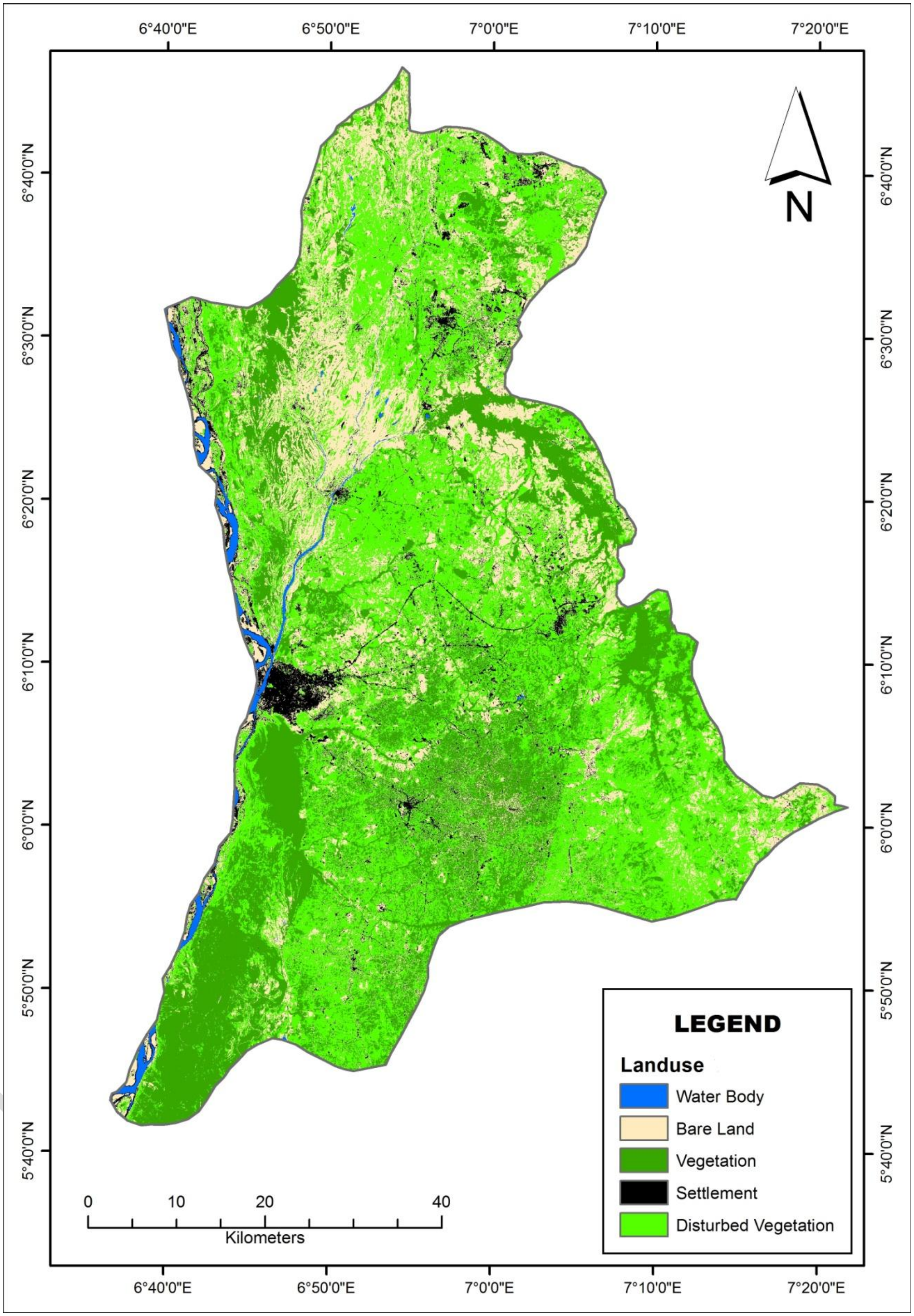

Fig 10: Land Use Cover Change (LUCC) of the Study Area in 1990

Source: USGS, Modified by the Authors, (2021)

