Assessment of Landuse and Landcover Change in Trans-Amadi: Rivers State, using Geographic Information System (GIS)

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Abstract
The landuse and landcover changes over Trans-Amadi for twenty-five years period were analyzed using Landsat (TM) imageries and Landsat (ETM) imageries. The landuse and landcovers were classified into vegetation, water bodies, swamp, farmland, forest and built area. The result of the study revealed that the period between 1990 and 2015 witnessed both reduction and appreciable increase in landuse and landcover types. Whereas swamp forest, farmland and water bodies witnessed reduction, built area and sparse vegetation have experienced an appreciable increase. Based on these, the following recommendations are put forward to check the negative consequences that characterize unguided landuse and landcover change. Key among these recommendations is for the government to put in place an efficient urban planning such as planned layouts, development control and other regulatory mechanisms.

Introduction

Balogun *et al.* (2011), urban populations in most developing countries have grown by 40% between 1900 and 1975. This trend the authors assert will add about 2 billion persons to the urban population of today's third world countries for the next three decades. In line with this Appiah, (2015) and Owoeye and Ibitoye (2016) observed that the world is becoming increasingly urbanized with 45% of the population already living in the urban areas in the year 2000. They projected that half of the world population living in urban areas by 2007. It was further estimated that by the year 2025, 60% of the world's population will live in cities (UNPF, 1999).

The rate of urbanization has an effect on land use and land cover change thus causing space needed for agricultural development to undergo constant rapid transformation; with land coming under increasingly intense pressure through construction to provide space for array of urban land use (Ujoh *et al*. 2010).
In other words, a lot of environmental challenges have arisen in recent time due to land use and land cover changes (Mmom and Fred-Nwagwu, 2013).

Material and Methods

The study was conducted October 2017 .This study was conducted in Trans-Amadi Industrial Layout, Rivers state, located in the humid tropics, of the southern part of Nigeria. It lies approximately between Latitude 4^{o} 48^{I} 55^{II} North and Longitude 7^{o} 02^{I} 14^{II}East. Trans-Amadi lies in the north and is bordered by D/line in the southwest, Woji Township to the east and Rumuola to the northwest, all in Obio/Akpor L.G.A.

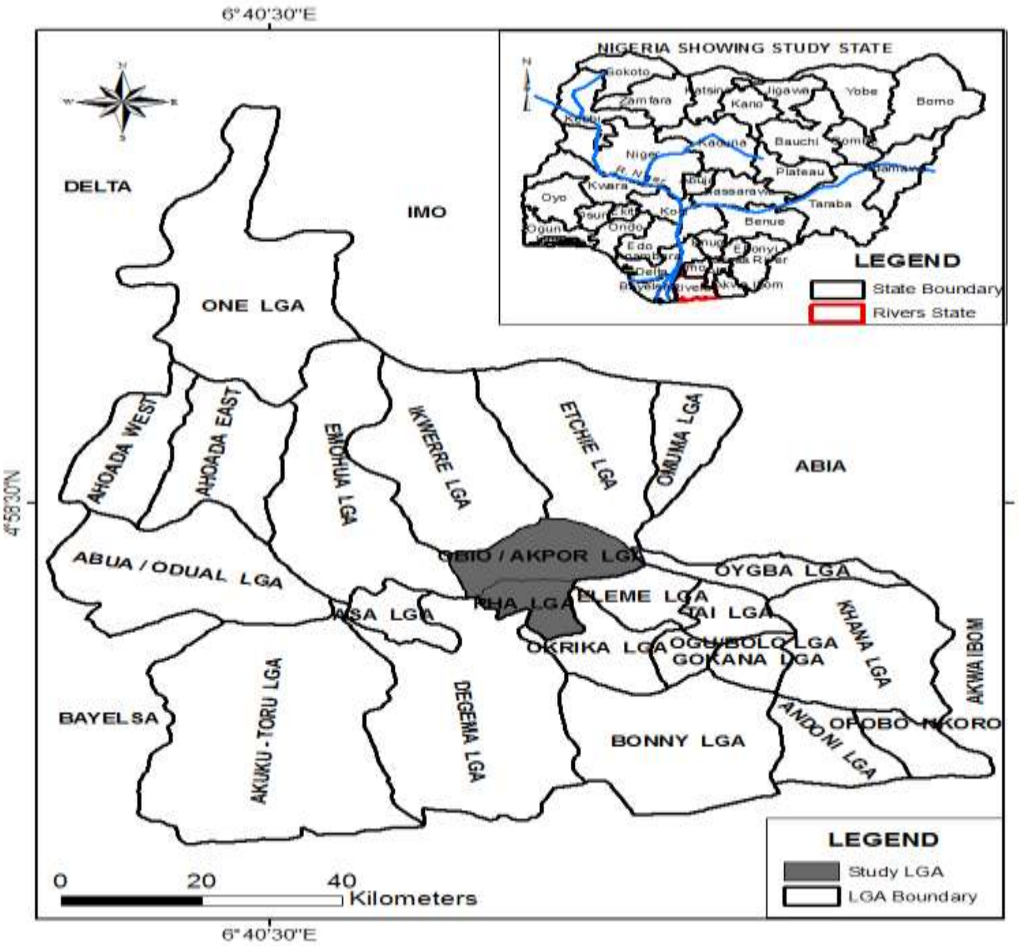

Fig.1
Map of Rivers State Showing study area
Source: Rivers state Ministry of Lands and Survey

