Spatial Assessment of Urban Growth in Selected Capital Cities of South-South Region of Nigeria

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Abstract: - The study assessed the urban growth in the selected capital cities (Asaba, Uyo and Port Harcourt) of South-south region of Nigeria. Landsat 5 TM of 1986, Landsat 7 ETM of 2000 and Landsat 8 OLI/TIRS of 30m x 30m were used and classified using supervised classification technique. The magnitude and trend of change and percentage change of landuse types were also determined. Findings revealed that in Port Harcourt, the built up area was 106.81 km^{2,} 176.62 km^2 and 205.89 km^2 in 1986, 2000 and 2020 respectively. In Uyo, built up area in 1986 was 37.89 km^2, and 46.89 km^2 in 2000 and 134.61 km^2 in 2020. However, in Asaba the built up area was 23.47 km^2, 38.03 km^2 and 65.08 km^2, in 1986, 2000 and 2020 respectively. Furthermore, the primary forest reduced drastically in the entire study area within the period of study. The study concluded that the selected capital cities in the South–south region has grown and expanded within 1986 and 2020. The study therefore recommended among others that enacting and implementation of government policy restraining individuals of illegal construction should be established, educating individuals on illegal acquisition of primary forest should be absolutely done; and periodic assessment of landuse change to discover the trend of change and to foresee the possible landuse change in future should be encouraged.

Key Words: — ***Urban, Growth, Sustainable, Capital, Landsat, Land use.***

I. INTRODUCTION

Urban development is imminent especially in a city with high expectation of expanding due to its function as an administrative area. As a result, the development has led to people from the built up area intruding to other landuse types but in different magnitude in a given time. Empirical studies of such that can lead to quantification of the affected of each landuse are highly needed in recent time with a view to using geo-information technologies. Land use and land cover change analysis is one of the most precise techniques to understand how land was used in the past, types of changes expected in the future as well as forces and processes behind the changes (Belay 2002, cited in Messay, 2011). The interaction between man and his environment have become increasingly complex and diverse especially in natural resource exploitation and development. Urbanization of the developing world began to accelerate in late twentieth century (Timberlake, 1987).

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In an urban environment, human induced environmental changes are of concern today because of deterioration of environment and the urbanization of the developing world began to accelerate in late twentieth century (Timberlake, 1987). One of the critical concern of the world today is on land use/land cover changes because of the adverse consequences they have on weather and climate, surface runoff in relation to erosion and flooding, ecological biodiversity, socio economic and health and the general state of environmental degradation. This is largely because landcover has considerable control on biophysical, biogeophysical, biogeochemical, hydro-meteorological processes (Abubakar et al, 2002).

The issue of landuse/land cover changes in world today is of critical concern because of the adverse consequences they have on weather and climate, surface runoff in relation to erosion and flooding, ecological biodiversity, socio-economic and health and the general state of environmental degradation. This is largely because landcover has considerable control on biophysical, bio-geophysical, biogeochemical, hydro-meteorological processes (Abubakar et al, 2002). In addition, land use and land cover emerged as an important issue on the international research agenda since 1970s, because of the concern for the impact of land use and land cover changes on regional and global climate (Woodwell et al. 1983; Houghton et al, 1985; Lambin et al. 2003) In addition, the effect is being extended to the loss of biodiversity due to deforestation which results to the decline in ecosystem integrity and affects hydrological processes, leading to flooding and soil erosion (FAO 2000b, Houghton, 1994, Millennium Ecosystem Assessment, 2005; UNEP 1999; Lambin, 1993; Stromph et al. 1994).

Land use and land cover is driven by a variety of socio-economic, political, cultural, technological and biophysical factors (Agarwal et al., 2002; Burgi et al., 2004; Lambin et al, 2003). Hence, drivers of the process include the physical attributes of the landscape such as topography (Pan et al, 1990; Silbernagel et al., 1997), land tenure (Southworth and Tucker, 2001; Turner et al, 1996), institutions and social services (Sernels and Lambin, 2001), water availability (Fox et al, 2003), the general socio-economic situation of households (Moram et al, 2003; Walker et al, 2002), or economic opportunities mitigated by institutions (Lambin et al, 2001).

