

## **Spatio-Temporal Analysis of Land Use Changes in South-Eastern States, Nigeria**

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DOI: 10.29322/IJSRP.10.04.2020.p10060

<http://dx.doi.org/10.29322/IJSRP.10.04.2020.p10060>

**Abstract:** Urban growth processes, usually accompanied by increased population also sees cities growing rapidly in terms of physical dimension leading to rapid expansion and changes in land characteristics of the area concerned. This study examined land-use changes of states in the south-east, Nigeria. Satellite imageries of the study area for 1986, 2006 and 2018 were sourced from US Geological Survey and NASRDA (March, 2019). Landsat Thematic Mapper imagery constitutes the base data layer from which the land use and land cover (built-up and non-built up) maps were derived. A total of 270 data points were obtained from the ground truth field survey from which 195 ground truth points were used for accurate assessment through the use of Global Positioning System (GPS). The result revealed that there is spatio-temporal variation in land use characteristics among the various states in the south-east, Nigeria in all the years examined. Abia state grew from a built-up area of 223.3 Sq.km in 1986 to 285.18Sq.km in 2006 and 405.72 Sq.km in 2018. For Anambra, it was 377.78Sq.km, 599.15Sq.km and 1795Sq.km in 1986, 2006 and 2018 respectively. Ebonyi also had its share of land use changes with a built-up area of 812.37Sq.km, 1074.50Sq.km and 1451.91Sq.km in 1986, 2006 and 2018 respectively. The built-up area for Enugu for 1986, 2006 and 2018 are 1866.31Sq.km, 1929.28 Sq.km, and 3353.49Sq.km respectively while for Imo State it was 155.07Sq.km (1986), 309.06sq.km (2006), and 642.40Sq.km (2018).Changes in land-use pattern of states in South-East Nigeria tends to follow a combination of infilling and spontaneous growth, edge-expansion and outlying growth type. For settlements in the region to continue to play their role, there is need for deliberate urban growth management approach through a well thought out land-use planning.Strict adherence and compliance to planning regulations and political will on the part of government in the area is a desideratum to achieving sustainable urban growth in the region.

**Key words:** Urban growth management, urban expansion, Livability, built-up, land use/cover change

## 1. Introduction

All over the world, urban growth has been considered as one of the essential indicators of economic growth and development of any country they are found. Although, the world is experiencing rapid urban growth, the rate is felt more in developing countries making urban growth one of the most important issues. According to the prediction of the United Nations, the population of Africa will double within the next 40 years: from about 1 billion in 2010, Africa is expected to reach 2 billion inhabitants around 2045 (UN-Habitat. (2010). Most of these rapid urbanization will take place on agricultural land, vegetation and other natural land cover. Seto, Sánchezrodríguez, and Fragkias (2010), argued that the rate of urban physical expansion often referred to as urban sprawl, is much faster than urban population growth in many cities that put pressure on land resources. The increasing scarcity of limited land resources due to anthropogenic activities – particularly by urban growth – has not been given enough attention, which poses a great challenge to achieve the goals of sustainable development (Haber, 2007).

Urban growth processes, usually accompanied by increased population also sees cities growing rapidly in terms of physical dimension leading to rapid expansion and changes in the urban space pattern and land cover characteristics of the of the area concerned. (Mohapatra, Padmini & Monika, 2014). Although urbanization is often accompanied by positive outcomes, it also has some negative implications to include loss of agricultural land, surface and groundwater depletion, changes in geomorphic features, flooding, and landslides. (Mohapatra, et. al, 2014)

Uncoordinated urban growth has huge implications on the demand for infrastructure development and improved amenities calls for greater need to explore areas of concern by identifying the specific drivers of growth in each state and with a view to prioritizing the development scenario.

According to Jianzhu, Ikechukwu and Maduako (2018) in developing countries' large cities, the lack of timely, accurate and credible data on the location, spatial extent, rate and driving factors of urban growth has always been a crucial obstacle for implementing suitable and effective planning policies by city management. For them, although dynamic spatial-temporal change process of urban development cannot be prevented, modeling, simulation and prediction of cities' future growth remains powerful planning tool to understand the interactions between the natural and anthropogenic environment, and the problems arising from rapid urban growth.

