Global Scientific JOURNALS

GSJ: Volume 6, Issue 12, December 2018, Online: ISSN 2320-9186
www.globalscientificjournal.com

MONITORING URBAN SPRAWL AND LANDUSE DYNAMICS IN ABUJA USING REMOTE SENSING AND GIS

Okeke, F.I. and Akpata, S.B.M.

Okeke F.I. is a Professor of Geoinformatics and Surveying at the Department of Geoinformatics and Surveying, University of Nigeria, Enugu Campus, E-mail: francis.okeke@unn.ng
Akpata S.B.M. is currently pursuing a PhD degree program in Geoinformatics and Surveying at the department of Geoinformatics and Surveying, University of Nigeria, Enugu Campus, Nigeria. E-mail:Akpatasylvester@yahoo.com

KeyWords
Urban, Landuse, Srawl, Dynamics, Remote sensing, GIS

ABSTRACT

Urban growth and land use changes in the Federal Capital City (FCT) of Nigeria is on the increase and need to be investigated using geospatial (Remote Sensing and Geographic Information System GIS) techniques. The remotely sensed LandSat data of 1990, 2004, 2008, 2015, and Sentinel 2 of 2018 were used for the study. The image pre-processing and processing were carried out using ENVI 4.7, ArcGIS 10.1 and QGIS 2.3.18. The stacked composite images were classified into Built-up, rivers, rock surface, vegetation, Thick vegetation, and bare land. The classified images for the various years were compared to investigate urban sprawl and land used changes within the FCT. Cross-tabulation was used to estimate the degree of the urban sprawl, and land use changes in the FCT. It was noticed that urban sprawl has completely change land use pattern within the FCT most especially Abuja municipal area council which has virtually converted agricultural land to built up. Also, there are considerably more changes noticed across the remaining five area council. However, the degree of urban sprawl and land use changes has affected the natural surfaces, weather, and climatic condition and geological foundation within the FCT. Slums settlement and un-pattern Built-up area have claimed 90% of greenery in the FCT which has resulted to Urban Heat Island (UHI) in the FCT. The ENVI, ArcGIS, and QGIS software were used for download, processing, and creation of the thematic map. The results of the study are the classified thematic map that shows the various classes, accuracy assessment of classified results, cross tabulation results that analyses the transformation of the classes from one class to another within the study area. Conclusively, this study will help town planners to have a better understanding on how to monitor urban growth and development such that, it will favor living condition within the FCT and to preserve agricultural land, greenery, and natural reserve.

INTRODUCTION

The extent of urban conurbation and sprawl in Abuja because of rural-urban migration require urgent attention. This urban agglomeration has affected the earth ecosystem combined with the pressure exerted on land due to agricultural activities and other land use such as mining activities, construction, and development of impervious surfaces in the Federal capital territory (FCT) which desperately has affected climate change in the FCT. These land use dynamic has also affected energy fluxes through selective reflection and radiation of solar energy which causes urban heat island effect that has resulted to changes in energy balance by negative modulation of evapotranspiration which is one of the causes of global heat. Land use dynamic is often caused by urban disappropriation, and dis-proportion of settlement is due to rural-urban migration. Construction and mining activities are the major factors that cause UHI. The disappropriate exertion on urban land has totally changed and affected land use and decent urban development in the FCT of Nigeria especially phase 2 and 3 of the area council. Urban areas exert influences on the Earth ecosystem far disproportionate to their geographic extent and require consideration in a digital earth (15).

The changes in land use across the FCT to a large extent have affected land use and agricultural activities in the FCT. Urban growth has dealt seriously with the ecosystem through the conversion of agricultural land to buildings and roads (12). Agricultural land in the municipal area has almost been converted to build-up except for part of phase 2 and 3. More importantly, some part of phase 2 and 3 are occupied with slums settlements which completely uttered the Abuja master plan. Green area which would have provided greenery for fresh air is fully developed with slums in a hazard pattern. These developments, however, provide an uncomfortable leaving environment for people because the entire environment is heating up. Examples of places that are subjected to this terrible living condition are Dakybiu, Karmo, Gbaduma, Lokogoma, Lugbe, Dutse, Kuje, Piwoyi, villages, etc.

Land use pattern affects the living condition in an urban area because un-planned urban growth can cause excess warm up to the urban environment and (UHI) can kill (16). Tentatively, to have a comfortable living condition for an urban environment, a good policy must be enforced by the government to allow greenery as was implemented during Mallam El- Rufai regime as minister of the FCT.

This study wants to investigate urban growth and land use dynamics in the FCT and to highlight the various land use pattern and urban development from 1990 to 2018 to access the impact it has caused to agriculture and the ecosystem. The knowledge from the study will suggest future plan to allow land for agriculture and greenery and planned urban settlement that would eradicate slums settlements within the FCT and all cities and urban area in Nigeria.

Statement of the Problem

The extent of urban conurbation and sprawl in Abuja because of rural-Urban growth cannot be avoided especially as population increases with high mortality rate dues to advancement in medicine. Young school graduates will definitely move to the cities for a better job. They need a place to put their things and relax when they are back from work. These basic needs for the sustenance of young school graduates have put pressure on decent accommodation in the cities. Therefore, developers and landlord build to satisfy these demands. However, these decent accommodations are always in insufficient quantities thereby resulting in slums settlement which follows the un-planned pattern. And because of the closeness of this slums settlement to place of work, desperate applicants and employed workers throng these areas for accommodation. Landowners therefore eventually built everywhere without leaving space for green. More importantly, agricultural lands are converted to buildings with the living condition at a serious threat. Tentatively, to have a better living condition, a proper plan should be put in place in cities to monitor urban growth which will accommodate rural-urban migration and balance energy fluxes (living condition, agriculture, and preserved ecosystem) (21) within the FCT. The study will investigate urban growth from 1990 to 2018 in the FCT to know the impact of urbanization in the study area to agriculture, living condition, and the ecosystem.