Land use and land cover change have become a central component in current strategies in managing natural resources and monitoring environmental changes. Mmom (2008) noted that the land use and land cover of region is a reflection of the level of development in that region on the other hand, and the level of development influences land use and land cover of a region. Land cover is continually transformed by land use changes suggesting that land use is the cause of land cover change and the underlying demographic factor remain economic, technological and institutional (De Sherbiner, 2002). Land cover change is one of the most important variables of environmental change and represents the largest threat to ecological systems (Foody, 2003). The quest and strive toward industrialization, technological innovations and the drive to modernism have resulted to modification and change in landuse and landcover in a region. Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management, landuse mapping and planning. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system functions, patterning, and change at local, regional as well as at global scales over time (Lambin and Strahler, 1994; Lambin et al, 2001; Lambin et al, 2007). Such data provides an important link between intensive localized ecological researches, regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996). GIS is a valuable tool to better manage, interpret and maintain resources. It is a proven decision support system employing landcover change maps among other data resources that are major products created from remotely sensed data. Keeping track of change is important to our understanding of the earth as a system. Knowing about those changes is the first step towards understanding why and where they are happening. Change data can be used to update maps, and to estimate the rate of change in certain areas. As a result of technological advancements, changes of the earth's surface have become visible by satellite imagery and at such remote sensing and geographic information systems have become the most effective tool for assessing and monitoring all these changes (Deer, 1995). They are also vital in mapping the earth's features and infrastructures, managing natural resources and studying environmental change. GIS and remote sensing are powerful tools that have been widely used for monitoring and detection of land use and land cover change (Anderson *et al*., 2001; Musaoglu *et al*., 2002; Tardie and Congalton, 2002).

II. MATERIALS AND METHODS

The study was carried out in the selected capital cities of the South-South region of Nigeria (Figure 1). The selected States included Delta, Akwa Ibom and Rivers States in which their capital cities respectively area Asaba, Uyo and Port Harcourt. The area has been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. The major geological characteristic of the state is sedimentary alluvium. The entire state is formed by abandoned beach ridges and due to many tributaries of the River Niger in this plain, considerable geological changes still abound. The major soil types in the state are young, shallow, poorly drained soils and are acid sulphate soils. There are, however, variations; some soils occupy extensive areas whereas, some are of limited extent. The soil texture ranges from medium to fine grains. Like any other area in the Niger Delta, the vegetation in the South south region is composed of mangrove forests, freshwater swamp and lowland rain forests. These different vegetation is associated with the various soil units of the area. Generally, along the ridges above the tideline exists a vegetation of palms with scattered trees while mangroves dominate the water courses. The region is one of the areas with oil mineral and natural gas deposits. As a result, petroleum production is one of the sustaining economic activities in the region. The study area has a riverine setting and thus fishing is another occupation which is in vogue in the area. Agriculture or farming is another mainstay of the study area economy. Thus, another main occupation for the people is farming which involves planting of both annual crops like maize and perennial crops. In a similar development, raphia palm tapping and local gin distillery, lumbering, carving, hunting weaving and gathering of oil palm nuts and snails hunting are occupations in the area. The secondary occupations include trading, dressmaking, carpentry, gold smithing, food vending, bicycle and auto repairs. Therefore, the greatest potential for future industries in the study area lies in the fields of agriculture, fish processing and petro-chemicals.

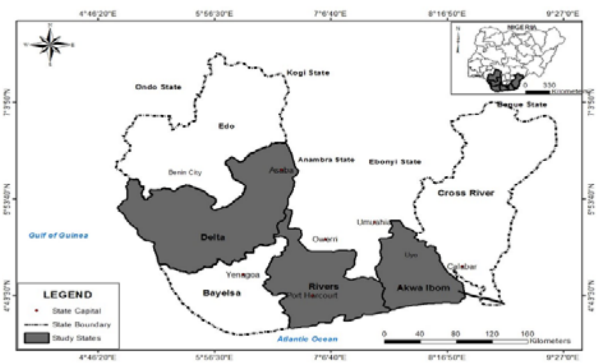

Fig.1. South-south Nigeria showing the Study Area States (NASRDA, 2020)

Reconnaissance survey was carried out to different communities in Uyo metropolis, Asaba Metropolis and Port Harcourt Metropolis. This gave an insight to familiar with different types of landuse in the area. The visit to the place thus assisted to ground truth the landuse types observed in the Landsat imagery. The ground-truthing was enhanced with the use of global positioning system (GPS) to determine the longitudes and latitudes of at least a location in each landuse type. This study employed the use of both primary data. The primary data included the use of landsat imagery of 1986, 2000 and 2020 to determine the landuse types of different periods. The landsat imageries were acquired from the United State Geological Survey (USGS) and the detail information of the imageries are shown in Table.1.

