

Assessment of Urban Conurbation along the Development Corridor of Abuja-Keffi, Nigeria

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Abstract- The aim of this research is to examine the physical (landuse) growth along Abuja-Keffi development corridor. Data for the study were Landsat Imagery (ETM) of 2001, Nigeria Sat-1 Imagery of 2007 and Nigeria Sat-X Imagery of 2013. Others included Google earth image of 2014 and Nigeria political shapefile. The study revealed that between 2001 and 2007, portion of Nigeria Federal Capital Territory (FCT), Abuja within the study area grew from 83.23 km² to 99.89 km² while that of Keffi increased from 3.77 km² to 9.13 km². This increase respectively accounted for 16.68% and 58.71% growth rate within 2001 and 2007. The study also revealed that between 2007 and 2013, in Abuja, landuse development along Abuja-Keffi Road increased from 99.89 km² to 158.07 km² while the portion in Keffi grew from 9.13 km² to 22.36 km². The minimum and maximum distance between settlements along the Abuja-Keffi development corridor was 0.21 km and 8.96 km in 2001, while, it was 0.08 km and 3.57 km in 2013. The study concluded that the rate of agglomeration of urban landuse along the Abuja-Keffi development corridor was high, hence the need to manage and control development.

Index Terms- Conurbation, GIS, Remote Sensing and Developmental Corridor

I. INTRODUCTION

Abuja is the present Federal Capital Territory (FCT) of Nigeria. The choice of Abuja as the new capital to replace Lagos the former capital was as a result of its centrality and availability of land for expansion [1,2]. Abuja is 525 km from Sokoto state (Northwest, Nigeria), 736 km from Maiduguri (North-East, Nigeria), 465 km to Calabar (South-South, Nigeria), and 806 km from Lagos (South-West, Nigeria), this shows the centrality of Abuja to the rest of the states in Nigeria. According to COHRE (2008), relocation of the FCT to Abuja became effective on 12th December, 1991. In this circumstance, over 200,000 public sector workers and that of foreign embassies, multilateral and bilateral agencies moved from Lagos to Abuja. Ever since, high spatio-temporal dynamic of landuse have been noticed in the Abuja and its surrounding settlements. The population was reported to have grown from 171,000 in 1981

to 378,671 in 1991, 445,699 in 1996, and 1,405,201 in 2006. Similarly, the land area covered by development was 78.75 km² in 1987, 147.22 km² in 1999 and 416.22 km² in 2007 [1].

Abuja has been reported as the fastest growing city in African [3]. The effect of this has extended to satellite and neighbouring towns bordering the FCT. Some of the satellite towns include: Gwagwalada, Kuje, Kwali along the Abuja-Lokoja Road; Bwari, Dutse, Kubwa along the Abuja-Kaduna Road and New Nyanya and New Karu along the Abuja-Keffi corridor. Rate of landuse development along these corridors were reported to be around 20% to 30 % annually [4]. Cursory observation of these three main development corridors revealed that the Abuja-Keffi development corridor is the fastest growing and accommodate larger Abuja population who reside outside the territorial areas. Hence, this study is an attempt at examining the continuous agglomeration of built-up urban landuse along this corridor.

1.1 AIM AND OBJECTIVES

The aim of the study is to examine the rate of agglomeration along Abuja-Keffi corridor Nigeria, using geospatial techniques. This includes the rate of growth and the possibility of settlements merging along the corridor.

II. STUDY AREA

The study area is a 10km buffer along the Abuja-Keffi 50.78 km road. The area is located within longitude 7° 25' 42.115'' and 7° 57' 9.346'' East and latitude 8° 46' 9.826'' and 9° 8' 17.569'' North of the equator. The study area covered a total of 1292.97 km² (129297.23 ha). This road links Abuja with the six North-eastern States of Borno, Yobe, Adamawa, Taraba, Bauchi and Gombe. It also links Plateau, Nassarawa and Benue States (North Central State) and some part of Kaduna State to the FCT. Major towns/settlements within the study area include: Karu and Nyanya in FCT and Maraba, New Nyanya, Uke in Nasarawa State. The administrative extent of the study area covers Abuja municipal council and part of Bwari area council in the FCT and Karu, Keffi and Kokona Local Government in Nasarawa State, Nigeria (See Fig. 2 and Fig. 3).