Justification of the Study

The study definitely has addressed urban sprawl and land use dynamic from 1990 to 2018 in the FCT of Nigeria using remote sensing and GIS techniques. The techniques were used to monitors the growth in urban cities across the six area council to check decent settlements and slums as discussed in (2, 3, 4, 5 & 6). The impact of this settlement on land use, and agricultural activities are also monitored to check UHI (17, 13, 11), and land use dynamics (6, 11). Land cover, land use classification was carried out to check the growth in development, and land used changes within the period of 27 years, the observed changes were analyzed and suggestion made to check future development that would enhance living condition and preservation of the ecosystem.

Why Urban Sprawl?

Urban sprawl is an outward spreading of a city and its suburbs to full capacity, to low-density and often auto-dependent development on rural land (4). Simply put it, it is a very quick arrangement of developing structures in a rapid manner that often makes one stay outside the structure in search of comfort instead of sleeping comfortably in the house. Urban sprawl is one of the global geographical phenomena that occur on the earth, especially developing countries like Nigeria (7, 8). It is an expansion of buildings due to the rapid increase in population within a particular geographic location (7, 9). Population increase no doubt is the reason for Urban sprawl (9, 10). The increase in population is as a result of advancement in medicine and lack of birth control. This has negatively

affected the decent living condition in developing country's Town like Abuja the Federal Capital City (FCT) of Nigeria. Urban sprawl in Nigeria's Federal Capital City is in a mess due to poor living condition of the dweller of slums settlement. The reasons are attributed to poor policy by government and development control unit who could hold a building plan approval for several years without genuine reasons for doing so. Hence, people get land close to cities from the village head where approval is not required and build temporally to hide their head. Annoyingly, the said temporally structure has housed several families for 15 to 25 years now and still counting more years. The slums settlement has increased rapidly in Abuja to accommodate the growing population that keeps rushing into the city. The neighboring states like Niger and Nasarawa are the worse settlement in the histories of mankind where people risk their life with the hope of trying to succeed in the city in search of a better job. If the urban accommodation is organized and decently built, it would have been term decent urban environment. But when it spread in an unplanned manner, it is term Urban sprawl.

Land Use Dynamic

Land use dynamics is the changes that occur on the earth surface in term of land use for various purposes. Land use change in urban area is a composite process (3). Land use change is caused by many factors ranging from physical activities to natural occurrence which has been investigated using remote sensing and GIS (1, 2).

The physical factor is physical development such as built up, farming, mining, and lumbering activities which have definitely change the earth ecosystem. The major factor that has brought land use change in urban area is Urban sprawl which has resulted to built-up and development of impervious surfaces, conversion of agricultural land to built-up and lumbering activities (1, 2, 3, and 14). These changes have definitely left the ecosystem and living condition of mankind to a helpless situation. There is a solution to all these challenges (25).

Negative Impact of Urban Sprawl

1. Several reviews have discussed urban growth and land used changes, and have suggested the benefits of urban monitoring for future development, and examined the effect of urban growth to living conditions in cities centers (2, 6, 8, 9, and 10). Urban sprawl is a sign of improvement to the developing countries. Young graduates go to the cities in search of good jobs to enhance leaving condition. This development has actually improved the lifestyle of many Nigerians and has promoted people from being extremely poor to averagely comfortable. However, the negative effect of urban sprawl could consume the whole world one day if the mitigating measure is not considered. Because in some years to come when virtually about 80% of the solid earth is completely occupied with buildings, then, the earth will melt away with fervent heat generating from human construction and industrialization. This noticed insinuation of what would happen to the earth is the negative impact of urban sprawl. It has resulted in the death of many in the cities through excessive heat, flooding, and pollution. The major impact is (UHI), food crises, and climate change as analyzed in several reviews (23, 17, 18, 19, 20, 20, 21, 22, 23, and 24). UHI is one of the effects of urban sprawl which has to make residence in cities to be uncomfortable both day and night. UHI is the excessive rise in temperature at cities center compare to the surrounding rural environment (17, 16, 18, 19, and 21). UHI is as a result of built-up, construction of impervious surfaces and conversion of the natural environment to structures, construction activities, and industries (15, 20. 21, 22, and 23). This UHI can kill (16). It has killed many people in Abuja and Nigeria. Especially people infected by diseases related to UHI, such as Cerebra spinal meningitis. The heat generated by excessive heat up of buildings and impervious surfaces by sun rays due to thermal absorption, radiation and reflection of radiant heat is caused by heat radiation from buildings, construction activities, and impervious surfaces. However rich people try to mitigate this effect by using the air conditioning system (16). This cooling system is another driving force that increases UHI in cities (16). As the poor and the average man bear the menace of UHI effect. In Nigeria, and Abuja where energy is exclusively scarce and sacred, no one is 100% comfortable with the use of air condition. Hence we need natural help from the ecosystem to mitigate UHI. However, UHI can be mitigated (25).The lost of agricultural land is another negative impact of urban sprawl. The loss of agricultural land and the suddenly disappearance of greenery and vegetation is another terrible effect of urban sprawl to mankind (18). The rapid construction of slums settlement in urban area has gotten Abuja environment crazy both day and at night when you talk of excess heat and food supply. The reason is not far from the fact that, virtually all agricultural land has been converted to buildings. More importantly, streams have been converted to buildings. These buildings have taken over agricultural land which is a threat to food security in Abuja and Nigeria. This agricultural land helps balance energy fluxes within the ecosystem. Rapid development supervised by cutting down of tress and natural vegetation, has successively exposed the ecosystem to nakedness and attack due to energy deficiency and unbalance of fresh air to the ecosystem. The only remedy to the menace post by rapidly converting agricultural land to buildings is through artificial method of replacing natural surfaces (21, 22, and 25)
2. Climate change is another bad effect of urban sprawl. If the daily surface temperature both day and night are compared for several years as was discussed in some reviews (17, 19, 20, 21, and 22), one would notice that there is a significant difference between the temperatures of a non-urban area compared to when it becomes an urban area. Time series satellite data can determine this obvious anomaly. This change is the reason behind excessive rainfall, heat, and flood in the urban area.