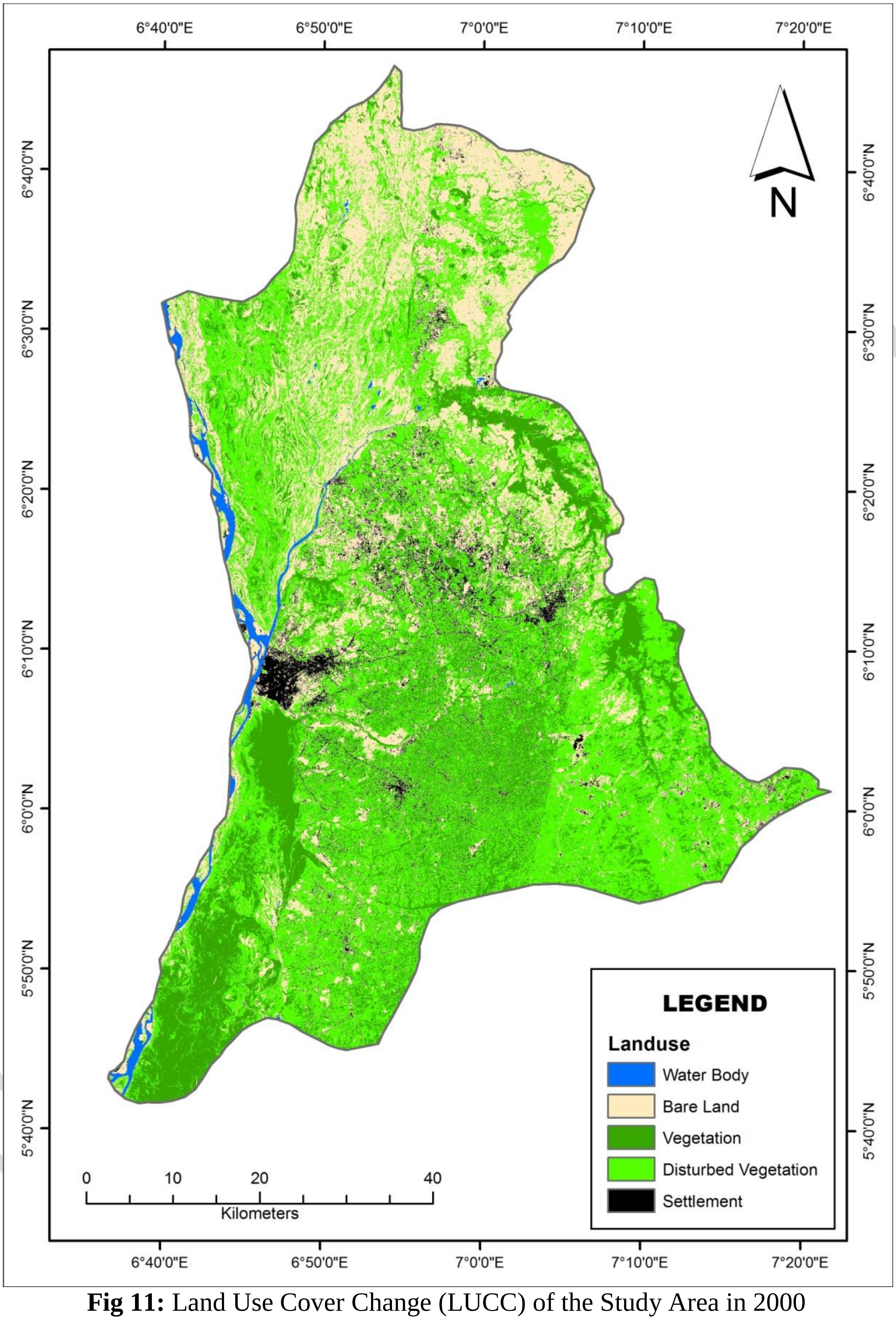

Fig 11: Land Use Cover Change (LUCC) of the Study Area in 2000

Source: USGS, Modified by the Authors, (2021)