In terms of elevation, Trans-Amadi Industrial Layout can be classified as lowland, as it has an average elevation of 10m above sea level. Thus the terrain is generally flat (Wokocha, C.C *et al* 2011)This is so as the area falls within the coastal belt dominated by low lying coastal plain sands (Wokocha, C.C *et al* 2011). The Amadi and Rose creeks drain the area and flow in southeast direction into the Bonny River. These creeks are characterized by fluctuation in volume of water during the seasons of the year. They also have a narrow and shallow waterway in which vast quantities of alluvial materials are deposited (Wokocha, C.C *et al* 2011).

Rainfall in Trans-Amadi Industrial Layout is heavy and more persistent (Osuiwu and Ologunorisa, 1999). Her monthly rainfall is almost predictable and follows a sequence of increase towards the months of July - August before decreasing in the months of November - February. Rainfall in Trans-Amadi Industrial Layout is at its peak in July and September with little dry season occurring in August. Like Port Harcourt, her heaviest rainfall occurs during September with a mean rainfall of about 367mm. On the average, December is the driest month of the year, with a mean rainfall of about 20mm (Garba, *et al* 2013).

Remote sensing is the science and to some extent, the art of acquiring information about the earth surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing and applying that information. The collection of remotely sensed data facilitates the analysis of the earth system, function, patterning and changes in local, regional and global scale over time. Remote sensing becomes useful because it provides synoptic view and multi- temporal land use and land cover data that are often required, serves as tool for environmental resources assessment and monitoring (Garba, *et al* 2013).

Geographic information system (GIS) is a computer assisted system for the acquisition, storage, analysis, and display of geographic data. It is a computerized tool for performing operations on geographic data with a view to reveal what is otherwise invisible in geographic information (Ukor, C. D *et al* 2016).GIS allows for the integration of data for different topics and from various sources, time dimensions, scales and fronts, (Uluocha, 2006). The power of a GIS lies in its ability to bring both spatial and attribute data within a common framework to form a unified database system; and its ability to compare different entities based on their common geographic occurrence through the overlay process.

Data (primary), for this study was mainly sourced directly from field observations (ground trothing), to confirm the features on the map and satellite images to use. Also some data (secondary), was sourced from textbooks, journals, periodicals, magazines, gazette and other publications. Satellite images of Trans-Amadi were also used in the course of the study.

(a) Data Collection:
Reconnaissance survey of Trans-Amadi was undertaken before commencement of the study. Coordinate reading of points within the study area were undertaken. These were acquired using a hand held Global Positioning System (GPS).The coordinates tracked by this device will include: longitude, latitude and elevation. This was done to ensure that the features on the satellite images actually exist on ground.

(b) Land TM (Thermatic mapper) imageries of 1990 and 2015, which both had spatial resolution of 60 meters, that is each pixel represent an area on the earth surface 60m ×60m was used. It also has an orbital altitude of 800 kilometers. The Landsat TM is an active sensor and has enough energy to penetrate soil for as much as 1m. The imageries cover the entire study area.

Software Used for Remote Sensing Analysis
Software used is

- **(a)** Arc view 3.3 – this was used to display, process and enhance the image used. It was also used for carving out Obio/Akpo L.G.A and subsequently Trans-Amadi from of Rivers state satellite images.

Results and Discussion:
GIS and remote sensing techniques were used in change detection in the study area. The study area was compared between the years of 1990, 1995, 2000, 2005, 2010 and 2015. In other words, the comparison of land use and land cover assisted in identifying the percentage change, trend and the rate of changes between 1990 and 2015. In achieving this, the land area was measured against each land use and land cover type.

Classes of land use and land cover were delineated on the basis of supervised classification. This is presented as follows:

Table 1: Landuse and landcover classification scheme

Landuse/ Landcover	Distribution
Vegetation	Lawns, shrubs, orchards and other ornamental trees
Water Bodies	River, permanent open water, lakes, ponds, canals and reservoirs
Swamp	Lands that are water logged
Farm land	The land which is mainly used for growing food crops. It include: crop fields and fallow lands
Forest	This describes the areas with evergreen trees mainly growing naturally.
Built Areas	All residential, commercial and industrial areas, settlements and transportation infrastructure

Source: Researcher's classification (2017).

Landuse and land cover were delineated into six distinct classes namely: vegetation, water bodies, swamp, farmland, forest and built area.

Landuse and Landcover Change Distribution:

The result of landuse and landcover change distribution over Trans-Amadi is presented as follows:

Table 2: Landuse and Landcover Change (1990-2015):

Land use/ Land cover	1990		1995		2000		2005		2010		2015	
	Area M^2	% Area	Area M^2	% Area	Area M^2	% Area	Area M^2	% Area	Area M^2	% Area	Area M^2	% Area
Vegetation	28932	11.60	30069	12.03	32682	13.07	35310	14.12	37209	14.88	39032	15.60
Water Bodies	39267	15.70	35039	14.02	33987	13.59	31996	12.79	30213	12.10	28979	11.59
Swamp	50692	20.30	48996	19.60	43602	17.44	42682	17.10	40968	16.39	38975	15.59
Farm land	43189	17.28	42872	17.15	40096	16.04	39872	15.95	37998	15.20	37023	14.81
Forest	45392	18.16	42347	16.94	41010	16.4	40009	16.00	38972	15.59	38147	15.21
Built Areas	42528	17.00	50677	20.27	58623	23.45	60131	24.05	64640	25.86	67844	27.14
Total	250000		250000		250000		250000		250000		250000	

Source: Researcher's computation (2017).