The change in climate due to urban sprawl is as a result of the destruction of the natural resource which over time is the backbone that normalizes energy fluxes within the ecosystem (13, 14, 15, and 20). The sudden destruction of the ecosystem which has exposed natural surfaces to excessive sun rays has dried up the earth's nourish vegetation and natural resource (25,15). These challenges can also be mitigated (25)

Solution to the Negative Impact of Urban Sprawl

There are many suggestions that were proposed to be adopted why try to provide a solution to the negative effect of urban sprawl (16, 17, 21, 22). The remedy is to plant trees and create enough green area in cities and urban area (17, 18). Greenery helps to balance energy fluxes within the ecosystem and to create an atmosphere of fresh air. More also, future development must put in place by town planners the separation between residential, recreation, agriculture, and industrial land. This will help to balance energy circulation within the ecosystem. Food crises can be eradicated by adopting organized farming system within the FCT and Nigeria. Climate change can be mitigated by preserving and replacing the destroyed natural resource.

Materials and Methods

Study Area

The study area is Abuja the federal Capital Territory. It was carved out from the old Nasarawa, Kogi and Niger state in 1976 as the federal capital City of Nigeria. It is bounded by latitude 8^0 25'N and latitude 9^0 25' N and longitude 6^0 45'E and longitude 7^0 39'E. It has boundary with Kogi state in the south, Nasarawa in the east and Niger state in the north-west. The major language spoken among the people are mainly Gbagyi, Nupe, Koro, Gwandara, and Gade. Its total area is about 724,473.9 hectares. The major food among the indigenes are mainly corn, yams, millet, beans, garri, and cassava floor, garden egg, soya beans, Mellon, okra, groundnuts and vegetables. The major occupation among the people within the study area is farming. The farm products are yams, cassava, maize, groundnuts, soya bean, millet, potatoes, garden eggs, beans, water Mellon, Mellon and vegetables. The gbagyi's are peaceful people and very accommodative. The map of the study area is shown in figure 1.0.

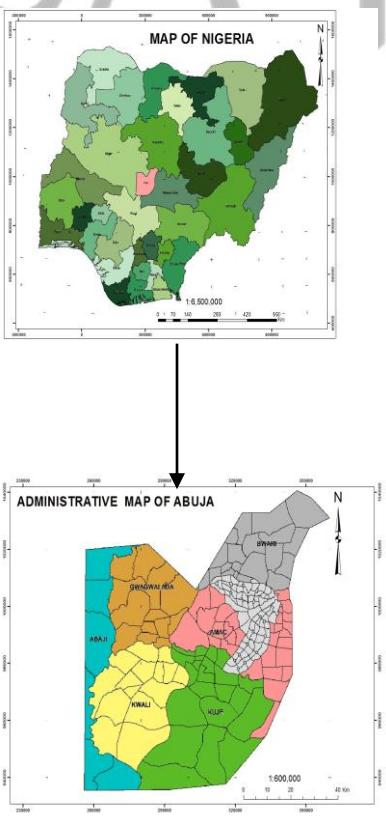

Figure1. Map of the Study Area (Akpata SBM)

Methodology

Data Acquisition

The data set used for the study were landsat images for 1990, 1994, 2004, 2008, and 2015, and Sentinel 2 image of 2018 which were downloaded from usgs.GLOVIS.gov, and https://scihub.copernicus.eu/apihub respectively. The street map shape file of the study area was used to delineate the study area.

Landsat 4 TM, Landsat 7 ETM+ and Landsat 8 LDCM for the years 1990, 2004, 2008 and 2015 were used in the classification respectively. The satellite images were downloaded from Earth Explorer website (USGS) with paths 189 and row 54. Landsat 4 TM has about 7 bands; Landsat 7 has about 8 bands while Landsat 8 has 11 bands with a quality assessment band. The green, red and infrared bands were used to form a false color composite with which the features were easy to identify. QGIS and Arcgis software were utilized for the classification. The Land cover classification was done with Semi-Automated Classification Plugin in the QGIS interface while transitional analysis, graph and map production was done using the ARCGIS.

Data Processing

The images were first corrected for atmospheric influences by converting their DN to Top-of-Atmosphere Reflectance using their metadata files (.MTL) downloaded alongside the images. Landsat 7 images for 2004 and 2008 respectively had scan line errors. This was corrected using the gap mask files. The correction was done using the QGIS software. Tools such as Merge and Fill no data were used. The Merge tool is used to combine the scan line images into a composite while the Fill no data tool uses the gap mask file for each band used in the composite to fill the scan lines according to the bands. The images were later clipped with the Abuja shapefile and band set were created that will enable toggling the band combinations. Maximum Likelihood, a supervised classification algorithm was used for classification.

Results

1. Classification Classes

Table 1: Different Classes that Were Identified in Each Image.