The south-east geopolitical zone in Nigeria has witnessed rapid urban expansion due mainly to its location and position. The discovery of coal in the region near Enugu in the early 20th century around the Udi Plateau; led to the establishment of coal mining industry and subsidiary firms that acted as force towards the region's growth. The region was also famous in producing palm kernel that accounted for half of the world's total output making the region a net exporter in agricultural produce.

The presence of good atmosphere for trade also exerts centrifugal force pulling both man and industries into the region with attendant implication on land use changes in the area. Understanding the nature and pattern of land-use changes in the south east region of Nigeria is a desideratum to ensuring a sustainable urban growth in the area. This study therefore seeks to examine the nature and trend of land use dynamics in the south east region of Nigeria.

## 2. Study Area

The South-Eastern Nigeria is generally regarded as “Igbo land” and occupies a land mass of 76,145.65 km<sup>2</sup> comprising of Abia, Anambra, Ebonyi, Enugu, Imo and major parts of Delta States (Uchem, 2001).Historically, Igbo land has taken up a large part of South East Nigeria, mostly on the eastern side of the Niger River. It extends westward across the Niger to regions of Aniocha, Ndokwa, Ukwuani and Ika in present day Delta State and also minute parts of Edo State in Nigeria. Its northernmost point enters the Savannah climate around Nsukka (Uchendu, 1965). The States of South East Nigeria include; Abia, Anambra, Enugu, Ebonyi and Imo. Their State Capitals include; Umuahia, Awka, Enugu, Abakaliki and Owerri respectively. (Figure 1).



**LOCATION MAP OF STUDY AREA**

**Figure 1: South-East Nigeria Administrative**

### 3. Methods and Materials.

The studies utilized the longitudinal survey research design since it intends to explore changes in land-use of states in the south-east Nigeria over time. Both primary and secondary sources of data were used. The primary data took the form of ground truthing via the use of Global Positioning System (GPS) and physical observation carried out in the area. A total of 270 data points were obtained from the field survey from which 195 ground truth points were used as ground truth for accuracy assessment. Ground truth survey was performed in order to obtain accurate location point data for each land use and land cover class included in the classification scheme. Ground-truth surveys are essential components for the accurate determination and assessment of classified satellite imageries (Congalton, 1991).

Secondary data came in the form of satellite imageries sourced from US Geological Survey and NASRDA (March, 2019). Landsat Thematic Mapper imagery constitutes the base data layer from which the land use and land cover (built-up and non-built up) maps were derived. The scope of this study required the acquisition of three Landsat TM sheets for different years 1986, 2006 and 2018, which were corrected for cloud cover and other interferences.

The acquisition dates of the ETM Scenes employed in the change detection process fell within an acceptable anniversary window: November 18th, 1986 and February 6th, 2018. The best time for phenological stability in this region is during the dry season from November to February.

Each Landsat ETM Scene is 36, 247 Sq. km, but when five of each is *mosaic*, it produced an area of 181,235 Sq. Km. The study area has an area of approximately 287,71.12 Sq. Km. In order to subset the study area from each of the five Landsat scenes, a vector file defining the county boundary with the same geo-referenced coordinates as the Landsat images, UTM Zone 32N, WGS 1986, was imported into ArcGIS 10.2. The state boundary vector file was converted to a binary bitmap mask and overlaid on to each of the TM scenes.

Image classification was achieved using the a multilevel, hierarchical land use classification derived from the author's a priori knowledge of the study area and is roughly based upon an Anderson level II classification (Anderson et al, 1976). The land use and land cover categories of focus were urban areas, forest, agricultural land, barren land, and water bodies. The urban areas were further categorised as built-up, while the forest, agricultural land, barren land, and water bodies were considered as non-built up. To enhance comprehension, schematic presentation in the form of maps was used.