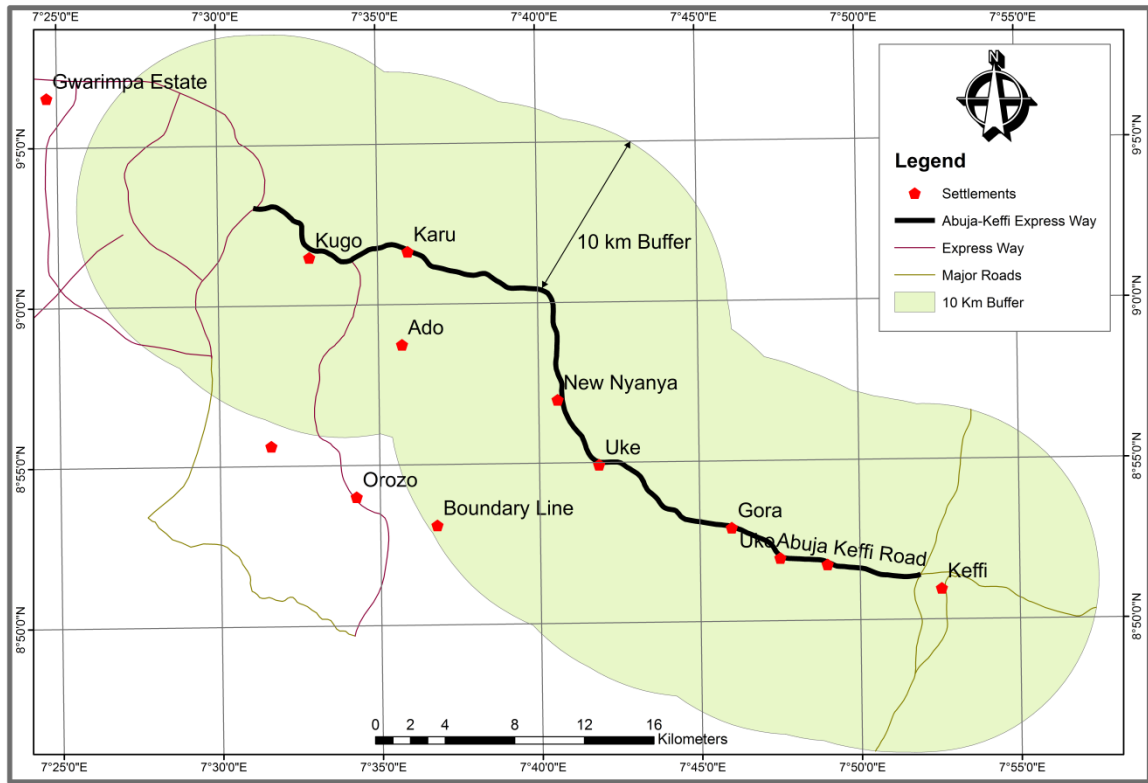


Fig. 1: Map showing 10 km buffer along the corridor under study

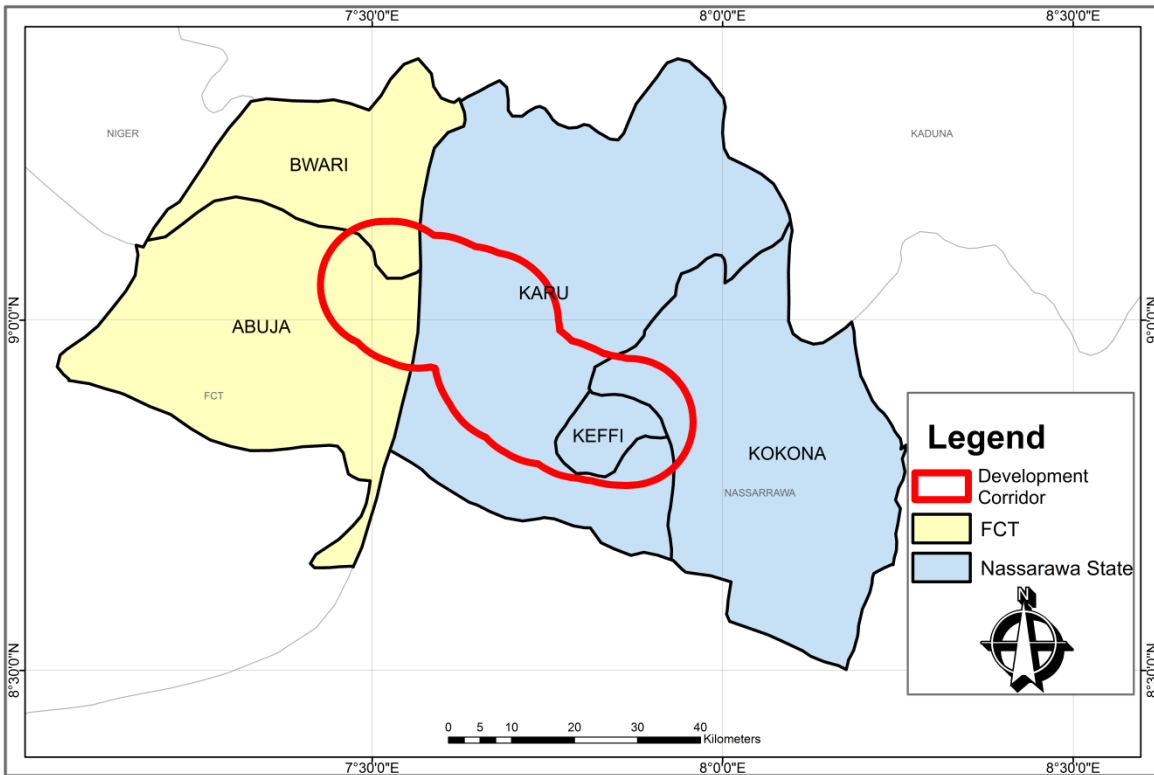


Fig. 2: Map showing the spatial coverage of the study area across the geographical boundary