Table 2 shows that sparse vegetation covered a total area of 28932m^{2,} (11.60%) in 1990. It increased to 30069m^2 (12.03%) in 1995.In the year 2000 the total area occupied by sparse vegetation increased again to 32682m^2 (13.07%). It also increased to 35310m^2 (14.12%) in

2005. By the year 2010 total area occupied by sparse vegetation increased to 37209m^2 (14.88%). In 2015, the land area occupied by sparse vegetation stood at 39032m^2 (15.60%). This increase in vegetation could be accounted for by increase in lawn, parks, shrubs orchard and other ornaments.

In 1990 land area occupied by water bodies was 39267m^2 (15.7%). It decreased to 35039m^2 (14.02%) in 1995. It further decreased to 33987m^2 (13.59%) in 2000. By 2005, land area occupied by water bodies decreased to 31996m^2 (12.75%). It further decreased to 30213m^2 (12.10%) in 2010. By 2015 the land area occupied by water bodies decreased to at 28979m^2 (11.59%). The decrease in water bodies could be caused by climate change and global warming where water bodies are been dried up leaving dry lands.

Swamp occupied 50692m^{2}area (20.30%) in 1990, decreasing to 48996m^2 (19.60%) in 1995 and further decreased to 43602m^2 (17.44%) in 2000. Again there was a decrease to 42682m^2 (17.10%) in 2005 and 40968m^2 (16.39%) in 2010 and a decrease to 38975m^2 (15.59%) in 2015. This decrease can be said to be caused by an increase in urbanization and industrialization in the study area, where lands are sand filled and used in the construction of industries, buildings, paved roads, and other amenities.

Farmland occupied a total area of 43189m^2 (17.28%) in 1990. Reducing to 42872m^2 (17.15%) in 1995 and by the year 2000 farmlands had occupied a total area of about 40096m^2 (16.04%). There was a reduction to 39872m^2 (15.95%) in 2005 and by 2010 farmlands occupied an area of about 37998m^2 (15.20%). In 2015 the land area occupied by farmland stood at 37023m^2(14.81%). This was simply caused by the conversion of farm lands to build up areas, paved roads and industrial buildings.

In 1990 land area occupied by forest was 45392m^2 (18.16%), which reduced to 42347m^2 (16.94%) in 1995 and 41010m^2 (16.40%) in 2000. By 2005, forest occupied a land area of 40009m^2 (16.00%) and further decreased to 38972m^2 (15.59%) in 2010 and 38147m^2 (15.21%) in 2015. This was as a result of deforestation, where forest covers were removed and land used for urbanization and industrialization, buildings as well as roads.

Built up areas covered a total area of 42528m^2 (17.00%) in 1990 and increased to 50677m^2 (20.27%) in 1995. In 2000 built up areas increased to 58623m^2 (23.45%). It further increased to 60131m^2 (24.05%) in 2005. In 2010 built up areas occupied a total area of 64640m2(25.86%), increasing further to 67844m^2(27.14%) in2015.This changes occurred as a result of urbanization as well as industrialization.

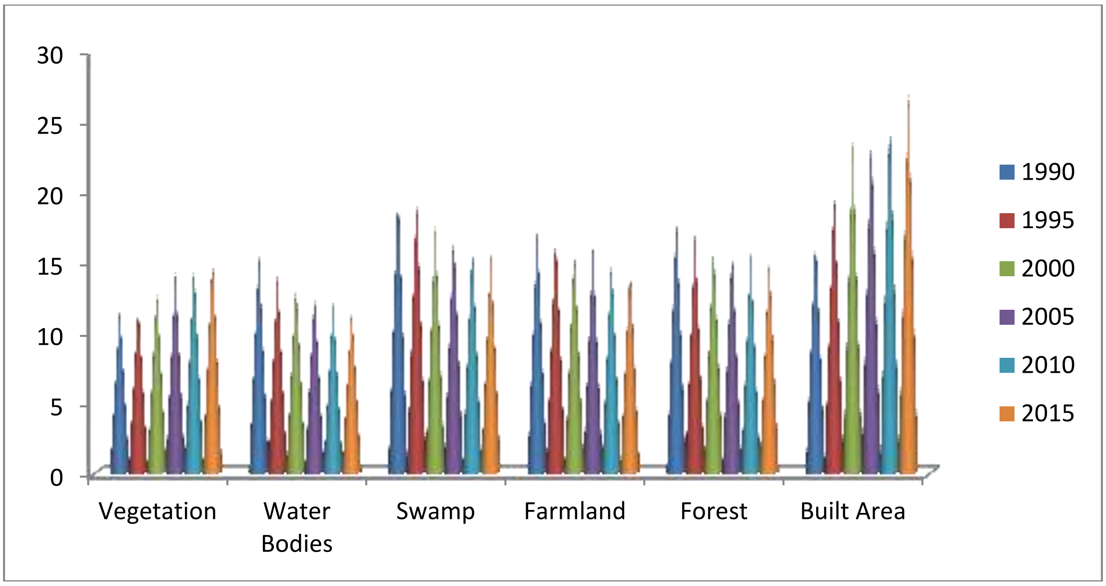

Fig 2: Land use Dynamics 1990-2015:

Note :(%) values on the left corner of the graph.