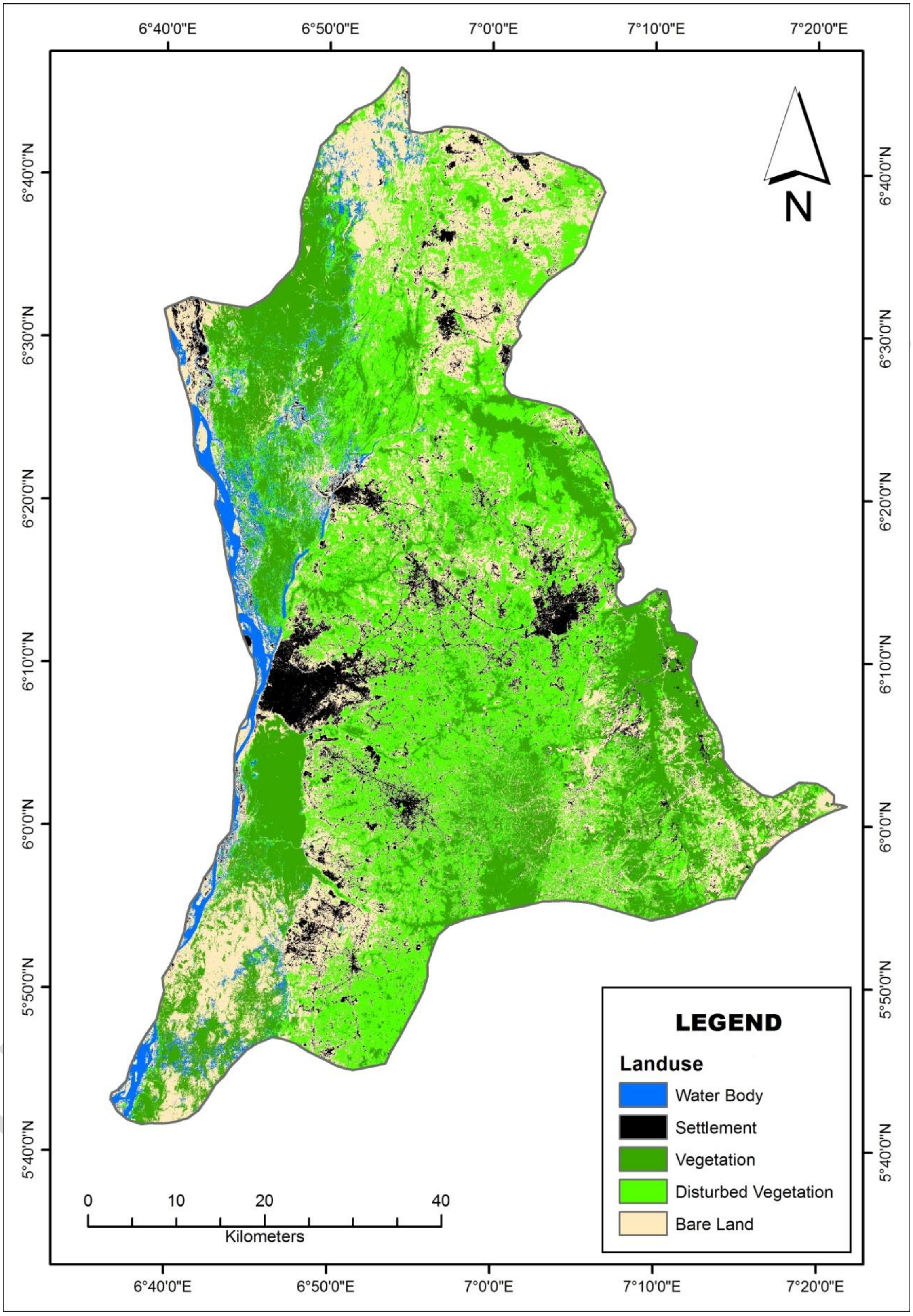

Fig 12: Land Use Cover Change (LUCC) of the Study Area in 2010

Source: USGS, Modified by the Authors, (2021)