LAND USE (1990)	LAND USE (2004)	LAND USE (2008)	LAND USE (2015)	LAND USE (2018)
Water body	Built ups	Water body	Built ups	Built ups
River	Rock Surfaces	Rock Surfaces	Water body	Water body
Open spaces	Water body	Built ups	River	River
Developing land	River	Developing lands	Rock Surface	Rock Surface
Bare surfaces	Developing land	Open spaces	Open Space	Open Space
Built ups	Open spaces	River	Developing lands	Developing lands
Forests	Vegetation	Bare Surfaces	Vegetation	Vegetation
Farmland/Vegetation	Farmland	Grassland	Grassland	Grassland
Rock Surfaces	Grassland	Vegetation	Farmland	Farmland

The various classes for the classification are water body, river, open space, developing land, bare surface, vegetation/ farmland, Forest, and Rocks. These classes were used to carry out classification and to monitors urban sprawl and land use changes in the FCT from 1990 to 2018. From the study, it was observed that there are significant changes in all the classes within the period of 27 years.

2. **Thematic Maps**

The thematic map for the study area was produced for 1990, 2004, 2008, 2015, and 2018. The various classes for water, developing land, built-up, Forest, open space, vegetation, and farmland, and bare land was calculated to know the extent of urban sprawl in the FCT.

Built up had a coverage of 4.5% in 1990, 5.4% in 2004, 5.7% in 2008 and 9.7% in 2015 and 10.5% in 2018. Developing lands increased from 24% in 1990 to 38% in 2006; it reduced to 27% in 2008 and increased to 30% in 2015. Water body exhibited little or less increase or decrease that is significant. Open spaces, over the course of the years in view, had a significant change. It had 0.8% coverage in 1990, increased to 5.3% in 2006 due to developments, reduced to 2.8% in 2008 and further reduced to 1.3% in 2015 due to changes in land use and climate change.

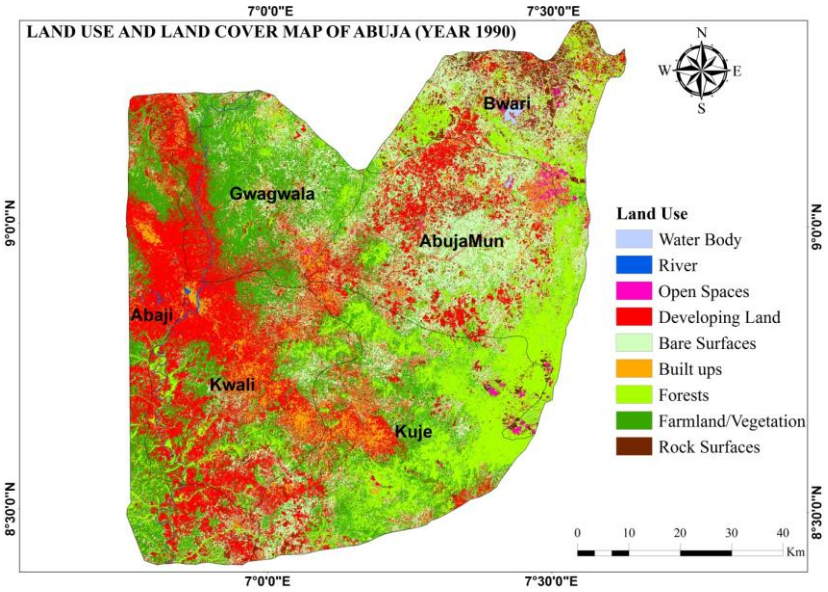

Figure 2 1990 Classified Map of Abuja

Figure 2 shows the classification across the six area council of the FCT, and the classification accuracy was considered to be appropriate when compared with the survey data.

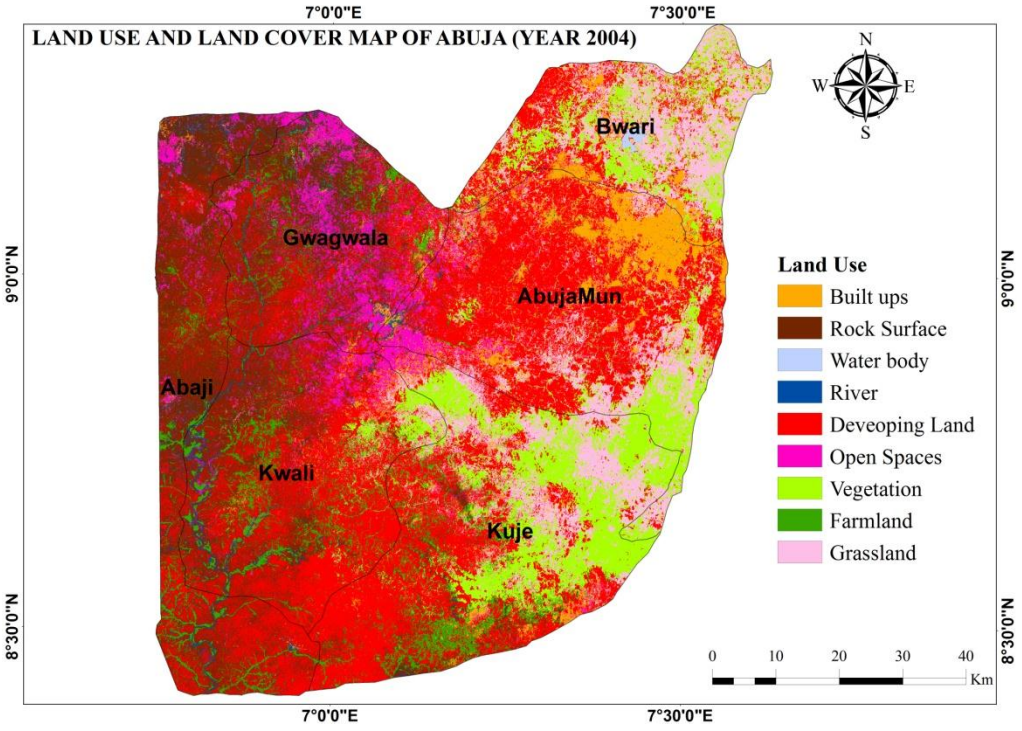

Figure 3 2004 Classified Map of Abuja

Figure 3 shows the classification across the six area council of the FCT, and the classification accuracy was considered to be appropriate when compared with the survey data