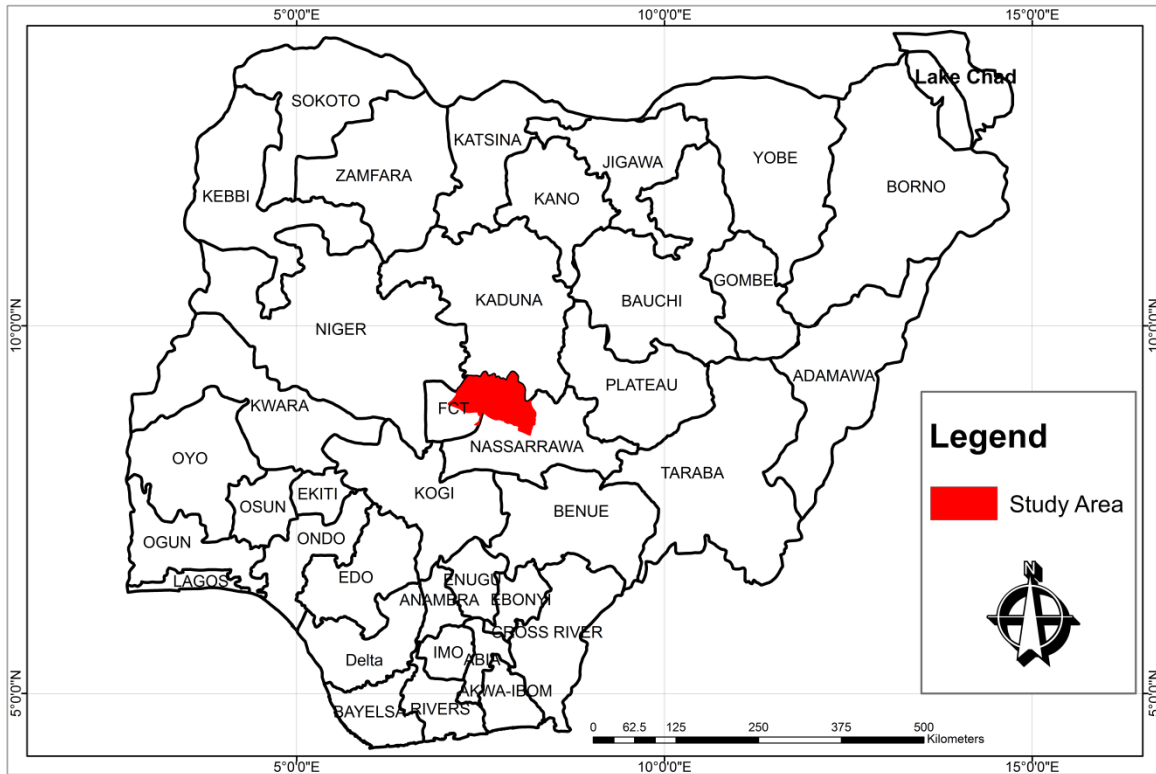


Fig 3: Map of Nigeria showing the study area.

III. MATERIALS AND METHODS

Multi-data Remotely sensed data (satellite images covering the study area) was used for the study. These satellite images include Landsat Enhanced Thematic Mapper (ETM) of 2001; with 30 metre resolution sourced from Global Land Cover Facility (GLCF) an earth observation interface (See Fig.4). Others were Nigeria Sat-1 Imagery of 2007, with 32 metre resolution (See Fig.5) and Nigeria Sat-X with 22 metres resolution (See Fig.6). Both were sourced from Advanced Space Application Technology Laboratory (COPINE). Google earth software was also used for the study.

The shapefile of the study extracted from the 10 kilometre buffer of the Abuja Keffi express road was also used to subset the Images. This shapefile was the determinant of the irregularity of the study area (See Table 1). Nigeria shape file, a populated data showing the 36 state of Nigeria and the FCT and that of all the local government areas in Nigeria was also used for the study. It is important to note that the Landsat 2001, Nigeria Sat-1 2007 and Nigeria Sat-X 2013 were used based on data availability. Some of the software's used for the study includes: Arch GIS 9.3, Microsoft Word 2010, and Microsoft Excel 2010.

Table 1: Showing the data used for the study.

s/n	Data Type	Date of Capture	Resolution	Source
1.	Landsat Imagery (ETM)	2001	30 m	COPINE, OAU
2.	Nigeria Shape file	2006		NCRS, Jos
3.	Nigeria Sat-1 Imagery	2007	32 m	COPINE, OAU
4.	Nigeria Sat-X Imagery	2013	22 m	COPINE, OAU
5.	Google Earth	2014	0.6 m	Google Earth.
6.	Shapefile of the study area	2015		Field Survey, 2015

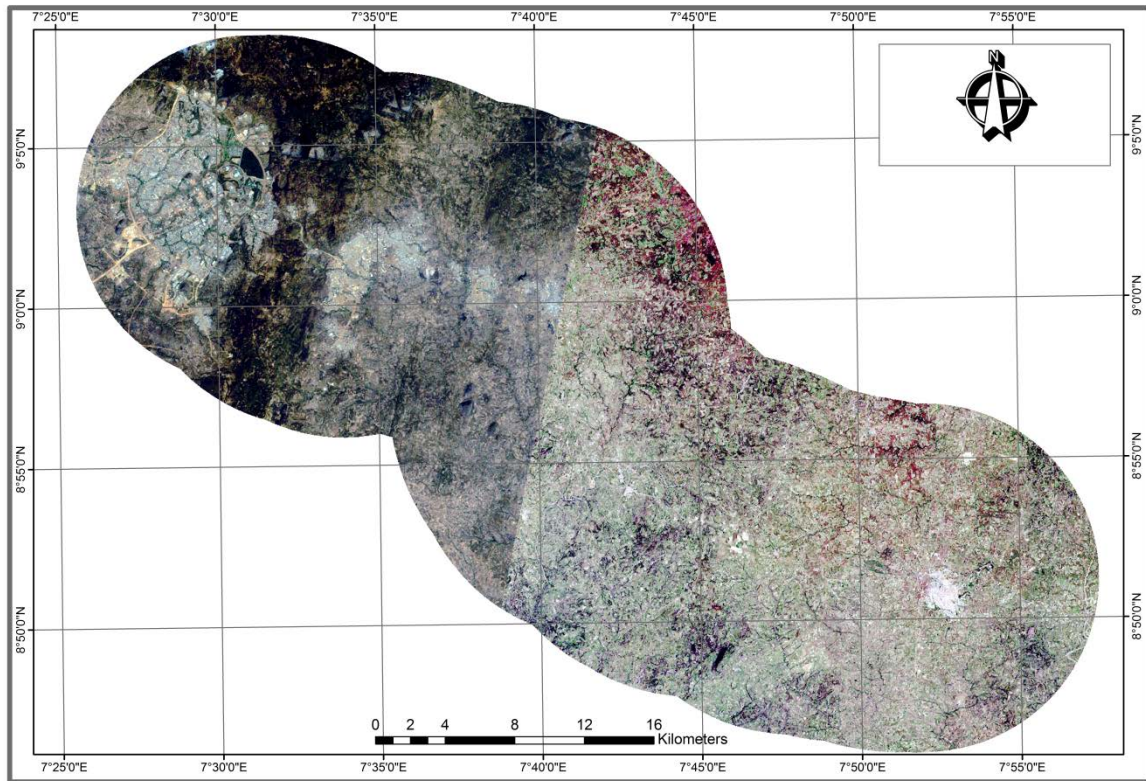


Fig. 4: Satellite image of the study area (Landsat ETM 2001).