The land use and land cover distribution for 1990 and 2015 are shown in Fig. 2 and Fig. 3

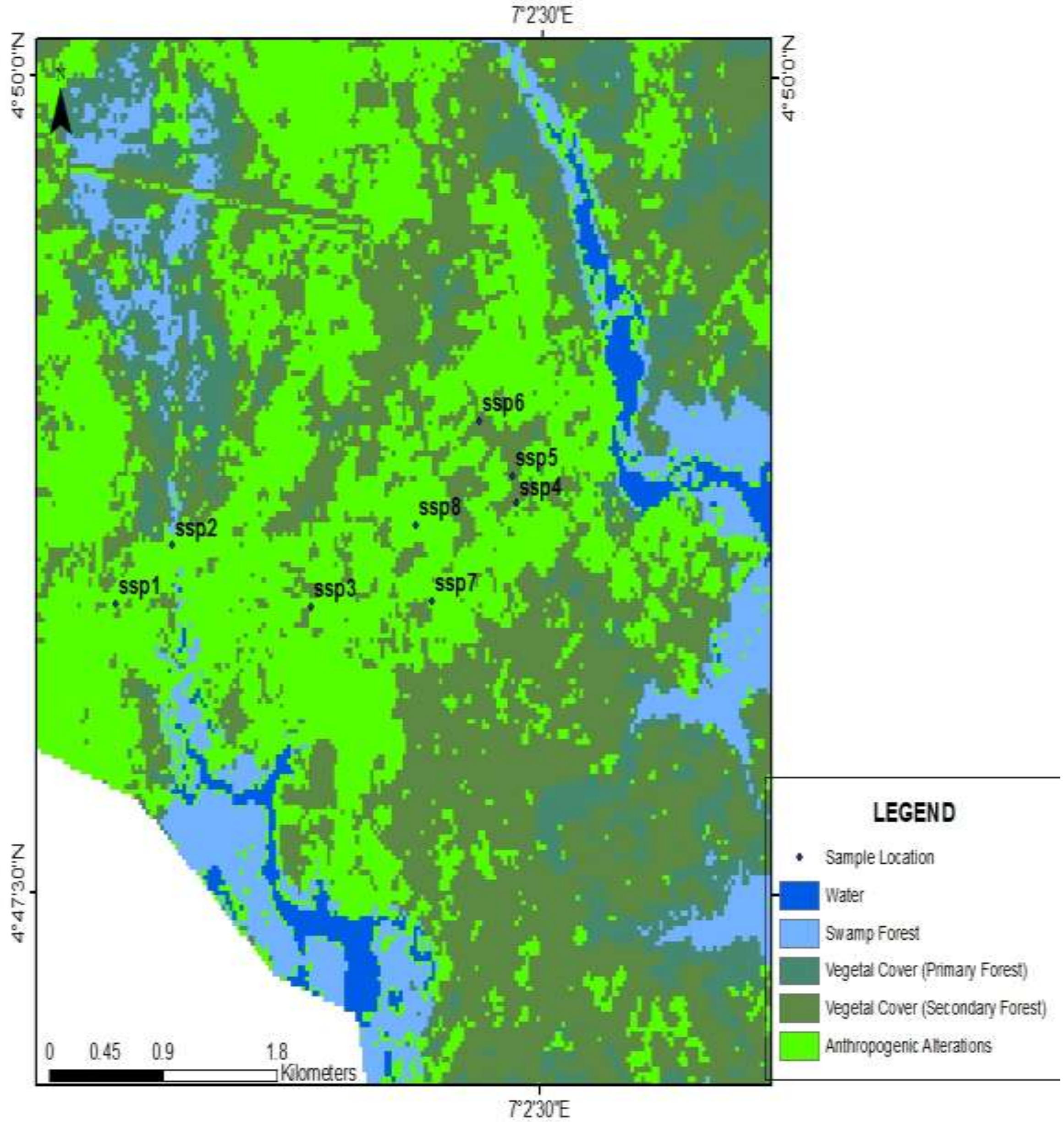

Figure 3: Land use and Land cover change of Trans-Amadi (1990)
Source: Satellite Imagery from the Department of Geography and Environmental Management, University of Port Harcourt