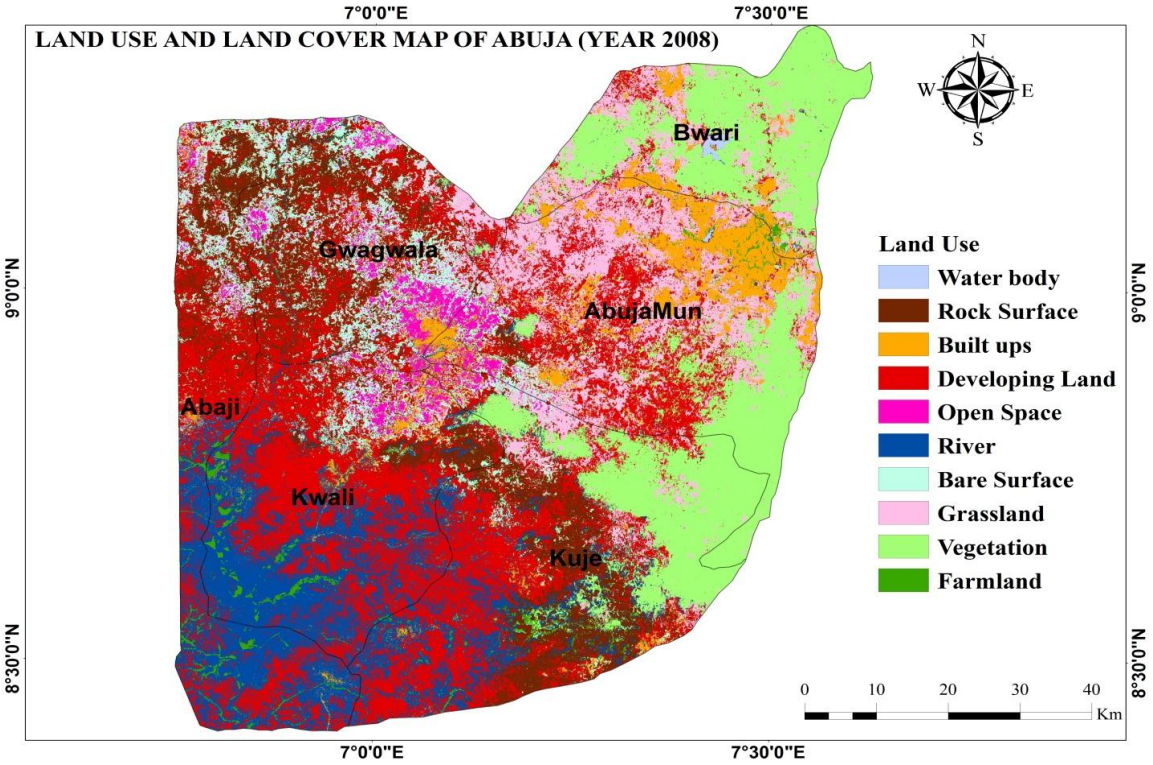

Figure 4: 2008 Classified Map of Abuja

Figure 4 shows the classification across the six area council of the FCT, and the classification accuracy was considered not too appropriate when compared with the survey data due to spectral variability.

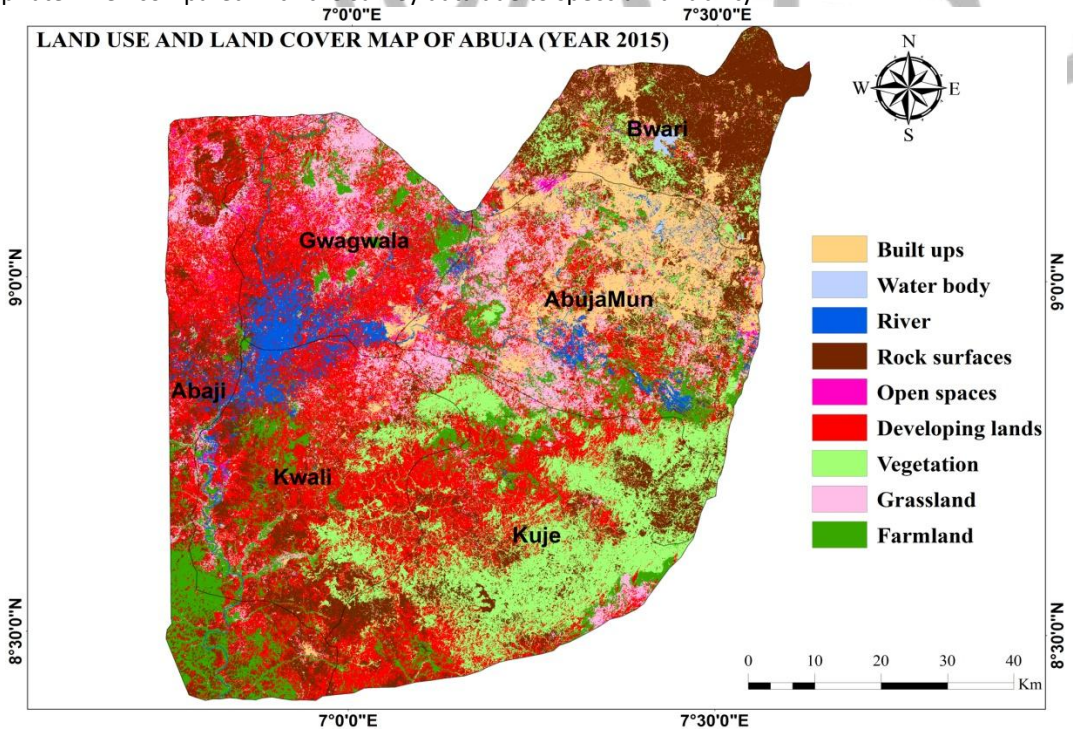

Figure 5: 2015 Classified Map of Abuja

Figure 5 shows the classification across the six area council of the FCT, and the classification accuracy was considered to be appropriate when compared with the survey data