Composite analysis was carried out for the bands of each image in each period in order to produce a false composite imagery in ArcGIS 10.7 From the ground-truthing of the land use types in the area derived through reconnaissance survey, different landuse types were identified such as built up area, sparse vegetation/farmland, thick vegetation and waterbody. The boundary of each of the selected cities was used to clip the geo-referenced imageries so as the boundary of the study area can be maintained. Maximum Likelihood Classification Algorithm of supervised classification was used to run the analysis. The spatial coverage of each landuse type was determined in squared kilometers using the calculate geometry module of ArcGIS 10.7. The area of landuse in each year was calculated and simple arithmetic was done by subtracting the area of land use in initial year from the final year. Thus, the area of each landuse types in previous period was subtracted from the area of the same land use in the next period. The difference gave the landuse change in terms of spatial coverage and direction of changes. The percentage change of each landuse was then computed to determine the percentage increase or decrease of each landuse using the formula in equ.1.

$$\text{LU Final} - \text{LU Initial} \times 100 \quad (1)$$

III. RESULTS AND DISCUSSIONS

3.1 Landuse/Land cover in Port Harcourt in 1986, 2000 and 2020

The landuse types identified in the study area through the satellite images obtained for the study includes; built up area/ bare surface, wetlands/riparian vegetation, water bodies, farmland/ sparse vegetation, and thick vegetation (Figure 2 - Figure 5). These were analysed based on the years considered which were 1986, 2000, and 2020 respectively. Table 1 showed that the year 1986 recorded 121.58 km^2 for thick vegetation, 106.81 km^2 for built up area, wetland/riparian vegetation occupied 150.17 km^2, water bodies occupied 26.25 km^2, and 78.59 km^2 for farmland/sparse vegetation. Furthermore, the results for the year 2000 showed that the thick vegetation had decreased to 106.81 km^2, built up area had increased to 176.62 km^2, wetlands/riparian vegetation size decreased to 57.51 km^2, waterbody also decreased to 18.69 km^2, while farmland/sparse vegetation increased to 98.59 km^2. Consequently, in 2020, changes were also observed as thick vegetation further decreased to 81.76 km^2, built up area/bare surface increased to 205.89 km^2, wetland/riparian vegetation size reduced to 42.70 km^2, water body also decreased to 16.32 km^2 and farmland/sparse vegetation increased to 111.55km^2.

Similarly, the results presentation in Table 2 also showed that in 1986, thick vegetation occupied 26.53% of the total landuse area, and decreased to 23.31% in 2000, and further decreased to 17.84% in 2020; built up area/bare surface occupied 17.81 % in 1986, and increased to 38.54% in 2000 and further increased to 44.93% in 2020; while wetlands total area in 1986 was

32.77%, it reduced to 12.55% in 2000 and further reduced to 9.32% in 2020; water bodies occupied a total of 5.73% in 1986, and experienced a slight decrease in size to 4.08% in 2000, and 3.56% in 2020; while, sparse vegetation or farmland increased from 17.15% in 1986 to 21.52% in 2000, and 24.34% in 2020.

Table.1. Landuse spatial pattern in 1986, 2000, and 2020 in Port Harcourt

Landuse	1986 (km^2)	Percentage (%)	2000 (km^2)	Percentage (%)	2020 (km^2)	Percentage (%)
Thick vegetation	121.58	26.53	106.81	23.31	81.76	17.84
Built Up Area/ Bare Surface	81.63	17.81	176.62	38.54	205.89	44.93
Wetlands/Riparian Vegetation	150.17	32.77	57.51	12.55	42.70	9.32
Water bodies	26.25	5.73	18.69	4.08	16.32	3.56
Farmland/Sparse vegetation	78.59	17.15	98.59	21.52	111.55	24.34
Total	458.22	100.00	458.22	100.00	458.22	100.00

Table.2. Percentage (%) Change in landuse/landcover between 1986 and 2020 in Port Harcourt