#### **4. Empirical Review**

The study of urban growth has elicited the interest of different authors (Calthorpe 1993; Wheeler 2000; Calthorpe & Fulton, 2001; Wheeler, 2002; Duany & Talen 2002; Talen 2008; Birch & Wachter 2008; Weje & Osanebi, 2018; Weje & Dapa, 2015 among others). This may not be unconnected to the role urban centers play to the continuous existence of the society. Tan., Lim., MatJafri and Abdulla (2010), investigated Land use/Land Cover Change (1999-2007) in Penang Island, and observed that highly built-up areas increased (109.03%), minimally built-up areas decreased (4.61%), barren land decreased (77.69%) due to urbanization, forested lands decreased an average of 16.89% grasslands increased (12.67%), and water areas showed a modest increase (0.75%).

In a related study, Chi, Shubo, Nao and Shuqing, (2015) explore the spatial patterns of different urban growth forms in relation to roads and pre-growth urban areas in the Nanjing metropolitan region of China. The result revealed that three basic urban growth forms - infilling, edge-expansion, and spontaneous growth - were distinguished using a topological quantitative criterion. The three urban growth forms identified generally showed exponential attenuation with increasing distance to roads and pre-growth urban areas.

Weje and Dapa (2015) worried by the rapid disappearance of wet land in Port Harcourt carried out a study and found that the increasing population of port Harcourt precipitates a situation where wetlands are reclaimed for residential use. The study revealed that uncoordinated nature of land reclamation (usually done with local materials) leads to the formation of slums in the area.

Weje and Osenebi (2018) also looked land use and landcoverdynamics in Ukwuani Local Government Area, Delta State, Nigeria. The findings indicated that the areas covered by forest which was 77,948 m<sup>2</sup> in year 2000, reduced to 25,226 m<sup>2</sup> in 2018 and the areas covered by other land uses increased from 389,449 m<sup>2</sup>. in 2000 to 442,234 m<sup>2</sup> in 2018. The total forest land lost to other land uses amount to approximately 52,785 m<sup>2</sup> while the total land area gained by other land uses amount to approximately 52,785 m<sup>2</sup>.

Agbora and Weje (2019) worried by the amorphous growth of Bori town examined the level of land-use changes in the area vis- a- vis the master plan prepared for its growth in 1972. The result of their investigation showed that rapid urbanization creates a situation where peripheral lands are subjected to intense pressure a phenomenon that precipitates rapid land-use dynamics, as rural areas are made to be part of the city leading to urban sprawl. The result of the analysis further shows that the present growth pattern of Bori is at variance with the provision of its 1972 prepared plan. Residential land use increased from 1,302.7 hectares in 1972 to 5,302.7 hectares in 2003, and 7,507.3 hectares in 2018 respectively. Commercial land use also grew at 144.8 hectares' in 1972 to 140.4 hectares in 2003 and to 1,117.3 hectares in 2018. Sharp decline in the land for forest and agriculture were also observed. Bori area had a total land devoted for forest covering 65.4 % about 10,159.6 hectares in 1972, this figure dropped to 1137.2 hectares a mere 7.3% in 2018.

Njoku, Ebe, and Pat-Mbano (2010) studied Land use and land cover dynamics in Owerri, the Imo State Capital and environs using Landsat TM 86 and ETM+ 2000. Their result showed that there is significant shift in the aggregate land use and land cover class due to natural and anthropogenic forcing agents. Forest vegetation class had the largest coverage on the land use and land cover maps of 1986 and 2000. As revealing as this study may seem, its analysis focused only on Owerri-the capital of Imo state.

To better appreciate the land use changes in the entire south-east Nigeria there is need to examine the land use dynamics of the area taking all States of the region at a time. This in our view constitutes a gap in literature that the present study intends to fill.