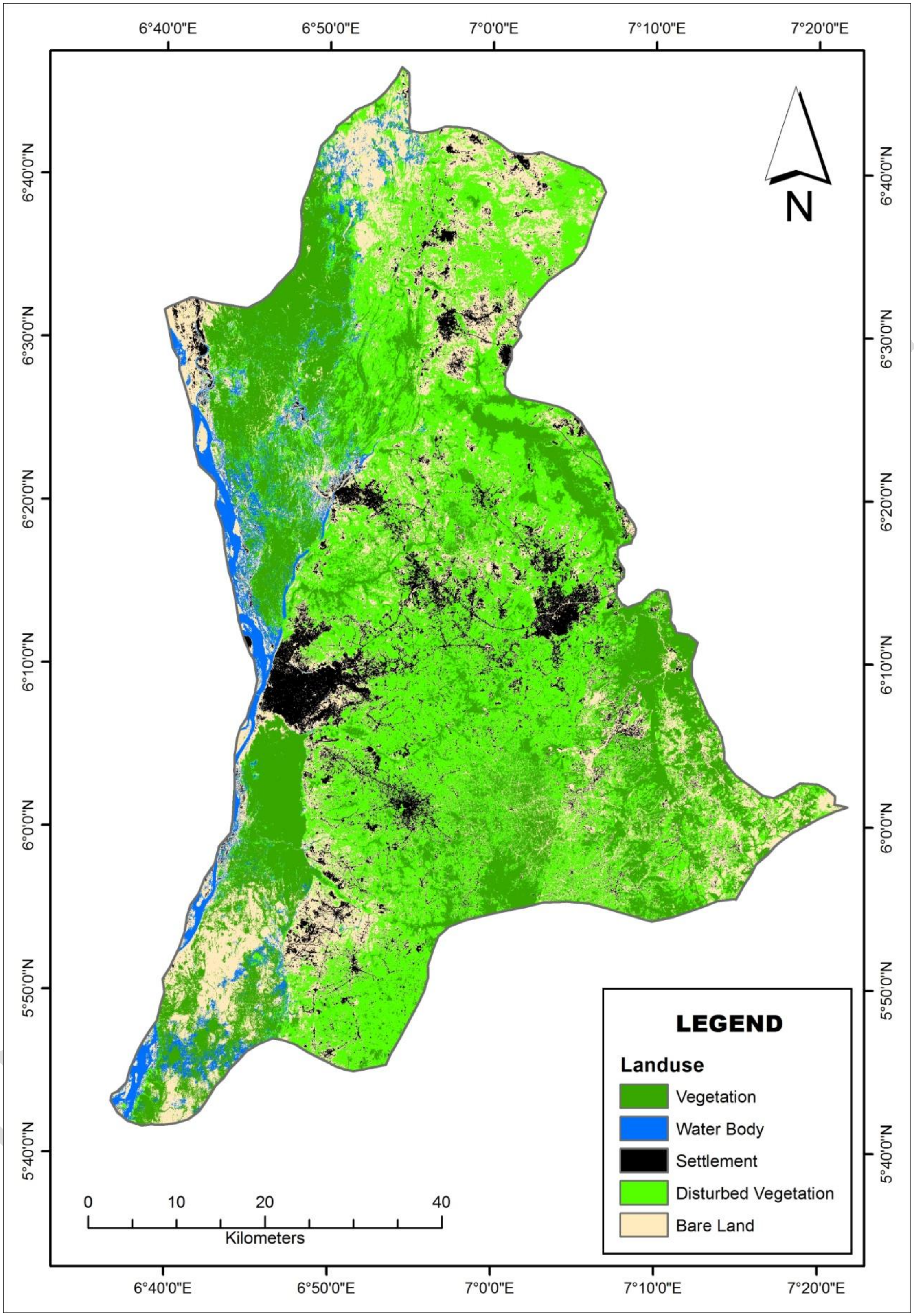

Fig 13: Land Use Cover Change (LUCC) of the Study Area in 2020

Source: USGS, Modified by the Authors, (2021)

Table 6: Areas and Percentages of Land Use Cover Change (LUCC)

Year	1990		2000		2010		2020		% Change
Name	Area (Km)²	Area (%)	Area (Km)²	Area (%)	Area (Km)²	Area (%)	Area (Km)²	Area (%)	
Vegetation	2579.91	53.26	2292.18	47.32	1541.85	31.83	1392.65	28.75	-24.51
Disturbed Vegetation	1282.69	26.48	1340.33	27.67	1186.30	24.49	1211.97	25.02	-1.46
Bare Land	717.88	14.82	907.77	18.74	1085.54	22.41	1149.48	23.73	8.91
Settlements	227.18	4.69	222.82	4.6	926.66	19.13	993.50	20.51	15.82
Water Body	35.85	0.74	81.38	1.68	103.66	2.14	95.91	1.98	1.24

Source: Authors Computation, (2021)