Landuse	1986 (km^2)	2000 (km^2)	Change (km^2)	% Change	2000 (km^2)	2020 (km^2)	Change (km^2)	(%) Change	Total Change (km^2)	Total % Change (1986-2020)
Thick vegetation	121.58	106.81	14.77	-12.15	106.81	81.76	25.05	-23.45	-39.82	-35.6
Built Up Area/ Bare Surface	**81.63**	**176.62**	**-94.99**	**116.37**	**176.62**	**205.89**	**-29.27**	**16.57**	**+124.26**	**+132.94**
Wetland	150.17	57.51	92.66	-61.70	57.51	42.70	14.81	-25.75	-107.47	-87.45
Water bodies	26.25	18.69	7.56	-28.8	18.69	16.32	2.37	-12.68	-9.93	-41.48
Farmland/Sparse vegetation	78.59	98.59	-20.00	25.43	98.59	111.55	-12.96	13.15	+32.96	+38.58

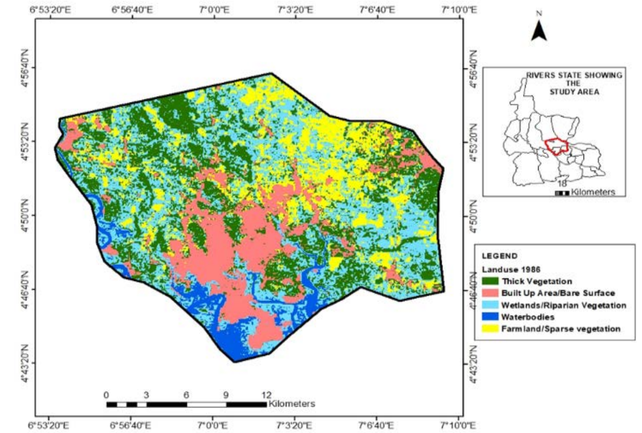

Fig.2. Landuse in Port Harcourt in 1986

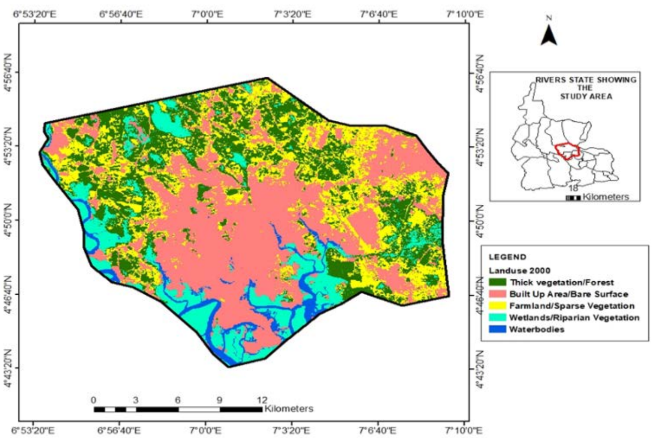

Fig.3. Landuse in Port Harcourt in 2000

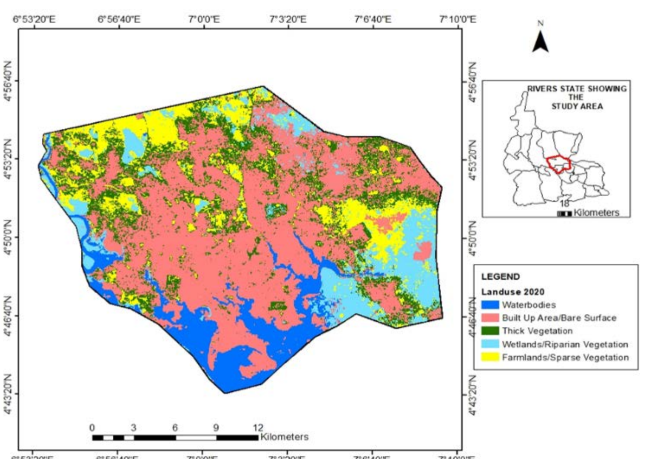

Fig.4. Landuse in Port Harcourt in 2020

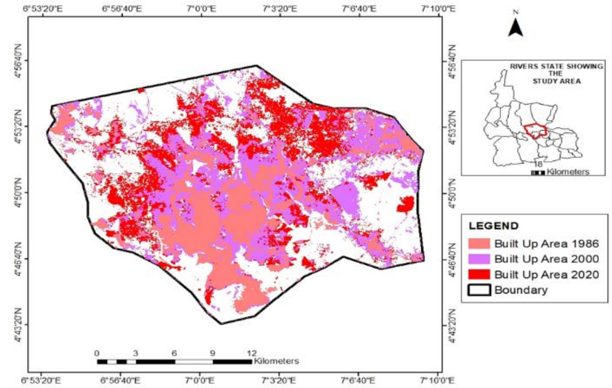

Fig.5. Urban Growth in 1986, 2000, and 2020 in Port Harcourt

3.2 Landuse/Land cover in Uyo in 1986, 2000 and 2020

The landuse types identified in the study area through the satellite images obtained for the study includes; built up area/ bare surface, disturbed vegetation, farmlands and thick vegetation (Figure 6 - Figure 8). Figure 9 also showed the spatial extent of built up area/ and urban growth analysis within the period under consideration. Table 3 showed that in 1986 recorded 122.85 km^2 for thick vegetation, 37.89 km^2 for built up area/bare surface, and 40.85 km^2 for farmland. The analyses also showed that in the year 2000 showed that the thick vegetation had decreased to 103.14 km^2, built up area/bare surface had increased to 46.89 km^2, while farmland/sparse vegetation increased to 47.45 km^2 and disturbed vegetation increased to 57.33 km^2. Consequently, in 2020, changes were also observed as thick vegetation further decreased to 46.82 km^2; but farmlands