## 5. Results and discussion

Table 1 is the result of analysis on landuse dynamics for various states in the south-east for 1986, 2006 and 2018. A dispassionate analysis reveals there is spatial variation in the landuse changes among the various states under investigation. For example, in 1986, the Abia State, had a built up area of 223.2 sq. km. and a sparsely concentration of settlements around Umu-Nneochi, Aba, and Isikwato axis. Built-up area in Anambra State in 1986 was not different as the landuse pattern tends to be quite uniform. There was no dominant urban area, but several built up scattered around within the area, indicative that opportunities and social amenities were distributed in a near uniform manner. Within the same period under reference (1986), there was outlying growth in the Northern parts of Anambra State concentrating in the areas such as Ayamelum and Anambra-West covering a built up area of 377.78 sq. km. the non-builtup areas for Anambra within the same period was 4344.58 Sq.km.

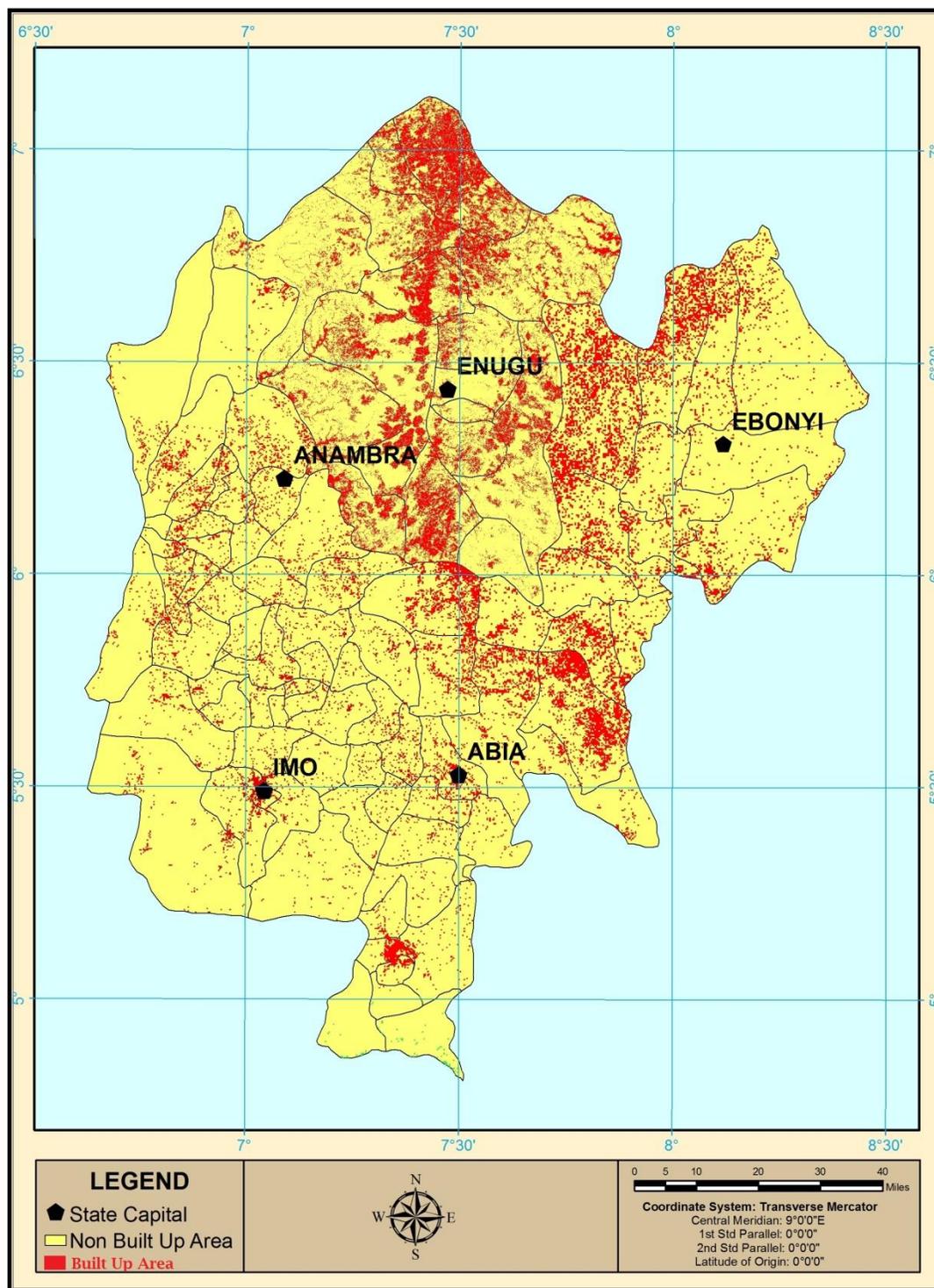
Ebonyi State also witnessed a near uniform pattern of urban growth in 1986. Although there was no dominant urban area, but several sub-centers these areas are obviously locations where jobs and social amenities are distributed in a near uniform manner having a built up area covered 812.37 sq. km. in 1986.