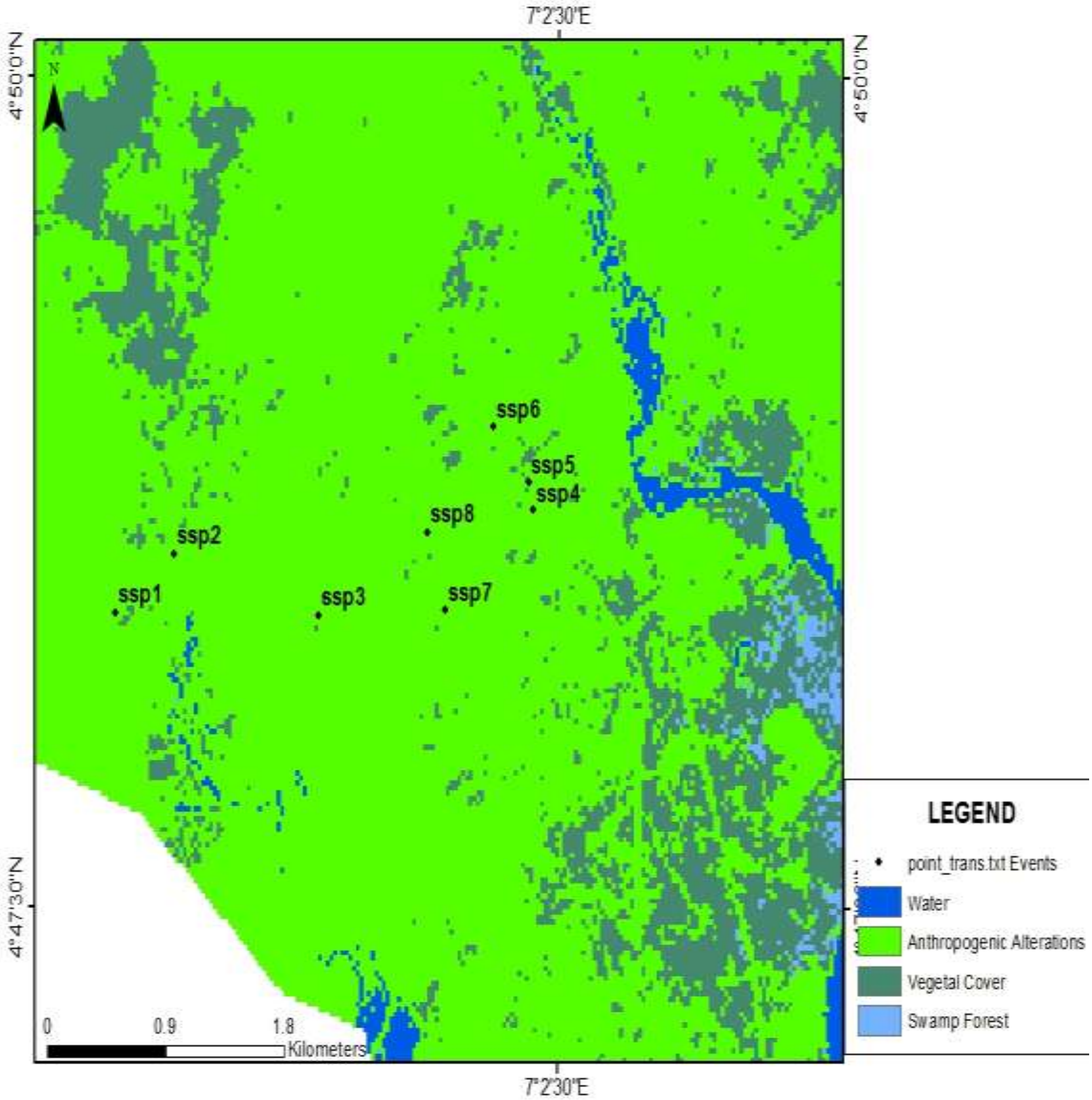

Figure 4: Land use and Land cover change of Trans-Amadi (2015)
Source: Satellite Imagery from the Department of Geography and Environmental Management, University of Port Harcourt

Table 3: Shows trend changes in landuse/landcover in Trans-Amadi:

Landuse/ Landcover	Trend change in Area (m^2)				
	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Vegetation	1137	2613	2628	1899	1823
Water Bodies	-4228	-1052	-1991	-1783	-1234
Swamp	-1696	-5394	-920	-1714	-1993
Farm land	-317	-2776	-224	-1874	-975
Forest	-3045	-1337	-1001	-1037	-825
Built Areas	8149	7946	1508	4509	3204

Table 3: Trend Changes:
Source: Researcher's computation (2017).

From the table above, vegetation other than forest and swamp forest recorded a change of 1137m^2 in 1990 and 1995.Though from 1995 and 2000, the changed area was recorded as 2613m^2 of the total study area. 2000 and 2005 saw changes to 2628m^2 while between 2005 and 2010 a change of 1899m^2 of was recorded. Change continued till 2010 and 2015 which led to a change of 1823m^2 of the total study area.

Water bodies in the study area were seen to have reduced within the twenty five years period of this study. Between 1990 and 1995, a change of -4228m^2 was observed. The five years period between1995 to 2000 recorded a decrease of -1052m^2 in the study area Reduction in water bodies was also recorded between 2000 and 2005. This period recorded a decrease of -1991m^2 while the period between 2005 and 2010 recorded a change of -1783m^2. This same scenario occurred between 2010 and 2015, where a decrease of -1234m^2 was recorded. This was caused by increased land reclamation activities within the study area.
Swampy areas decreased by -1696m^2 between 1990 and 1995, -5394m^2 between1995 and 2000, and -920m^2 between2000 and 2005, while between 2005 and 2010, swamp recorded decreased area of -1714m^2. This was the same between 2010 and 2015. This period saw swamp forest declining by -1993m^2. An attribute given to numerous land reclamation activities in the study area.