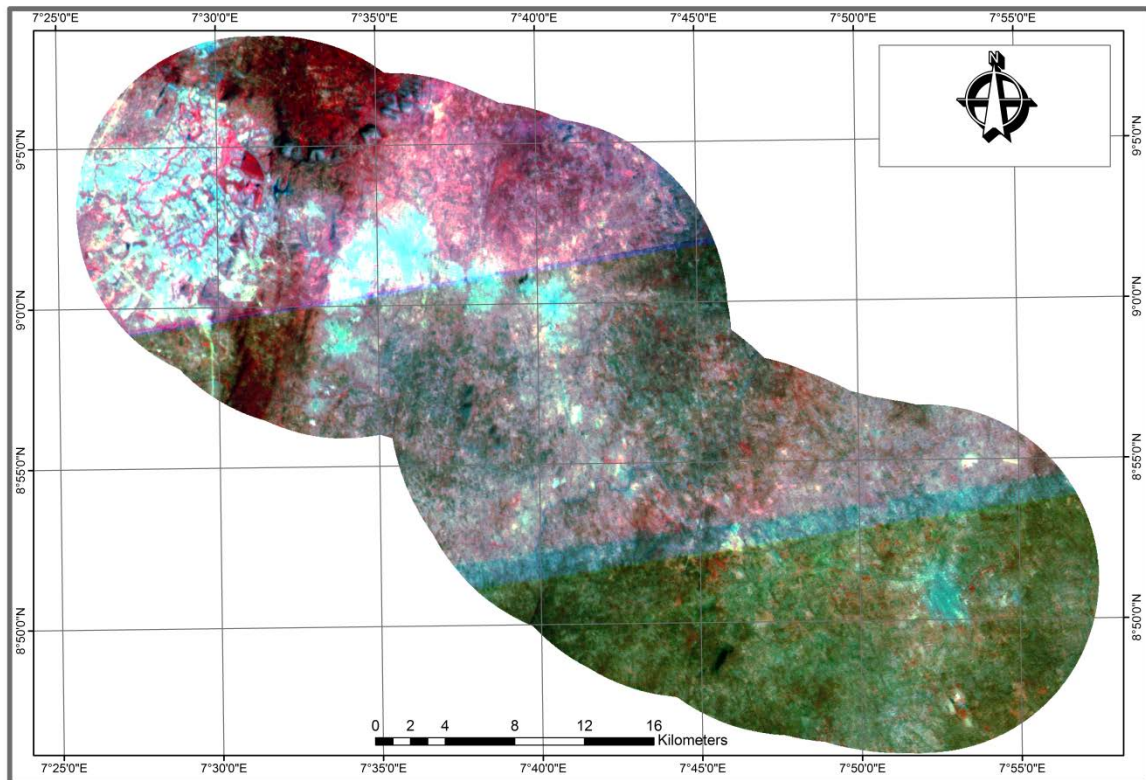


Fig. 5: Satellite image of the study area (Nigeria Sat-1, 2007).