For Enugu the built up pattern was observed to have no dominant urban center in 1986. The urban spread covered a sparsely built-up area of 1,866.31sq.km and a non-built-up area of 5799.69sq.km. Most built-up area was concentrated at the North and Western parts of the Enugu, with evidence of infilling and spontaneous growth in the Northern and Western parts (Figure 2). The densely built-up areas were found more in areas such as Nsuka, Oji River, Eze-Agu, and adjoining areas including parts of Enugu-North and Enugu-East. The result also indicates that Imo state had an overall built up area of 155.07sq. km and a non-built-up are of 5019.72in 1986 exhibiting a sparse but random concentration. Infilling growth was visible around Owerri-Municipal, Owerri-North and Owerri-West at this period. Figure 2 is the schema showing urban growth among states in the south-east, Nigeria in 1986.

**Table 1: Spatial Outlook of Built-up and Non Built-up Areas of States in South-East Nigeria**

States	BUILT UP AREA			Non built up area		
	1986 (Sq. Km)	2006 (Sq. Km)	2018 (Sq. Km)	1986 (Sq. Km)	2006 (Sq. Km)	2018(Sq. Km)
Abia State	223.2	285.18	405.72	4510.36	4448.38	4327.84
Anambra State	377.78	599.15	1795.96	4344.58	4123.21	2926.4
Enugu State	1866.31	1929.28	3353.49	5799.69	5736.73	4312.52
Ebonyi State	812.37	1074.50	1453.91	5508.04	5245.91	4866.5
Imo State	155.07	309.06	642.40	5019.72	5019.72	4686.38

Source: Field work, (2019).