reduced to 43.64 km^2 and built up area/bare surface increased to 134.61 km^2 and disturbed vegetation reduced to 29.74 km^2. However, the analysis on the percentage change in Table 4 showed that between 1986 and 2000, disturbed vegetation increased by 10.40%, farmlands increased by 9.65%, and built up area/bare surface increased by 13.16% but thick vegetation reduced by 33.21%. In addition, between 2000 and 2020, disturbed vegetation reduced by 40.34%, farmlands reduced by 5.57%, and also thick vegetation reduced by 82.35% while built up area/bare surface increased by 128.26%. Meanwhile, for the total percentage change, the disturbed vegetation from 1986 to 2020 had reduced by 29.95%, thick vegetation had also reduced by 115.56% while farmlands had increased by 4.08% and the built up area had increased by 141.42%.

Table.3. Landuse spatial pattern in 1986, 2000, and 2020 in Uyo

Landuse	1986 (km^2)	Percentage (%)	2000 (km^2)	Percentage (%)	2020 (km^2)	Percentage (%)
Disturbed Vegetation	50.22	19.71	57.33	22.50	29.74	11.67
Farmlands	40.85	16.03	47.45	18.62	43.64	17.13
Thick vegetation	125.85	49.39	103.14	40.48	46.82	18.37
Built Up Area/Bare Surface	37.89	14.87	46.89	18.40	134.61	52.83
Total	254.81	100.00	254.81	100.00	254.81	100.00

Source: Researcher's Analysis, 2020

Table.4. Percentage (%) Change in landuse/landcover between 1986 and 2020 in Uyo

Landuse	1986 (km^2)	2000 (km^2)	Change (km^2)	% Change	2000 (km^2)	2020 (km^2)	Change (km^2)	(%) Change	Total Change (km^2)	Total % Change (1986-2020)
Disturbed Vegetation	50.22	57.33	7.11	10.40	57.33	29.74	-27.59	-40.34	-20.48	-29.95
Farmlands	40.85	47.45	6.60	9.65	47.45	43.64	-3.81	-5.57	2.79	4.08
Thick vegetation	125.85	103.14	-22.71	-33.21	103.14	46.82	-56.32	-82.35	-79.03	-115.56
Built Up Area/Bare Surface	37.89	46.89	9.00	13.16	46.89	134.61	87.72	128.26	96.72	141.42
Total	254.81	254.81			254.81	254.81				