The table above shows the land use cover change (LUCC) of the study area from 1990 to 2020. In 1990, Vegetation (forest) covered 2579.91 (53.26%) square kilometers of the study area. It came down to 2292.18 (47.32%) square kilometers in 2000, 1541.85 (31.83%) square kilometers in 2010 and 1392.65 (28.75%) square kilometers in 2020 respectively. The areas termed as Disturbed Vegetation are vegetated areas being tampered through anthropogenic activities like farming; lumbering; harvesting of forest fruits among others, and they covered 1282.69 (26.48%) square kilometers of the study area in 1990, increased to 1340.33 (27.67%) square kilometers in 2000, decreased to 1186.30 (24.49%) square kilometers in 2010 and again went up to 1211.97 (25.02) square kilometers in 2020 respectively. Bare land covered 717.88 (14.82%) square kilometers of the study area in 1990, increased to 907.77 (18.74%) square kilometers in 2000, increased to 1085.54 (22.41%) square kilometers in 2010 and went up again to 1149.48 (23.73%) square kilometers in 2020 respectively. Settlements in 1990 was 227.18 (4.69%) square kilometers, decreased to 222.82 (4.6%) square kilometers in 2000, increased to 926.66 (19.13%) square kilometers in 2010 and again went up to 993.50 (20.51%) square kilometers in 2020 respectively. Water body measured 35.85 (0.74%) square kilometers of the study area in 1990, increased to 81.38 (1.68%) square kilometers in 2000 as a result of clearing of the vegetation which expose more of the water bodies to the satellite imagery camera, it recorded increased again to 103.66 (2.14%) square kilometers in 2010 and went down to 95.91 (1.98%) square kilometers in 2020 as reclamation and sand filling of water bodies began to take place for building constructions in the study area.

The indication here is that Vegetation lost 24. 51 percent of its size within the period under review, Disturbed Vegetation lost 1.46 percent at the same period, while Bare Land, Settlements and Water Bodies increased by 8.91 percent, 15.82 percent and 1.24 percent respectively. Percentage increase in the size of Water Bodies is attributed to deforestation that exposed the vegetated covered areas to the eyes of the satellite camera in space. The data represented in the maps above are collated and tabulated as seen in table 6 and the charts below

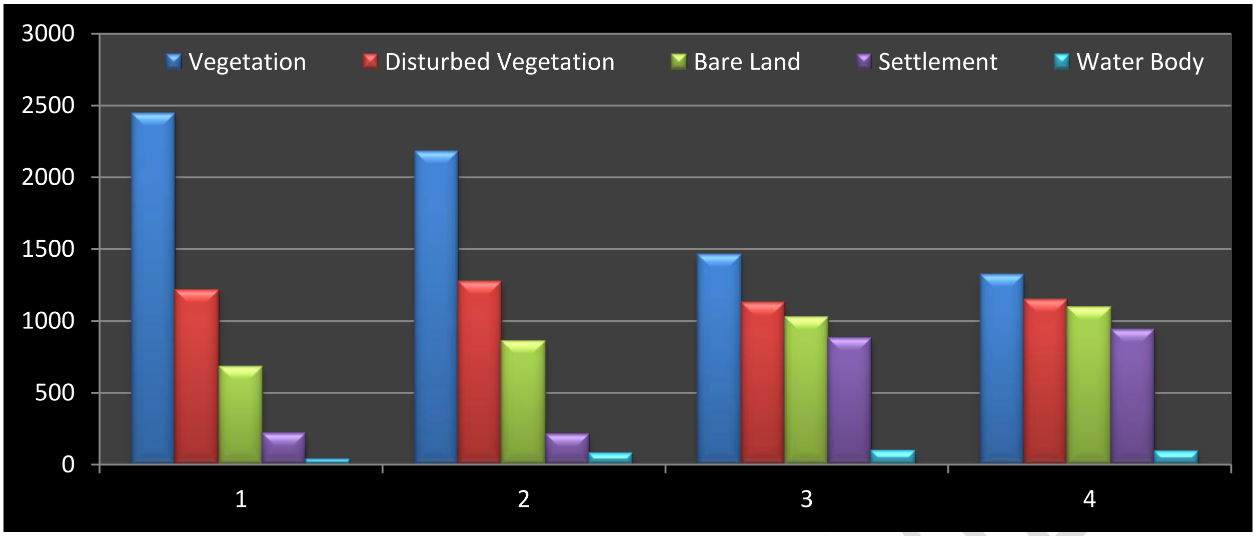

Fig 14: Land Use Cover Change (LUCC) Trend for the Periods under Review

Source: Microsoft Excel Output, (2021)