**Figure 2: Land-use Characteristics of States in South-East, Nigeria (1986)**

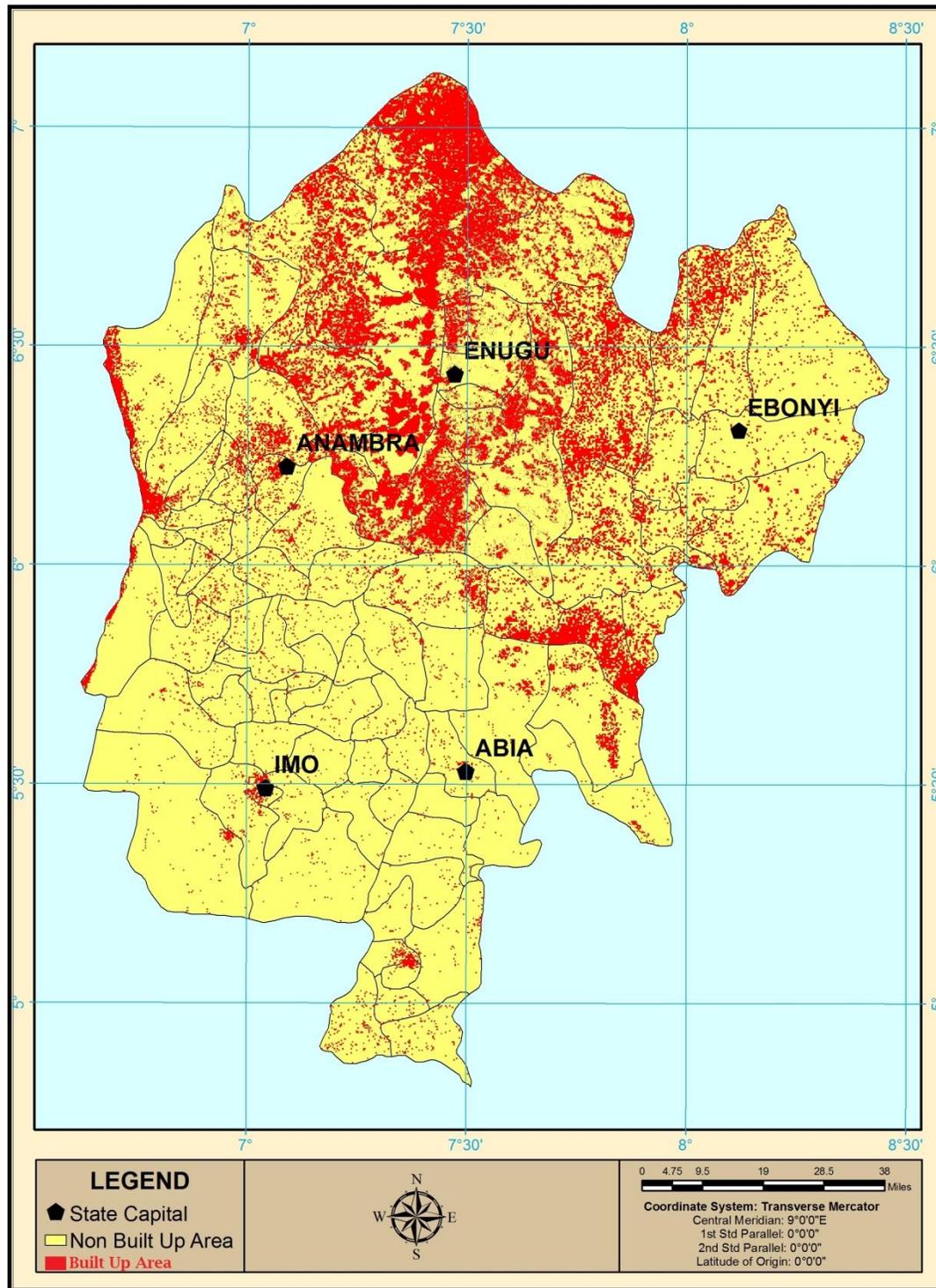
**Source: Researcher's Analysis (2019)**

As fascinating as the urban morphology of built-up areas in south-eastern states of Nigeria in 1986 may seem, the 2006 analysis of land use change in the area showed spatial variation among the various states in the region.

A close analysis however showed that in 2006, built up area for Abia State has extended to other settlements such as Ohafia, covering a total built up area of 285.18 sq. km- a far departure from 223.2Sq.Km in 1986 (Table 1). Intensification of settlements led to urban expansion extending up to Aba-South and Aba-North, Umu-nneochi, Ohafia and Umuahia-North. within this same period ( 2006) a total non-built up area reduced to 4,448.38 Sq.Km as against 4,510.36 Sq.Km in 1986. Generally speaking in 2006, landuse pattern in Abia State took a linear dimension as most built-up development occurred along major roads. The driving force for such growth was the presence of social amenities, job opportunities, and access road network. Leading radial movement of people from the periphery towards the highly dense built up spaces. Anambra State also witnessed urban increase in landuse conversion in 1986. With built up area of 377.78sq.km in 1986, by 2006 the built-up area had increased to 599.15 sq. km with obvious growth noticed at the southern parts of Ogbaru and Ihiala ends of the State. Within this same era, the non-built-up area in Anambra state was 5736.73sq.km in 2006 as against 5799.69 sq.km in 1986

The case of Ebonyi State appears not to be different. There was also a rise in the built-up area from 812.37 Sq.km in 1986 to 1074.50 Sq.km in 2006. The non-built space for Ebonyi in 2006 stood at 5245.91sq.km as against 5508.04sq.km in 1986. Even though there was an outlying and infilling growth around Afikpo-South at the initial stages of 1986, growth in Eboni state appeared to be quite dense. Though most establishments and Government presence was felt in the State Capital, Abakaliki, other locations including Afikpo South, Ohakwu, Ishelu, Ezza North, Afikpo North, Afikpo South and Ivo witnessed spontaneous and infilling growth. The reason for this outcome may not be far from the agrarian and indigenous nature of the Ebonyi people being one of the major producers of rice and other cash crops in Nigeria.