Farmland areas reduced by -317m^2, -2776m^2, -224m^2, -1874m^2, -975m^2 simultaneously in, 1990-1995, 1995-2000, 2000-2005, 2005-2010 and 2010-2015 respectively. Farmland recorded a great reduction because Trans-Amadi by virtue of its location is situated in an urban center, thus farming activities were not predominant.
Like swamp and water bodies and farmland, land use and land cover type identified as forest also recorded reductions over the period of study. 1990 and 1995 saw a decrease of -3045m^2; the second period (1995-2000) recorded a change of -1337m^2; .2000-2005 recorded a change

of -1001m^2; In 2005-2010 experienced a change of -1037m^2 while,2010-2015, recorded a change of -825m^2. The decrease in forest land cover is also attributed to the continuous conversion of forest to built-up environment.
Built-up area recorded a large increase of 8149m^2 change between 1990 and 1995. 1995 and 2000, witnessed a change of 7946m^2 was observed. Between 2000 and 2005 an incremental change of 1508m^2 in built areas was recorded. There was an increase in this land use type to 4509m^2 between 2005 and 2010 while the five years period of 2010 to 2015 saw an increase of built area to about 3204m^2.

Fig 2 shows trend change in area:

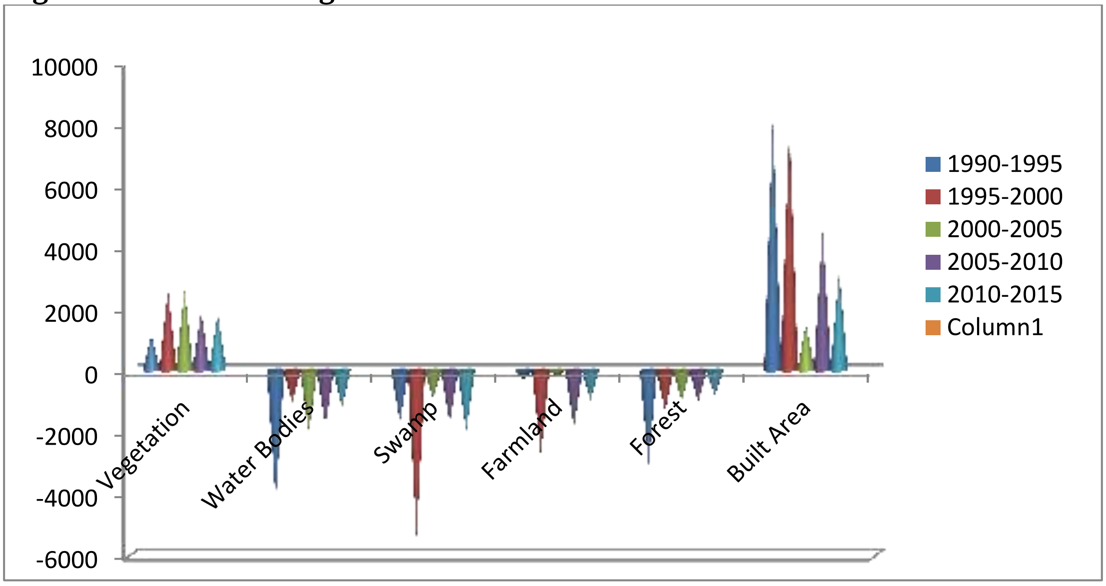

Fig. 5: Trend Change in Area
Note: (M^2) values on the left side of the graph

Assessment of Trend Change in Percentage
Table 4 shows trend changes in trend change in percentage over Trans-Amadi.

Table 4: Trend Change in Percentage

Landuse/ Landcover	Trend Change in Percentage (%)				
	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Vegetation	3.93%	8.69%	8.04%	5.38%	4.90%
Water Bodies	-10.77%	-3.00%	-3.50%	-5.57%	-4.08%
Swamp	-3.35%	-11.01%	-2.11%	-4.02%	-4.86%
Farm land	-0.73%	-6.48%	-0.56%	-4.70%	-2.57%
Forest	-6.17%	-3.16%	-2.44%	-2.59%	-2.12%
Built Areas	19.16%	15.68%	2.57%	7.50%	4.96%

Source: Researcher's computation (2017)

Sparse vegetation accounted for 3.93% in 1990-1995 in the study area as shown above. This increased to 8.69% in 1995-2000 and in 2000-2005, there was an increase by 8.04% while .38% was recorded in 2005 and 2010. A change in 2010-2015 was recorded at 4.90%.
Water bodies recorded a change of -10.77% between 1990 and 1995. While 1995 and 2000 saw changes of up to -3.00% . 2000 and 2005 had a -3.50% change 2005 to 2010 witnessed a -5.57% change while, the periods 2010 to 2015 recorded a change of -4.08%. This meant that water bodies were being filled up by sand and concrete and built on as well as has been reduced due to global warming.