Source: Researcher's Analysis, 2020

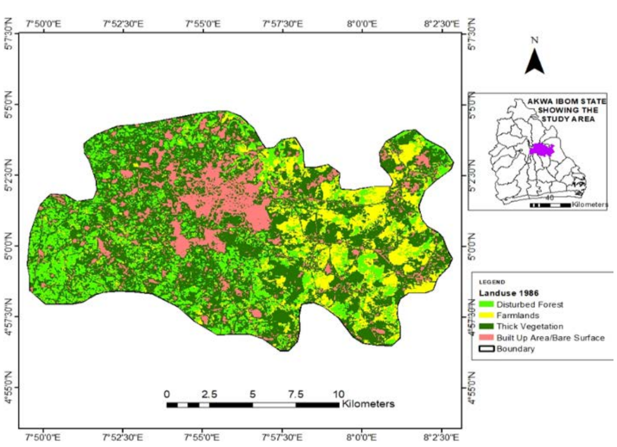

Fig.6. Built Up Area in 1986 in Uyo

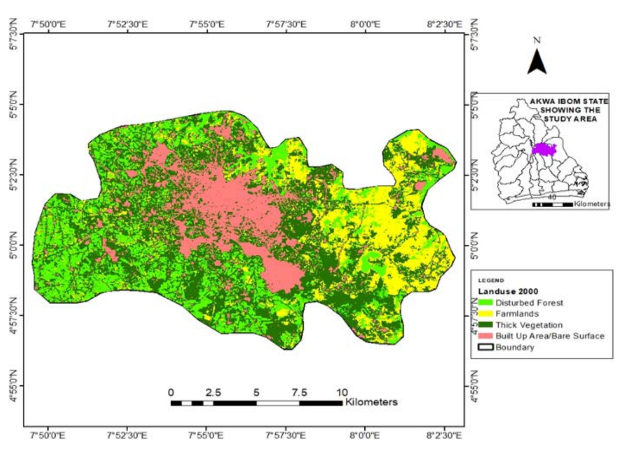

Fig.4.9. Built Up Area in 2000 in Uyo

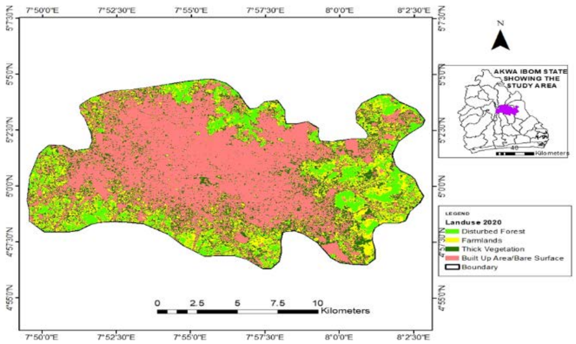

Fig.7. Built Up Area in 2020 in Uyo

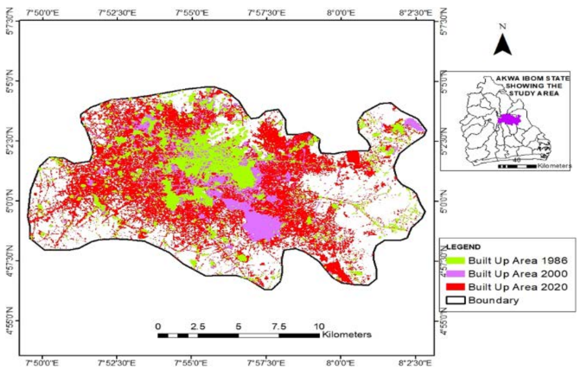

Fig.8. Urban Growth in Uyo from 1986 to 2020

3.3 Landuse/Land cover in Asaba in 1986, 2000 and 2020

The landuse types identified in the study area through the satellite images obtained for the study includes; built up area/ bare surface, farmlands/sparse vegetation, waterbodies, wetlands/riparian vegetation and thick vegetation (Figure 9 - Figure 11). Figure 9 showed the spatial extent of built up area/bare surface only and urban growth analysis in the study area. Table 5 showed that the year 1986 recorded 68.39 km^2 for thick vegetation, 23.47 km^2 for built up area/bare surface, 36.44 km^2 for farmland/sparse vegetation, 27.50 km^2 for wetlands/riparian vegetation and 7.65 km^2 for waterbodies. The analyses also showed that in the year 2000 showed that the thick vegetation had decreased to 47.13 km^2, built up area/bare surface had increased to 38.03 km^2, farmland/sparse vegetation increased to 45.10 km^2, while wetlands/riparian vegetation had reduced to 25.09 km^2 and waterbodies had increased to 8.10 km^2. In 2020, thick vegetation decreased to 35.42 km^2; wetlands/riparian vegetation had reduced to 16.35 km2 and farmlands reduced to 38.22 km^2 while built up area/bare surface increased to 65.08 km^2 and waterbodies increased to 8.38 km^2.