For Enugu, the dense built up in 2006 increased slowly in intensity and coverage around their borders indicative of settlement edge expansion. The dominant land use type in Enugu was outlying growth. Overall, built up area grew from 1866.31 Sq.km in 1986 to 1929.28 sq. km in 2006. Within the same year (2006) Imo state saw a rise in built-up area as significant edge expansion and outlying growth occurred at the borders of major urban areas resulting in annexation of the adjoining rural hinterlands. Urban built-up area for Imo State which was 155.07 Sq.km in 1986 increased to 309.06 Sq. km in 2006. (Figure 3)



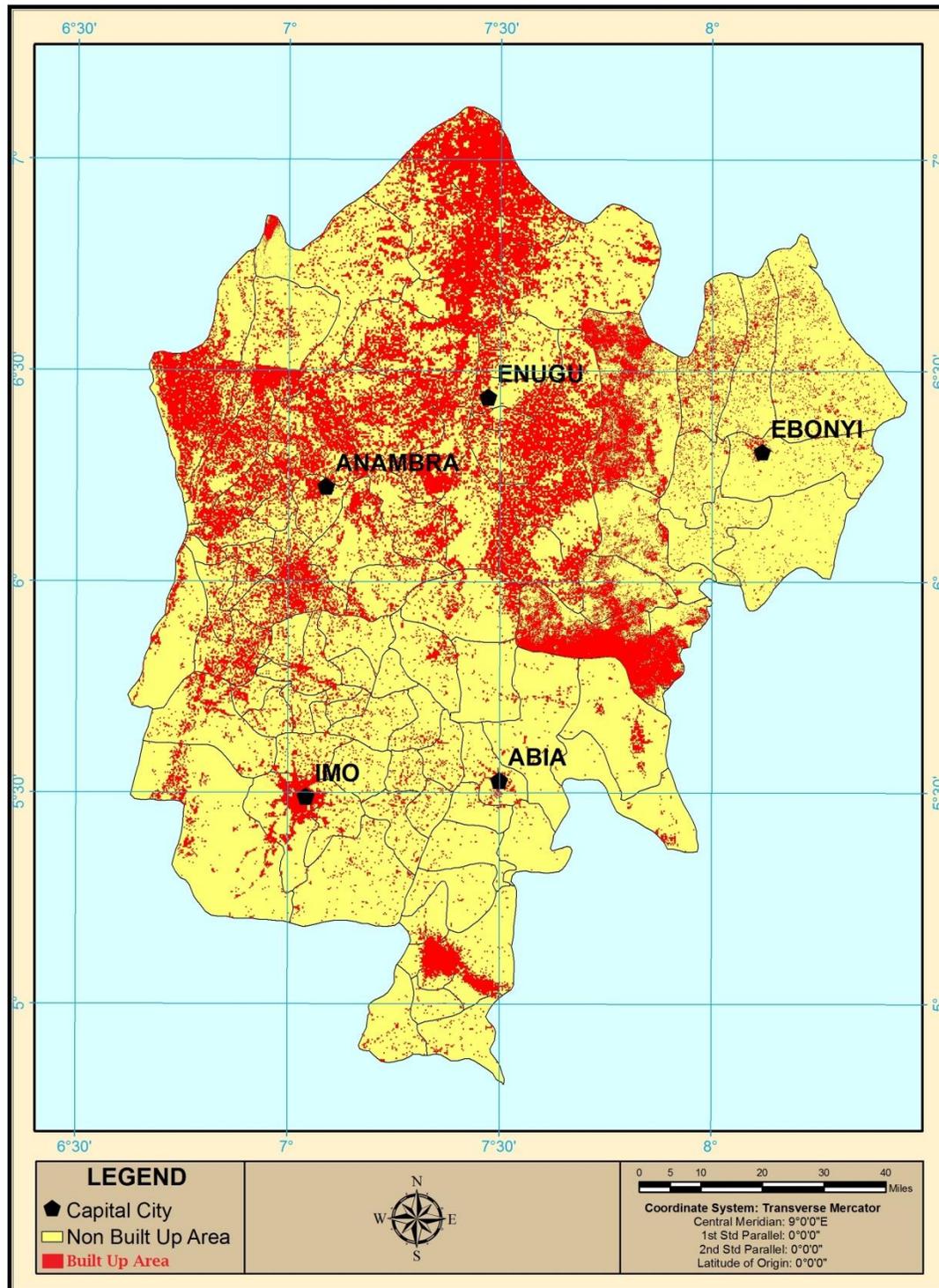
**Figure 3: Land-use Characteristics of States in the South-East, Nigeria (2006)**