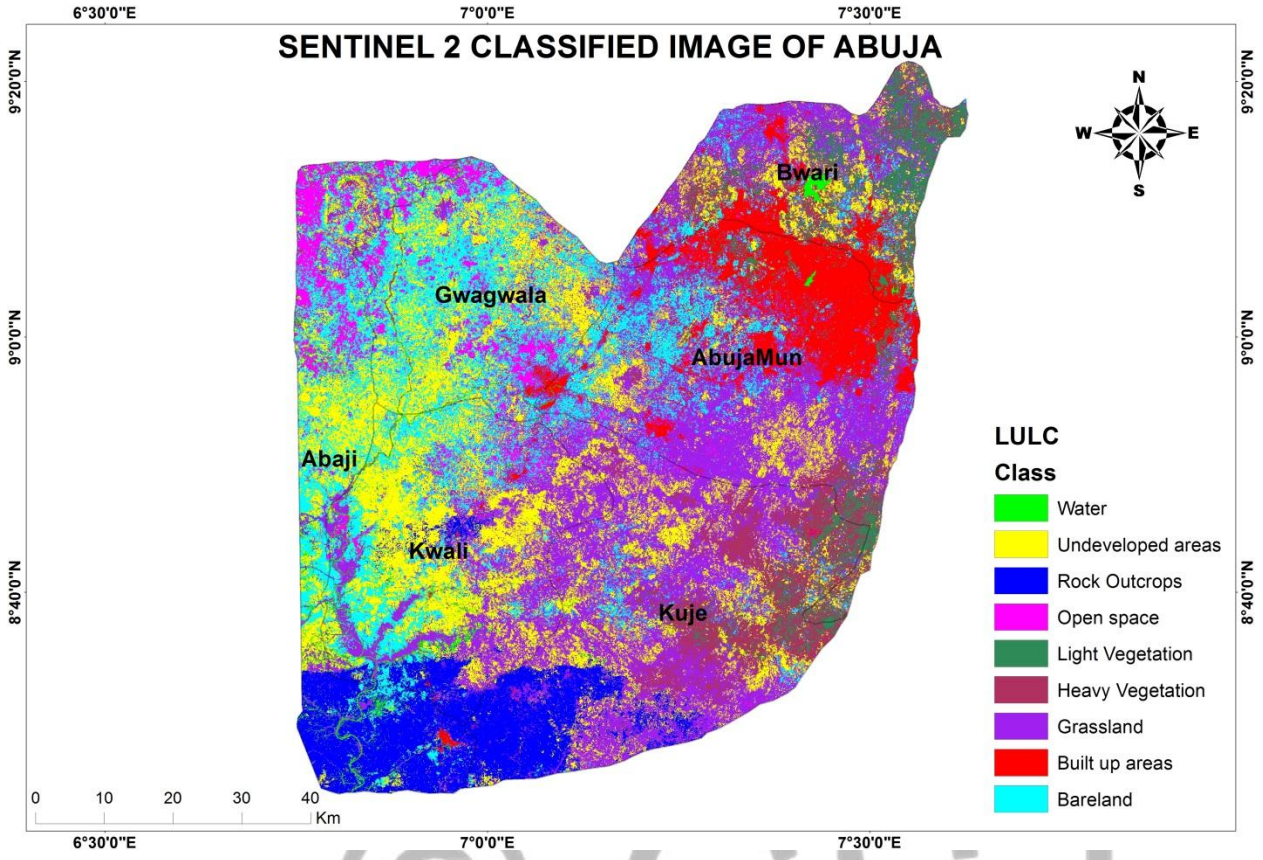

Figure 6: 2018 Classified Map of Abuja

Figure 2 shows the classification across the six area council of the FCT, and the classification accuracy was considered appropriate when compared with the survey data.

4. Accuracy Assessment Results

Classification accuracy was done to ascertain the degree of accuracy of each classification. The result is shown below.

Table 2: Accuracy Assessment

Land cover	Overall accuracy (%)	Kappa Coefficient (%)
1990	73.53	56.99s
2004	85.69	82
2008	89.91	85.82
2015	87.86	83.67
2018	89.99%	83.2%

5. Cross Area Tabulation for Land Cover Transition

Cross area tabulation was done for 1990 - 2004, 2004 – 2008, 2008 – 2015 and 2015 – 2018 respectively. Area and percentage coverage of each land use class was computed using ARCGIS field calculator since an attribute table was created. Since Landsat spatial resolution is 30 meters by 30 meters, the area of coverage can be calculated in square kilometers using the formula:
Area = Count * cell size * 0.000001

Where:
Count = number of cells present in each class

Cell size = the spatial resolution of the image used in classification in square meters
0.000001 = constant value used in converting square meters to square kilometers
Graph below shows the percentage of area cover for each class.
The tables are shown below. Area units are in square kilometers for the cross tabulation.