However, the analysis on the percentage change in Table 6 showed that between 1986 and 2000, thick vegetation had reduced by 31.09%, and wetlands/riparian vegetation reduced by 3.52% while built up area/bare surface increased by 21.29% and waterbodies also increased by 0.66%. Also, between 2000 and 2020, thick vegetation had reduced by 24.85%, and wetlands/riparian vegetation reduced by 18.54% while built up area/bare surface increased by 57.39% and waterbodies also increased by 0.59%.

In Asaba, the analysis from 1986 to 2020 shows that thick vegetation reduced by 48.21% and wetlands.riparian vegetation also reduced by 16.30%. The built up area, waterbodies and farmland/sparse vegetation had increased by 60.84%, 1.07% and 2.60% respectively.

Table.5. Landuse spatial pattern in 1986, 2000, and 2020 in Asaba

Landuse	1986 (km^2)	Percentage (%)	2000 (km^2)	Percentage (%)	2020 (km^2)	Percentage (%)
Thick vegetation	68.39	41.84	47.13	28.83	35.42	21.67
Built Up Area/ Bare Surface	23.47	14.36	38.03	23.27	65.08	39.82
Wetlands/Riparian Vegetation	27.50	16.82	25.09	15.35	16.35	10.00
Water bodies	7.65	4.68	8.10	4.96	8.38	5.13
Farmland/Sparse vegetation	36.44	22.29	45.10	27.59	38.22	23.38
Total	163.45	100.00	163.45	100.00	163.45	100.00

Table.6. Percentage (%) Change in landuse/landcover between 1986 and 2020

Landuse	1986 (km^2)	2000 (km^2)	Change (km^2)	% Change	2000 (km^2)	2020 (km^2)	Change (km^2)	(%) Change	Total Change (km^2)	Total % Change (1986-2020)
Thick vegetation	68.39	47.13	-21.26	-31.09	47.13	35.42	-11.71	-24.85	-32.97	-48.21
Built Up Area	23.47	38.03	14.56	21.29	38.03	65.08	27.05	57.39	41.61	60.84
Wetlands/Riparian Vegetation	27.50	25.09	-2.41	-3.52	25.09	16.35	-8.74	-18.54	-11.15	-16.30
Water bodies	7.65	8.10	0.45	0.66	8.10	8.38	0.28	0.59	0.73	1.07
Farmland/Sparse vegetation	36.44	45.10	8.66	12.66	45.10	38.22	-6.88	-14.60	1.78	2.60
Total	163.45	163.45			163.45	163.45			163.45	163.45