**Source: Researcher's Analysis (2019)**

With the passage of time, urban expansion in the various states in the south-east intensified. The result of analysis indicates that in 2018 Anambra state had major infilling and spontaneous and dense urban growth

extending to areas such as Onitsha-North, Idemili-North, Onitsha-South, Idemili-South, Orumba-North, Annocha, Orumba-South, Aguata, Ekwusigo, Nnewi-South and Dunukofia. The total built-up area in Anambra State in 2018 stood at 1795.96.Sq.km as against 599.15 Sq.km in 2006. The corresponding value for non-built-up areas between 2006 and 2018 were 4123.21 Sq.km and 2926.4Sq.km for 2006 and 2018 respectively.

Ebonyi State also witnessed very high land-use dynamics. From a built-up area of 1074.50 Sq.km in 2006, the built-up area rose to 1453.91 sq. km in 2018 leading to loss of cultivatable land of 379.41 Sq.km between 2006 and 2018. Also in 2018 high density built-up and spontaneous development was observed in Enugu state, with built-up area extending to adjoining areas mainly around the North and Western parts of Enugu(Figure 4). Sparse built-up and edge expansion growth was observed at Isi-Uzo, Uzo-Uwani, and parts of Enugu-East. Built up space within this period covered an area of 3353.49 sq. km indicating that Enugu State had the largest built-up space when compared to all the states in South East, Nigeria within the period under review (2018). For Imo state, in 2018, there was also an infilling and spontaneous growth leading to high density built up in Owerri-Municipal, Owerri-North and Owerri-West, Oguta and Orlu-West areas (Figure 4). Further intensification of built-up area in Imo state led to the spread of growth to other adjoining areas such as Mbaitolu and Ikeduru. Urban built-up area for 2018 covered an area of 642.40 sq. km. exhibiting an outlying growth leading to an increasing built up pattern within the Northern part of Imo State.



**Figure 4: Land-use Characteristics of States in South-East, Nigeria (2018)**

Source: Researcher's Analysis (2019)

## 6. Conclusion

This work looked at spatio-temporal analysis of land-use changes of states in the south-eastern Nigeria for the periods 1986, 2006 and 2018. Satellite imageries of the study areas were obtained from the United States Geological Survey (USGS) and National Air Space Research & Development Agency (NASRDA). Physical observation and ground truthing surveys were also carried out with the use of GPS. From the result, it was observed that though states in the south-east have increased in spatial extend, growth pattern however varied between and among the different states in the region.

One of the characteristic features of land-use dynamics in the south-east, Nigeria is the fact that growth took the form of infilling and outlying growth. Although, rapid changes in land use among states in the south-east Nigeria is expected given the changes that have taken place in the socio-political and economic spheres of the states in the region, our concern however hinges on the fact that, spontaneous land-use conversion in the region precipitates a situation where human settlement proceeds in an amorphous and uncoordinated manner with severe implications on livability. As a way of averting the negative consequence of uncoordinated land conversion, there is need for deliberate urban growth management approach through well thought out land use planning. Strict adherence and compliance to existing planning regulatory instruments and standards by the planning authorities coupled with political will on the part of government of the various states is a desideratum to achieving sustainable urban growth in the region.

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