Note in the chart that the years under consideration for the Land Use Cover Change are represented with numbers (1990 = 1; 2000 = 2; 2010 = 3; while 2020 = 4)

3.4 The Predictions

Following the observed trend of various land use types in the State, Microsoft Excel was employed to predict henceforth what the outcome will look like in the next thirty (30) to forty (40) years ahead. The results of the computation are presented thus:

Table 7: Percentage Areas of Land Use Cover Change (LUCC) with Predictions

	Vegetation (%)	Disturbed Vegetation (%)	Bare Land (%)	Water Body (%)	Settlements (%)
1990	53.26	26.48	14.82	0.74	4.69
2000	47.32	27.67	18.74	1.68	4.6
2010	31.83	24.49	22.41	2.14	19.13
2020	28.75	25.02	23.74	1.99	20.51
2030*	18.03	24.03	27.54	2.69	27.73
2040*	8.75	22.70	30.04	2.85	35.69
2050*	1.85	22.47	32.60	3.12	39.99
2060*	-8.15	21.31	35.74	3.55	47.57

Source: Authors Computation, (2021)

*Predicted years

The table above shows that by the year 2060, all the vegetated areas that exist now in Anambra State will fizzle out and become part of Disturbed Vegetation, Bare Land, Water Body or Settlements. By that same year 2060, Disturbed Vegetation will reduce to 21.31 % from 26.48 % it was in 1990. Bare Land; Water Body and Settlements will increase to 35.74 % from 14.82 %; 3.55 % from 0.74 % and 47.57 % from 4.69 % they were in 1990 respectively. It is worthy to note here that the increase in Water Body could be as a result of flooding which is likely to occur due to increase in land use cover change (LUCC) that will be generating lots of runoffs or as a result of exposing other areas of Water Body that is covered by Vegetation to the eye of the satellite during capturing. The charts below show the trend of various land use types in the State and they will be at near equilibrium in 2025 (Figures 15*a* and 15*b*).

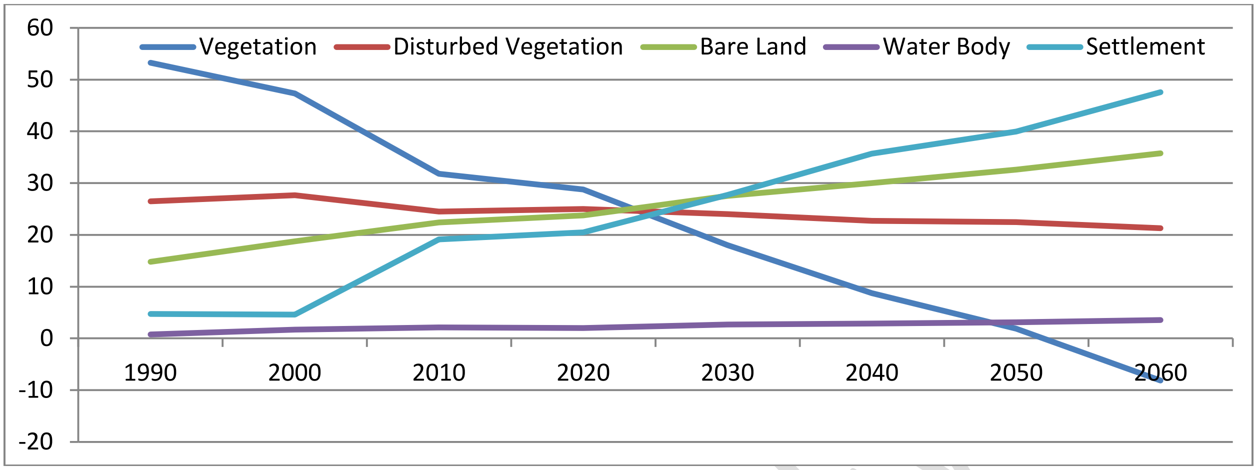

Fig 15*a*: Land Use Cover Change (LUCC) Trend for the Periods under Review
Source: Microsoft Excel Output, (2021)