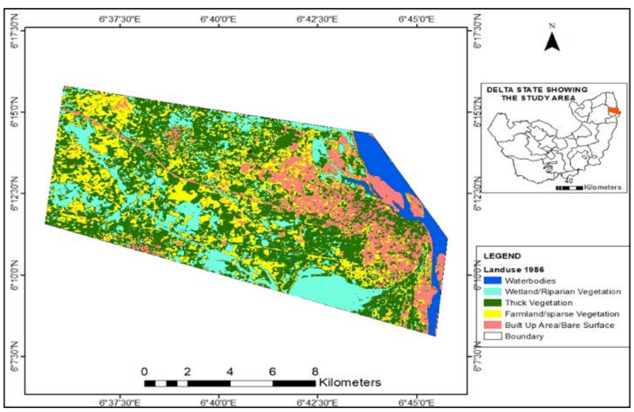

Fig.9. Landuse / Land Cover in 1986 in Asaba

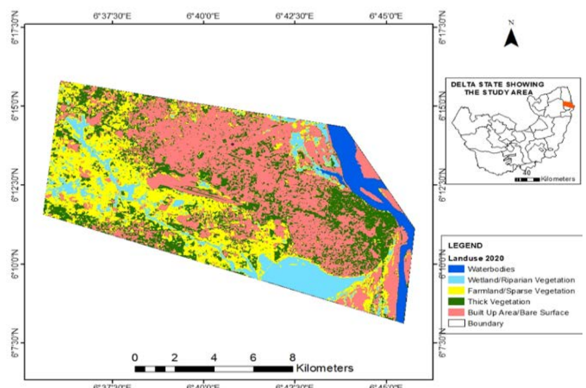

Fig.11. Landuse / Land Cover in 2020 in Asaba

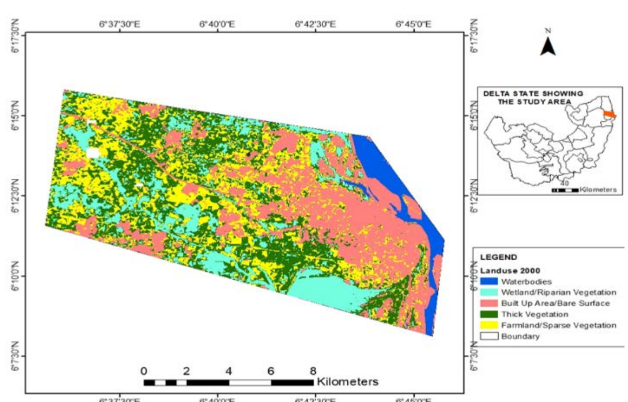

Fig.10. Landuse / Land Cover in 2000 in Asaba

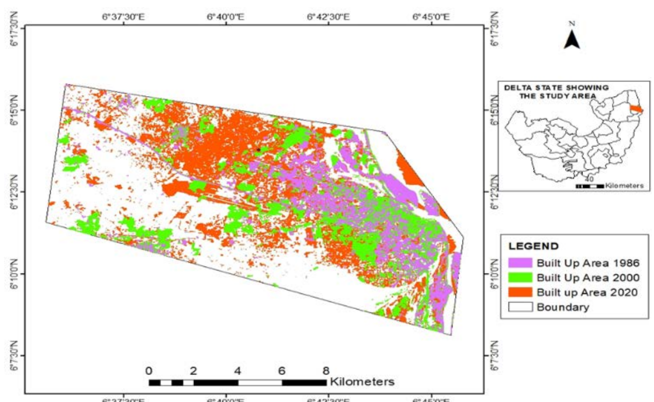

Fig.12. Urban Growth in Asaba in 1986, 2000 and 2020

IV. Discussion of Findings

Findings show that the spatial extent of built up area increased with time from 1986 to 2020. On the other hand, thick vegetation was decreasing. The increase in the built up area and decrease in vegetation with time is similar to the studies of Zubair (2006) and Suleiman et al (2014). The cause may be attributed to urban land that is constantly and rapidly changing due to various human development activities and natural conditions (Suleiman et al, 2014). Many people migrate into these cities to find better livelihood due to urbanization being experienced in the area. Eludoyin (2011) supported the fact that urbanization has been a driving force towards the rate at which a particular land use or land cover changes over time. People migrating into the city had taken over the vegetal cover to build houses, factories, industries, roads and so on. According to Lambin and Geist (2006), humans are increasingly being recognized as a dominant force in global environmental change. In addition, Moorman et al (2007) in Swangjang and Iamaram (2011) viewed that people transform natural habitats into man-made landscapes of residential, commercial, institutional and industrial areas as well as supporting infrastructure. In a deeper sense, the encroachment on the natural habitat is a reflection of poor landuse planning and policy implementation. It seemed the landuse change in Yenagoa City has adopted the transition concept as confirmed in Raskin et al (2002) that landuse change is associated with societal and biophysical changes through a series of transitions. No wonder, Xiao and Weng (2007) affirmed that poor land use planning is a contributing to uncontrolled expansion of the urban area. Eludoyin (2011) agreed that the decrease in the spatial extent of mangrove, primary forest, and sparse vegetation is mainly due to encroachment into these landuse types largely due to constructions. Thus, the outcome of the encroachment into the vegetal cover of the study area would have resulted into serious environmental degradation. Pellika et al (2004) believed that the outcome of the pressure are numerous and they included intensified agriculture, decreasing amount of forestland, loss of biodiversity, intensified land degradation and soil erosion.

V. Conclusion

The study established the fact that the selected capital cities in the South –south region has grown and expanded within 1986 and 2020 and this calls for sustainable development of these growing cities. Based on these findings, the study recommended that enacting and implementation of government policy restraining individuals of illegal construction should be established, educating individuals on illegal acquisition of primary forest should be absolutely done; campaign against deforestation should be encouraged; sensitizing people on the effects of improper landuse change should be carried out and periodic assessment of landuse change to discover the trend of change and to foresee the possible landuse change in future should be encouraged.

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