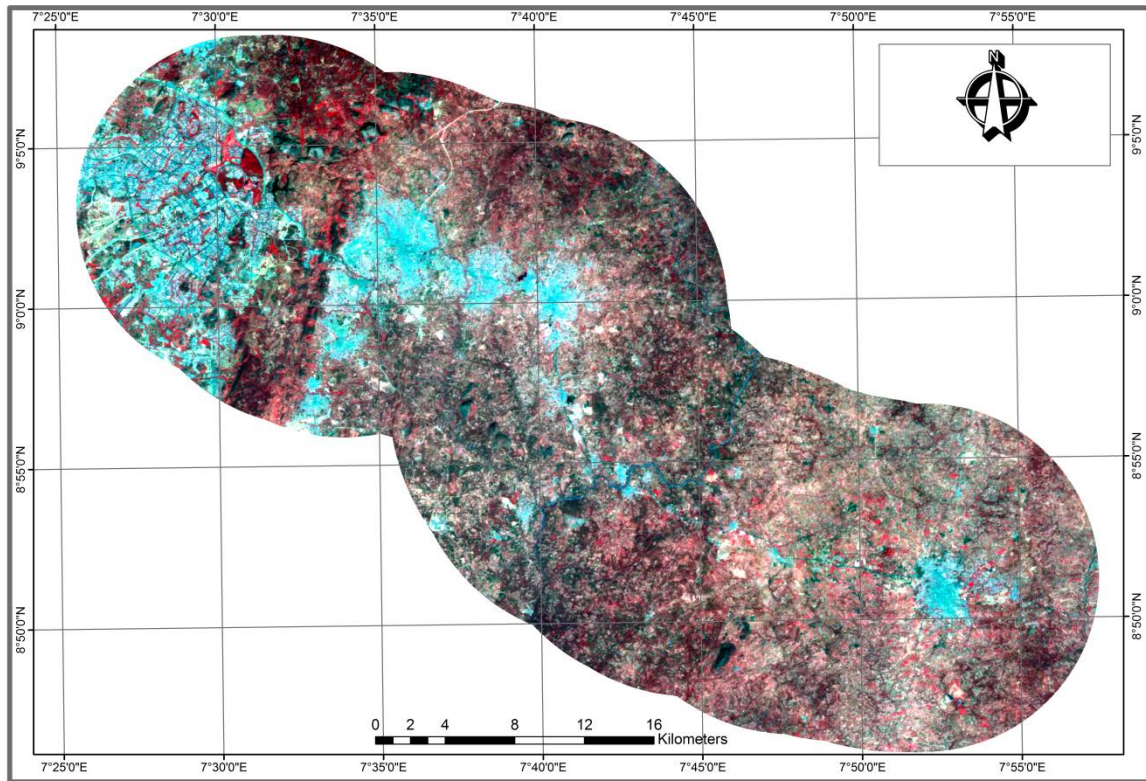


Fig. 6: Satellite image of the study area (Nigeria Sat-X 2013).

3.1 DATA PREPARATION AND ANALYSIS

The study used a multi-step method of data preparations and analysis. The first step utilised the Google earth interface to extract location of towns/settlement along the study areas. The extracted towns and settlements were plotted using Arc GIS 9.3. The second stage was the subsetting of satellite images of the study areas. This was done via the extraction of the boundary of the FCT and that of Nassarawa state. This was done to reduce the bulky nature of the data.

The third stage involves the importing of the Nigeria Sat-X image into the Arc GIS 9.3 where road network in the study area were extracted. The choice of the data was due to its clarity in terms of spatial resolution. The study also discovered that most of the settlements along the developmental corridor were within 10 km radius of the major road and this serves as the bases for delineation. The Abuja-Keffi road was extracted and 10 km buffer was created as shapefile. This forms the area under study (refer to Fig. 1). The created shapefile (Boundary of the study area) was used in the subsetting of the three medium resolution satellite images used for the study. Information extracted from those images (Landsat 2001, Nigeria Sat-1 2007 and Nigeria Sat-X 2013) are built up areas and distance between one town or settlement to another. The extraction were carried out through onscreen digitization where both the built-up areas and the road between one settlement to another were identified and extracted. The extracted data were overlay to display the graphical illustration of the changes over time. The Google earth data was used in for ground thruthing and populating of settlement names (See figure 7)

WORK FLOW

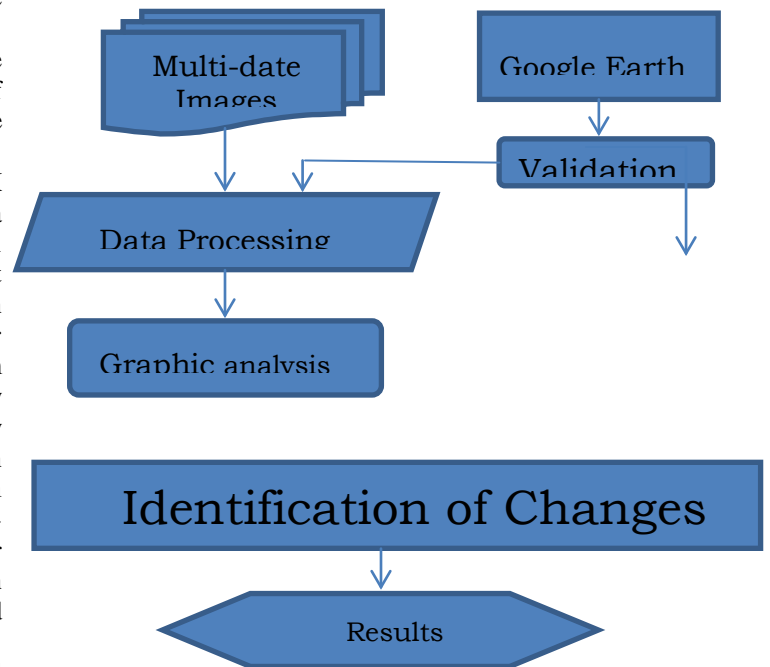


Fig. 7: Showing the flow diagram of the study.

IV. RESULT AND DISCUSSION

Growth of settlements along Abuja-Keffi Road

The study revealed that between 2001 and 2007, the portion of the FCT within the Abuja-Keffi Road grew from 83.23 km² to 99.89 km² while that of Keffi was 3.77 km² to 9.13 km². This established that about 16.68% and 58.71% growth within the years under study is witnessed in Abuja and Keffi respectively. The portion of Abuja that is within the study area grew from 99.89 km² in 2007 to about 158.07 km² in 2013, while Keffi

grew from 9.13 km² to 22.36 km² within the same range of 2007 to 2013. This implies that the portion of the study area in Abuja grew at an average of 9.70% per annum while that of Keffi was at 2.21%. This result revealed that rate of growth in Abuja between 2007 to 2013 has surpasses that of 2001 to 2007 while there was decline in the growth of Keffi between those years compared to Abuja. This corresponds to the finds most researcher that urban areas of developing countries are growing more than the smaller towns.

Table 2: Showing the attributed change within the developmental corridor under study.