There were changes in swamps of the study area between 1990 and 1995 to -3.35%. In 1995 to 2000 percentage change detected was -11.01%. Between 2000 and 2005 there was a -2.11% change while between 2005-2010 a change of -4.02% was detected. A -4.86% change was recorded between 2010-2015.These changes were all due to expanded urbanization and industrialization.

Change trend of farmland in 1990 to 1995 was -0.73%. There was a further reduction between 1995 to 2000 to -6.48%.. Farmland increased to -0.56% between 2000 and 2005 and -4.70% in 2005 to 2010. Swamp area noted a change of -2.57% between 2010 and 2015.
Between 1990-1995 forest experienced change of -6.71%;change in 1995 to 2000 was -3.16%; ,changes in 2000-2005 was -2.44%; while 2005-2010, also recorded a change of -2.59% while 2010 to 2015 experienced a change of -2.12%. This indicated massive deforestation due to industrialization and urbanization in the study area.

Built area recorded a high changes in the entire study period.

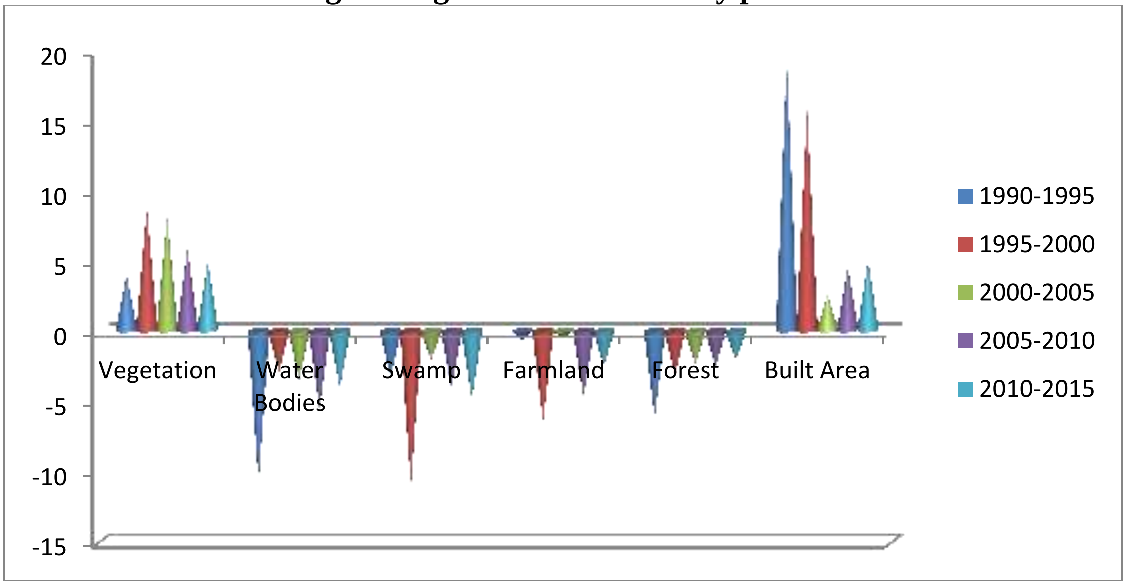

Fig. 6: Trend Change in Percentage

5: Assessment of five years Rate of Change

Table 5 Shows five years rate of change of landuse and landcover over Trans-Amadi.

Table: Five years rate of change (1990-2015)

Landuse/ Landcover	Five Years Rate Change in Area (m^2)				
	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Vegetation	227.4	462.6	525.6	379.8	364.6
Water Bodies	-845.6	-210.4	-398.2	-356.6	-246.8
Swamp	-339.2	-1078.8	-184.0	-342.8	-398.6
Farm land	-63.4	-555.2	-44.8	-374.8	-195.0
Forest	-609.0	-267.4	-200.2	-207.4	-165.0
Built Areas	1629.8	1589.2	301.6	901.8	640.8

Source: Researcher's computation (2017)

Table 5 shows five years rate of change for land use and land cover over Trans-Amadi. Between 1990 and 1995 annual rate of change for sparse vegetation was 227.4m^2 which increased to 462.6m^2 between 1995 and 2000, and 525.6m^2 between 2000 and 2005. In 2005 and 2010 change for sparse vegetation was 379.8m2 and 364.6m^2 between 2010 and 2015.

Between 1990-1995 water had a change index of -845.6m^2, while between 1995 and 2000 the change rate was -210.4m^2 .In between the years 2000 and 2005 change was detected at 98.2m^2. While between 2005 and 2010 annual rate of change for water bodies was -356.6m^2.Between 2010 and 2015 change was -246.8m^2. This shows differential increase in land use and land cover changes over the trend period, and also shows the various rate of global warming which affect the amount of water bodies.

In 1990 to 1995 annual rate of change for swamp was -339.2m^2.While between 1995 and 2000 annual rate of change for swamp was -1078.8m^2 .In 2000 and 2005 annual rate of change for the same landuse/land cover type was -184.0m^2. 2005 to 2010 annual rate of change for swamp was -342.8m^2. In 2010 to 2015 annual rate of change for the same landuse/land cover type was -398.8m^2. The values shows that there is difference in the trends as most of the year witnessed less land reclamation activities, less land area was actually reclaimed for other land use type.