Table 3: Cross Tabulation for 1990

NAME	BUILT_UPS	ROCK_SURFACE	WATER_BODY	RIVER	DEVELOPING_LAND	OPEN_SPACES	VEGETATION	FARMLAND
Water Body	1.3401	0.747	8.0514	0.3159	1.2348	0.0171	0.3591	0.0162
River	1.9737	7.3107	0.0603	16.2054	2.9061	0.3555	0.576	1.4877
Open Spaces	25.9884	1.7892	0.0261	1.6119	7.4052	2.8809	4.1472	0.162
Developing Land	94.5342	507.2436	0.1224	55.7496	848.2608	93.5829	26.3781	79.8534
Bare Surfaces	133.8786	124.245	0.1341	21.9618	757.5174	106.7265	65.9088	22.7889
Built ups	81.0594	75.078	0.0396	16.2603	197.6265	41.9274	10.899	8.5095
Forests	54.9945	109.1925	0.8559	24.1542	282.3921	26.7759	590.9895	151.5546
Farmland/Vegetation	43.8552	391.4748	0.0477	46.8963	530.8209	90.9387	133.1451	178.9947

Cross-tabulation results for 1990 and 2004 shows that about 197 sq. km of the built-up area changed to developing lands, 41 sq. km changed to open space, and 75 sq. km changed to the rock surface. This can be attributed to demolition and other development plans that have occurred within 14 years. On the other hand, about 94 sq. km of developing lands changed to built-up, 93 sq. km changed to open space due to recreational use while 26 sq. km changed back to vegetation.

Table 4: Cross Tabulation (2004)

NAME	WATER_BODY	ROCK_SURFACE	BUILT_UPS	DEVELOPING_LAND	OPEN_SPACE	RIVER	BARE_SURFACE	GRASSLAND	VEGETATION	FARMLAND
Built ups	1.0422	28.9395	204.075	58.6215	16.3989	17.046	32.0706	85.1337	8.1036	16.1595
Rock Surface	0	289.2447	17.8128	443.2815	26.8236	274.626	186.6312	13.2336	1.1322	7.3917
Water body	7.8174	0.0018	0.0153	0.1413	0.0009	0.2277	0	0.0297	1.611	0
River	0.0009	29.6154	14.562	38.9925	10.8837	50.5512	37.3464	5.1453	0.4446	4.563
Deveoping Lan	0.504	267.5727	124.8471	1124.4636	45.3087	440.0244	179.9019	413.6148	206.6562	8.3538
Open Spaces	0	33.9723	32.8797	56.4921	101.2329	10.0116	110.9376	39.7269	0.2538	0.5283
Vegetation	0.1278	91.1079	2.4309	37.8639	0.0468	46.2852	3.7683	40.077	634.9815	16.1523
Farmland	0	108.171	1.7991	130.1247	0.3672	124.0236	13.9725	9.8451	6.7518	55.0089
Grassland	0.0144	63.6264	22.581	137.5641	3.6216	13.9788	19.458	197.8425	440.0478	4.5027

This shows the changes in land use for 2004 and 2008. It can be noticed that there is an increase in development. Many vegetated areas have been converted to built-up especially in the Abuja Municipal area council. The change that occurs from 2004 to 2008 is high compared to 1990 to 2004. The reason is that of the movement of people from Lagos offices to the New FCT from 1997 to 2008 which witness rapid development to accommodate the growing population.

Table 5: Cross Tabulation (2008)

NAME	BUILT_UPS	WATER_BODY	RIVER	ROCK_SURFACES	OPEN_SPACES	DEVELOPING_LANDS	VEGETATION	GRASSLAND	FARMLAND
Water body	0.1566	8.9874	0.2781	0.0495	0	0	0.0207	0	0.0144
Rock Surface	16.245	0.0009	52.6131	101.9097	6.8076	361.3716	178.5735	91.161	103.5693
Built ups	258.2757	0.0648	18.3294	37.7784	12.6963	46.4886	5.3145	35.388	6.6672
Developing Land	97.5078	0.0765	123.4089	371.4957	11.0997	841.4487	185.8689	175.2282	221.4108
Open Space	30.6837	0.0027	4.9149	7.857	19.0593	88.9047	0.0999	51.3207	1.8414
River	22.5513	0.4374	29.1915	215.2224	4.6575	332.6508	143.2971	44.5437	184.2228
Bare Surface	40.9509	0.0333	31.5954	34.9632	19.9494	287.0919	6.8346	132.9057	29.7621
Grassland	193.5243	0.0072	19.8414	154.3878	17.5374	125.2071	57.5514	166.4334	70.1586
Vegetation	45.3987	0.1755	15.9633	516.8817	3.033	118.872	482.8689	25.0542	91.7352
Farmland	11.1141	0.0108	4.5342	9.7155	0.4005	5.823	23.8716	7.9155	49.275

The image above shows the cross tabulation between 2008 and 2015. There is an increase in built-up and many agricultural lands have been converted to built-up, Vegetation to grassland, and thick vegetation to light vegetation and farmland. This change is attributed to population increase and human activities within the FCT.

Table 6: Cross Tabulation (2015)

NAME	BUILT_UPS	WATER_BODY	RIVER	ROCK_SURFACES	OPEN_SPACES	DEVELOPING_LANDS	VEGETATION	GRASSLAND	FARMLAND
Water Body	0.5292	8.8911	0.7092	0.8919	0.0054	0.9954	0.1485	0.135	0.1971
River	2.6721	0.1143	19.6668	2.4372	0.4275	3.0267	0.5823	0.4563	1.8351
Open Spaces	26.9235	0.0108	2.619	13.0842	2.8494	3.4389	5.031	1.6848	0.4491
Developing Land	144.0693	0.0261	119.1591	393.3567	23.9625	732.1941	74.6649	178.8255	126.7245
Bare Surfaces	270.3096	0.045	38.304	353.1717	25.317	436.0005	100.4319	200.3715	84.1401
Built ups	103.1292	0.0864	21.5667	111.1662	8.7048	149.3748	23.0031	45.6075	13.8096
Forests	58.4478	0.3951	25.4304	249.3783	7.3728	197.5824	614.5398	97.5222	251.1513
Farmland/Vegetation	46.0323	0.1404	63.0765	147.4623	19.6686	596.0412	234.6057	167.8167	260.7885
Rock Surfaces	64.2951	0.0873	10.1385	179.3124	6.9327	89.2044	31.2939	37.5309	19.5615

In the space of 27 years (1990 – 2018), the changes were significant and as seen in all the land use. Built-ups, developing lands, bare surfaces, and open space have experienced transition within the years. These changes have an effect on the environment as there are lots of developing lands in the study area. The rapid and increased area of built up in 2015 is an example. In 1990, built up was a little less but showed an increase in 2015. Developing lands increase within the study area is as a result of overgrazing and farming activities due to bush burning.