Settlements	2001	2007	2013	Ch 2001-2007	% Ch 2001-2007	Ch 2007-2013	% Ch 2007-2013
1. Keffi	3.77	9.13	22.36	5.36	58.71	13.23	59.17
2. X1	0.10	0.14	0.42	0.04	28.57	0.28	66.67
3. X2	0.02	0.04	0.13	0.02	50.00	0.09	69.23
4. Uko	0.08	0.15	0.95	0.07	46.67	0.08	84.21
5. Gora	0.05	0.14	0.45	0.09	64.29	0.31	68.89
6. X3	0.00	0.04	0.45	0.04	100.00	0.41	91.11
7. X4	0.00	0.13	0.42	0.13	100.00	0.29	69.05
8. X5	0.21	0.27	0.66	0.06	22.22	0.39	59.09
9. X6	0.18	0.42	0.87	0.24	57.14	0.45	51.72
10. Uko	0.09	0.28	0.98	0.19	67.86	0.70	71.43
11. New Nyanya	0.33	0.82	3.33	0.49	59.76	2.51	75.38
12. X7	0.00	0.63	2.08	0.63	100.00	1.45	69.71
13. X8	0.00	0.00	1.25	0.00	0.00	1.25	100.00
14. Jikwai	0.65	1.18	5.16	0.53	44.92	3.98	77.13
15. Karu/Nyany	33.89	43.68	76.46	9.79	22.41	32.78	42.87
16. Abuja	83.23	99.89	158.07	16.66	16.68	58.18	36.81

*Names of settlements represented by X1 to X8 could not be found on the Google map.

The study further revealed that the settlement with the minimum growth in the study area between 2001 and 2007 was 16.68% while 67.86% was the maximum growth within the year. Between 2007 to 2013, the settlement with the minimum growth grew at the rate of 36.81% while the maximum growth was 91.11%. The result of the findings also revealed that the average growth of settlement under study between 2001 and 2007 was 44.93% while 65.99% was recorded between 2007 to 2013. The study further revealed that about 58.33% of the settlements in the study area were growing above the average growth rate between 2001 and 2007 while 62.50% of the settlements were discovered to be growing above the average growth between 2007 and 2013. (See Table 3).

<i>Minimum Growth Rate</i>	16.68 %	36.81 %
<i>Maximum Growth Rate</i>	67.86 %	91.11 %
<i>Average Growth Rate</i>	44.93 %	65.99 %
<i>Above Average Growth Rate</i>	58.33 %	62.50 %
<i>Number of new settlement</i>	5	1

Table 3: Analysis of the growth along the development corridor.

2001-2007	2007-2013
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The pattern of growth within the study area.

The study further revealed that the settlements within the study area were growing in a linear direction on the Abuja-Keffi road. This pattern was presented Fig. 8, Fig. 9, Fig. 10 and Fig. 11.