In the first period (1990-1995) farmland's annual rate of change was 63.4m^2. This decreased to 555.2m^2 in the second period (1995-2000). It was 44.8m^2 in the third period (2000-2005) and 374.8m^2in the fourth period (2000-2010). In the fifth period (2010-2015) farmland recorded an annual rate of change of 195.0m^2. This values shows that there is a significant difference in the trends as most of the years witnessed higher farmland changes into other landuse e.g. paved roads, building.

Between 1990 and 1995 annual rate of change for forest was -609.0m^2. In the second period (1995-2000) annual rate of change for forest stood at -267.4m^2 and -200.2m^2 in the third period (2000-2005). In the fourth period (2005-2010) annual rate of change for forest stood at -207.4m^{2}while in the fifth period (2010-2015) annual rate of change for forest stood at -165.0m^2. This changes in value shows a different of forest cover over the various trend periods where some trend period witnessed higher values than the other trend.

Unlike the last three landuse/land cover types, in the first period (1990-1995) built area recorded an annual rate of change of 1629.8m^2. Its annual rate of change in the second period (1995-2000) stood at 1589.2m^2 and 301.6m^2 in the third period (2000-2005). In the fourth period (2005-2010) built area recorded an annual rate of change of 901.8m^2. In the fifth period (2010-2015) annual rate of change for the same land use/landcover type was 640.8m^2. Fig. 4.4 shows the annual rate of change. This also shows a significant change in the various trends as the first period witnessed higher change as compared to other trends. This also shows that there was an increased urbanization within the said trend year than other trend year.

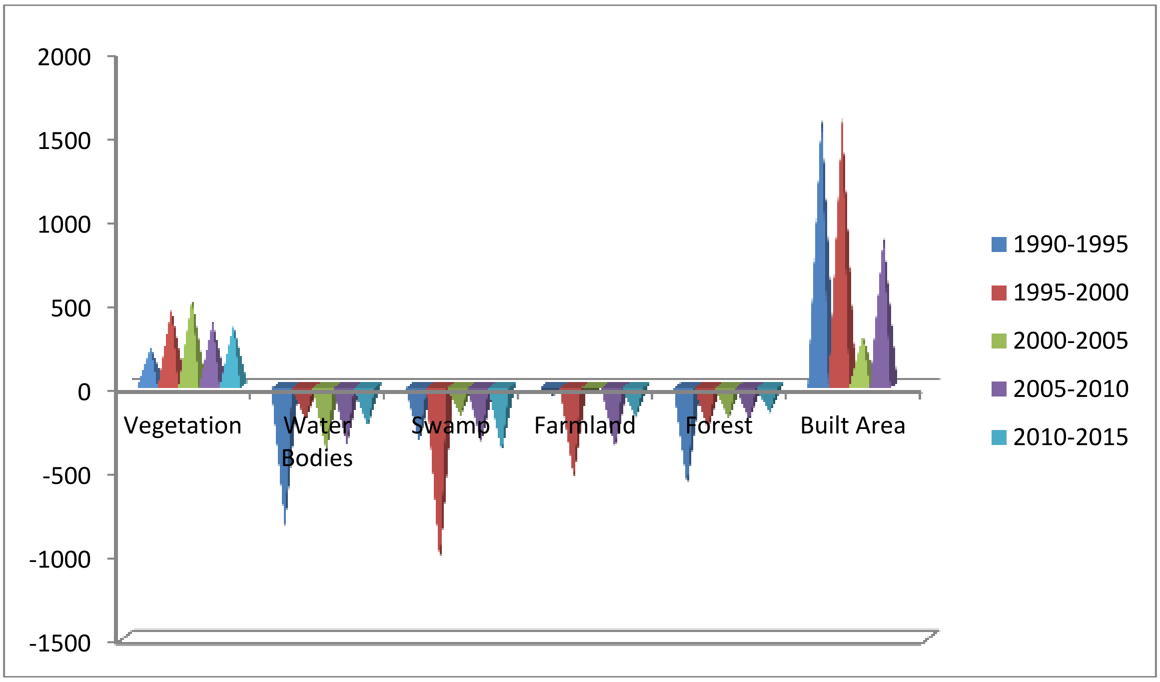

Fig. 7: Annual Rate of Change

Conclusion

From the findings, the following conclusion can be drawn: that Trans-Amadi before the period of increased urbanization had a less amount of buildup areas and a greater amount of swamps, farmlands, forest as a result of low urbanization. It can also be drawn that over the years that Trans-Amadi has experienced change in terms of landuse and landcover. Landuse and landcover types such as swamp forest, farmland and water bodies have experienced reduction while built-up area and sparse vegetation have experienced an appreciable increase. It can also be said that Trans-Amadi has experience a significant increase in population which is the major key to landuse and landcover changes in the study area. This increase in population in its own way triggered the reduction in other landuse pattern such as swamp, farmlands, forest to favor buildup areas of Trans-Amadi.

The use of remote sensing and GIS technology is a better way for decision making on complex issues related to the earth (land suitability) and the people living therein, such as agriculture, forestry, water resources planning, location analysis etc. In this study GIS and remote sensing technology were applied for decision making process in mapping the spatio-temporal changes in landuse and landcover over the study area (Trans-Amadi)

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