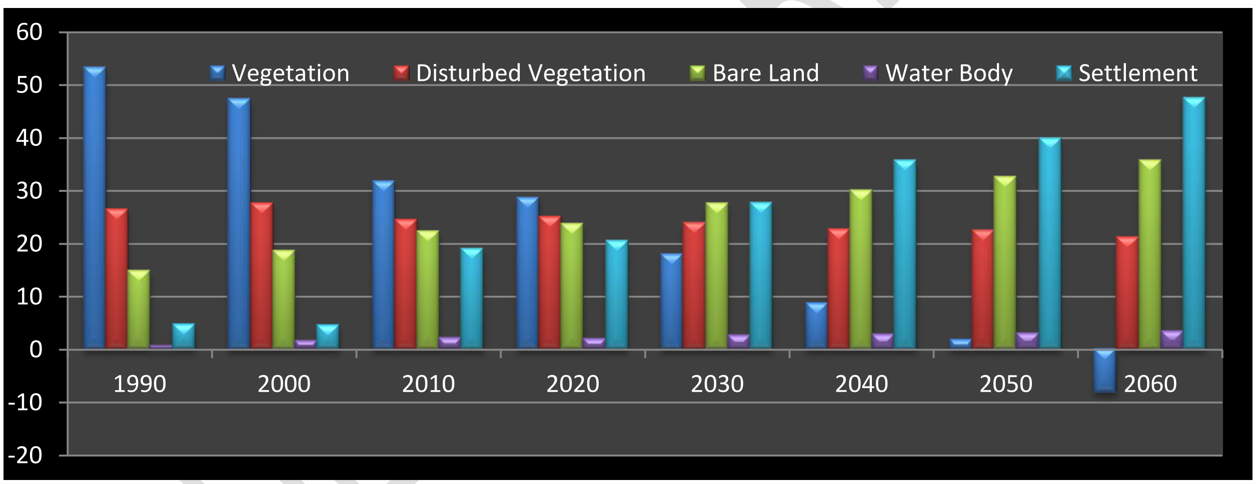

Fig 15*b*: Land Use Cover Change (LUCC) Trend for the Periods under Review
Source: Microsoft Excel Output, (2021)

4. CONCLUSION

People for long are not living in the active flood plains of Idemili-Niger area and other agriculturally endowed lands, but presently, due to increase in population and pressure on land, people have now started buying and sand filling land in these areas without considering the danger their actions may cause if there is soil failure.

Mixed land use type is visibly observed, especially urban related land use like commercial and other socio-cultural land uses. The land use cover change (LUCC) analysis shows that there is a reduction from 53.26% to 28.75% of vegetated (forest) land; reduction from 26.48% to 25.02% of disturbed vegetation (crop land) and a whopping increase of 20.51% from 4.69% of Settlement respectively in Anambrs State within a period of thirty (30) years. Presently, all the various land use types in the State are almost attaining equilibrium and if nothing is done to check the trend, there may no longer be available space for vegetation or farmland in the State in the next thirty (30) to forty (40) years ahead.

The government whose responsibility it is to protect the environment through enactment of laws want to remain in power and will do almost everything possible to please the people at the detriment of the environment, hence the reason for the delay in reacting to some actions of people or enforcing compliance to some safety measures relating to land use because of fear of being mobilized against by money bags and voted out of power.

Conference disclaimer

Disclaimer: - This manuscript was presented in a Conference.
Conference name: 5th African Regional Conference on Climate Change, Technology and Environmental Sciences. Theme: Global Challenges; Climate Adapation and the UN Sustainable GoalsAt: Kenyatta University, Nairobi, Kenya
Available link: - https://www.researchgate.net/profile/Dominic-Ndulue/publication/352738155_Conflict_of_Land_Use_Types_over_Geomorphological_Space_of_Anambra_State_Southeastern_Nigeria_The_Analyses_and_Predictions/links/60d5c4e3a6fdccb745e12ba1/Conflict-of-Land-Use-Types-over-Geomorphological-Space-of-Anambra-State-Southeastern-Nigeria-The-Analyses-and-Predictions.pdf?origin=publication_detail

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