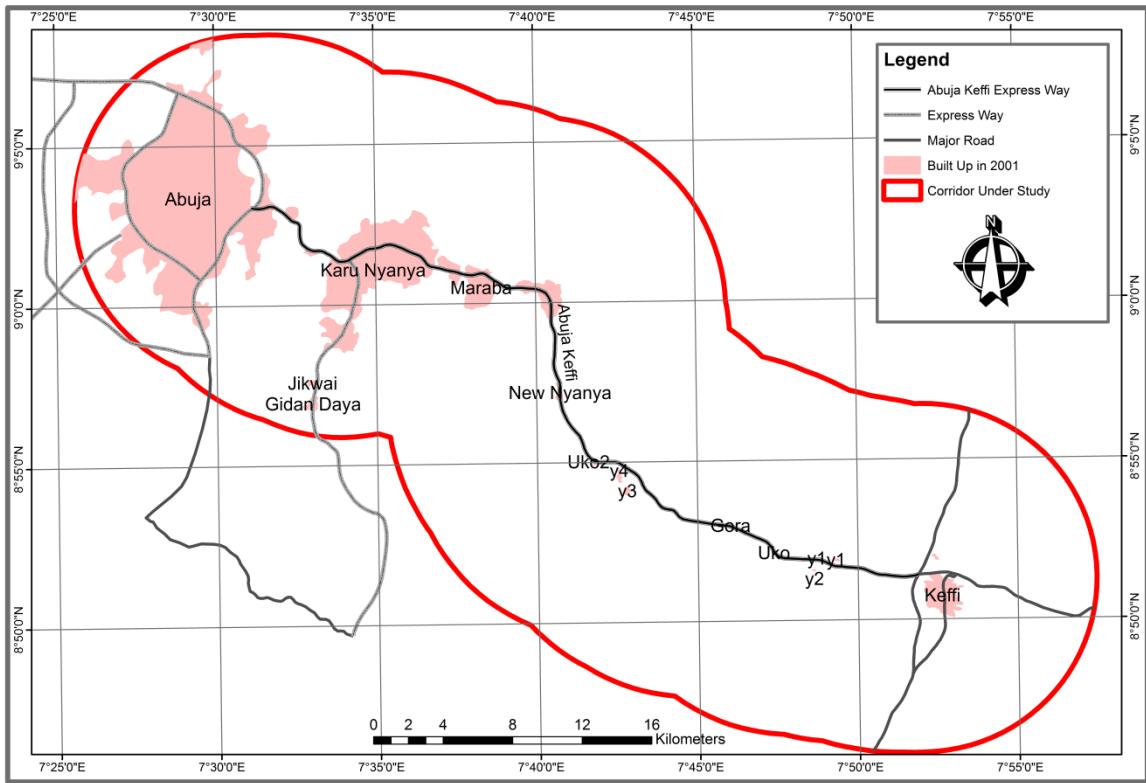


Fig. 8: Built Up area along the developmental corridor in 2001

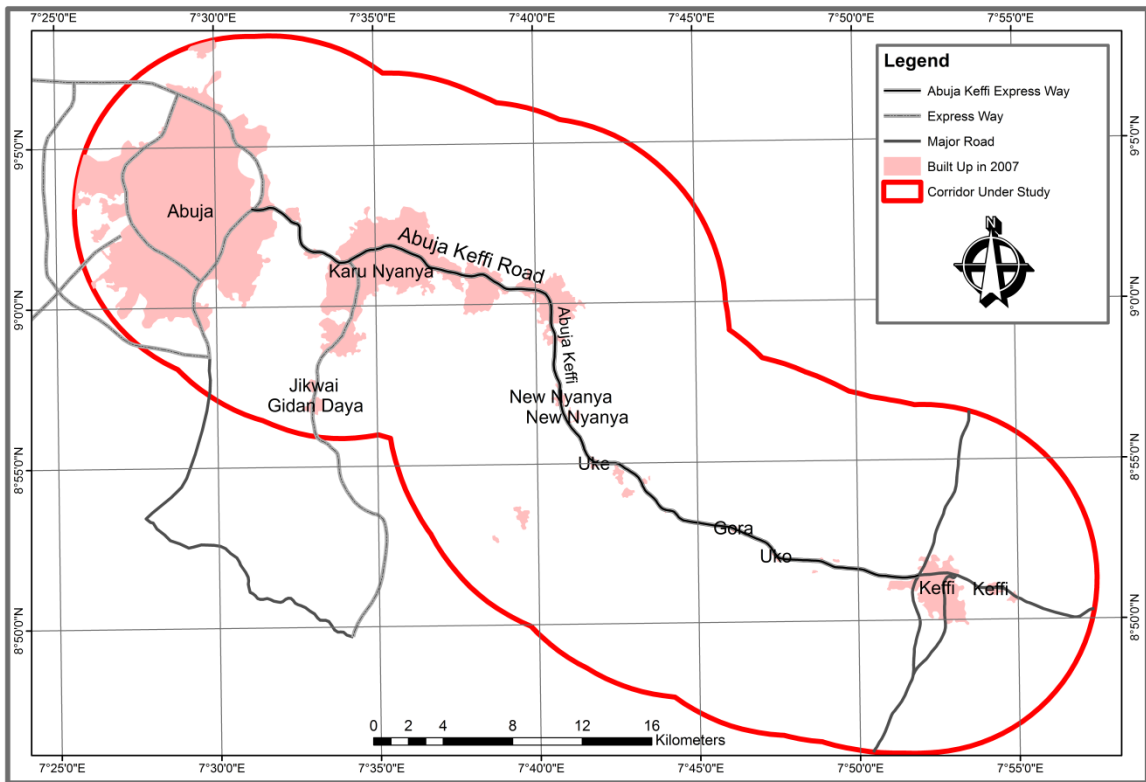


Fig. 9: Built Up area along the developmental corridor in 2007

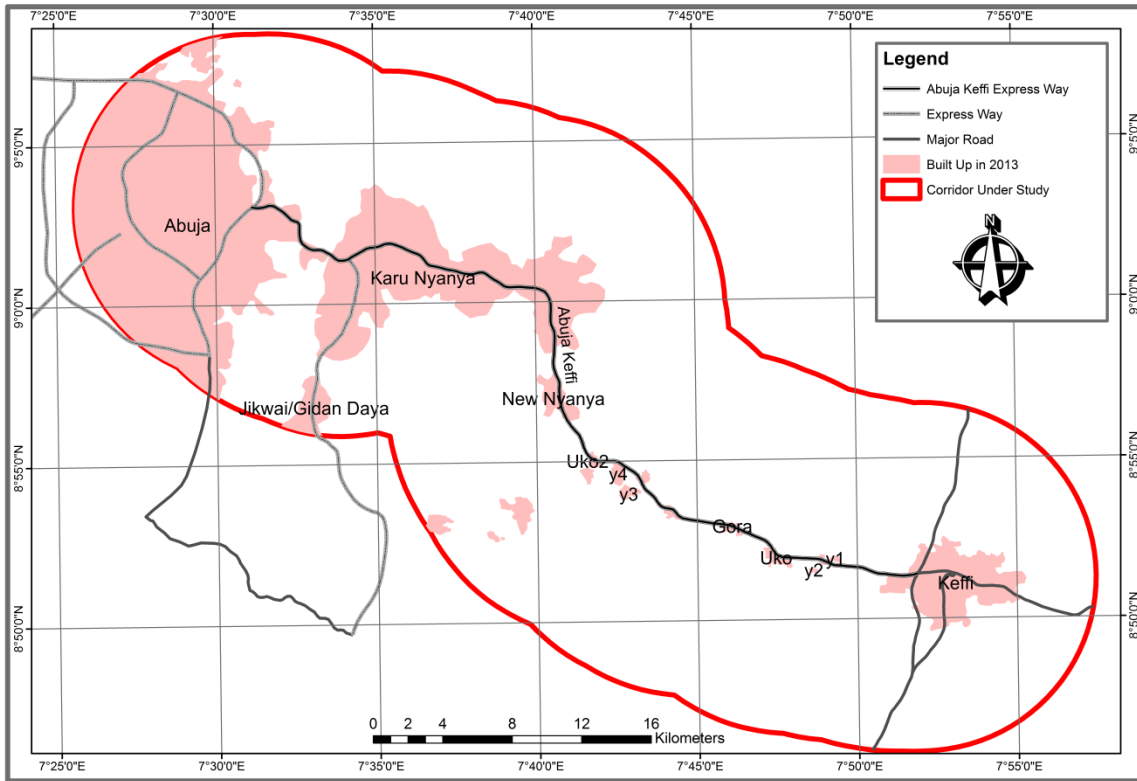


Fig. 10: Built Up

area along the developmental corridor in 2013.

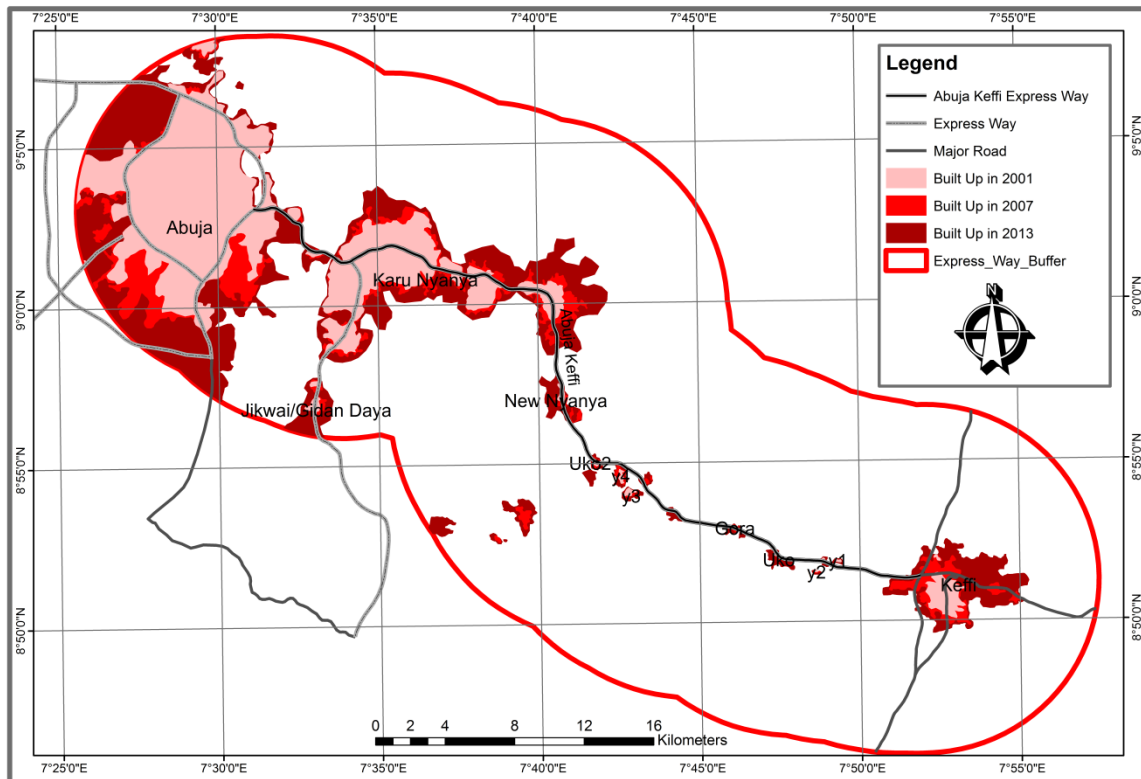


Fig. 11: Overlay of the built up areas along the developmental corridor for 2001, 2007 and 2013.

The study also revealed that the minimum and maximum distance between settlements along the corridor under study in 2001 is 0.21 km and 8.96 km. It was also revealed that in 2013, the minimum and maximum distanced reduced to 0.08 km and 3.57 km respectively. It was further discovered that the average distance between settlements along the developmental corridors also reduced from 2.72 in 2001 to 1.78 in 2013.

The study also discovered that in 2001, 32.68 km out of the 50.78 km corridor was not developed but as of 2007 and 2013, only 27.32 km and 17.76 km along the corridor remain un-built. The study also discovered that the standard deviation of the distance between settlements along the corridor was reducing. This signifies that the distance within settlement is more clustered around the mean in 2013 compared to the other years. The result of the study also shows that the number of nuclear settlements in 2001 was 12 in while 14 and 10 were recorded in 2007 and 2013. This revealed that between 2001 and 2007, 2 new settlements were added to the stock while in 2013, 8 settlements were merged together. (See table 4. and Fig 11)

Table 4: Distance between settlements along Abuja-Keffi Road

	2001	2007	2013
<i>Minimum Distance</i>	0.21 km	0.12 km	0.08 km
<i>Maximum Distance</i>	8.96 km	5.12 km	3.57 km
<i>Average Distance</i>	2.72 km	1.95 km	1.78 km
<i>Sum of Distance</i>	32.68 km	27.32 km	17.76 km
<i>Number of Settlement</i>	12	14	10
<i>Standard Deviation</i>	2561.42	1331.39	992.21

A view of the map on Fig. 11, revealed that most of the settlements between Abuja and New Nyanya have already merger. Indeed, a visible demarcation between these settlements is very difficult to identify. On the other land, the major land uses around the Keffi axis of the study area were dominated by agricultural land uses and undeveloped institutional land uses. This justifies while there were undeveloped areas in the Keffi axis of the study area. Another reason for the undeveloped areas along the Keffi axis could be attributed to land reservation either for future development or the activities of land speculators. One major implication of this conurbation is the traffic bottle neck witnessed along the corridor during the hours of 6 am to 9 am in the morning and 4 pm to around 9 pm in the evenings. The major reasons for this development were the result of the large FCT worker whom could not be accommodated within the FCT either due to high cost of rent or housing shortage.

V. SUMMARY OF FINDINGS

The study using the technique of Remote Sensing and Geographic Information System had revealed the spatial dynamic

of settlement along the Abuja-Keffi developmental corridors within the last 12 years understudy. The study was carried out using three multi-data satellite images of 2001, 2007 and 2013. The study revealed that the study year between 2007 to 2013 witnessed a high average growth rate of 65.99% compared to between 2001 and 2007. It was also revealed that about 8 settlements merged between 2001 to 2013. It was also discovered that the sum of undeveloped land between the Abuja and Keffi was around 32.68 km in 2001 but reduced to 17.76 km in 2013 with the average between settlements reducing from 2.72 km to 1.78 km respectively. This study concluded that the level of urban conurbation along the Abuja-Keffi developmental corridor moving at a faster rate than expected. However, the activities of land speculator and that of open space related uses prevented the corridor from merging to a single unit.

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