Discussion of Results

Urban sprawl and land use dynamic in Abuja was investigated in this research and the results from the study show clearly that there are changes in development for the past 27 years. These changes were as a result of development caused by rural-urban migration and increased in population. Various classes were identified to separate land cover land use details in the study area. The separation which has considerably described and gives details information about what has happened within the space of 27 years is important in this study. Most minor rivers do no longer exist especially in slums settlement. Built-up has increased rapidly in the space of 27 years while vegetations and forest has been taken over with development and built-up. Waterbody and rock are less affected because the change that occurs in rocks and water body is infinitesimally insignificant. The six area council in the FCT has experienced rapid changes in land use. Built-up has grown so rapidly because of demand for accommodation. These have also led to the growth of slums in the six area council which has completely altered the Abuja master plan. Slums settlement has no regard for vegetation and water body. Developers built-up everywhere and destroy completely the ecosystem. The slums settlement combined with planned settlement in the FCT has succeeded in putting serious pressure on agricultural land which has been converted to built-up for 27 years now. These built-up and development of impervious surfaces is one of the reasons for excessive heat in Abuja. Thick vegetation is virtually fading away because of farming activities and overgrazing.

However, the study area was categorized into different classes to identified land use changes and urban growth from 1990 to 2018. The growth experienced in terms of development and agricultural activities are as a result of rural to urban migration and increased in population. Population increase is as a result of growth in small family and improved health system. These growths have affected food supply as the demand for food and quality water is on the increase. The only decent settlements are in the Abuja municipal where the ecosystem is preserved. This is because natural surfaces are left in a strategic location to service the ecosystem. The Asokoro, Maitama, Wuse, Garki, many areas in Phase 2 allow space for greenery for ventilation and natural water flows to cool the day-

time temperature. This area is fairly ok at night and during the day. But places like Wuye, Karmo, Idu, Dawaki, Lugbe, and all other slums settlements within the FCT have an unplanned settlement. There is no greenery, no water, and decent settlements. All the natural surfaces have been built-up except narrow roads for movement and communication within the neighborhood. These slums settlements create discomfort for people leaving in these areas because of excessive heat at night and daytime. This heat is caused by overcrowding of buildings, an increase in population and heat generated from the cooling system, construction activities and development of impervious surfaces.

However, the five area council which is yet to experience massive development because of the delay in building plan approval by the development control unit of the FCDA has considerable planned accommodation with lots of slums settlement with a terrible living condition in some quarters.

Conclusion

Urban growth and land use changes in the FCT was investigated using remote sensing techniques. The remotely sensed Landsat data from 1990 to 2015 and Sentinel 2 of 2018 were used for the study. The image pre-processing and processing was carried out using ArcGIS 10.1 and QGIS 2.3.18. The stacked composite images were classified into Built-up, rivers, rock surface, vegetation, Thick vegetation, developing land, and bare land. The classified images for the various years were compared to investigate urban sprawl and land use change dynamics within FCT. Cross-tabulation was used to estimate the degree of the urban sprawl, and land use changes in FCT. And it was noticed that urban sprawl has completely change land use pattern within the FCT most especially Abuja municipal area council which has replaced agricultural land with built-up. More also, there s considerably more changes noticed across the remaining five area council. However, the degree of urban sprawl and land use changes has affected the natural surfaces, weather, and climatic condition and geological foundation within the FCT. Slums settlement and un-pattern Built-up area have claimed 90% of greenery in the FCT which has resulted to UHI in the FCT. Conclusively, this study will help town planners to monitor development such that, it will favor living condition within the FCT. The results from the study show that if urban growth is not monitored, there will be unplanned and indecent built-up in cities area and the ecosystem would not be preserve thereby resulting in UHI. UHI can lead to fatalities (16). Town planners must therefore, take the preservation of the ecosystem into consideration by allowing land for greenery to ensure energy balance in the cities when they design a layout for a city or town.

Recommendation

I recommend that Town planners should take into consideration the creation of open space for greenery and vegetation to service the energy balance for the ecosystem through cross ventilation.
It is also recommended in this research that future study should determine and investigate UHI, and evapotranspiration in the FCT.

Acknowledgment

The author wishes to thank the US geological survey for providing free of charge Landsat data and the European Copernicus for providing the required data offered by Sentinel 2 which aid and facilitate the success of this research.

References

1. R. Manonmani, S. Prabaharan, R. Vidhya and M. Ramalingam (2012), Application of GIS in urban utility mapping using image processing techniques, Institute of Remote Sensing, Anna University, Chennai 600 025, India; Department of Geology, Anna University, Chennai 600 025,India
2. R. P. , A. K. Bhowmik , P. C. , A. Zamyatin, O. Almegdadi and S. Wang (2017), Modelling Urban Sprawl Using Remotely Sensed Data: A Case Study of Chennai City, Tamilnadu, *Entropy 2017, 19, 163; doi: 10.3390/e19040163*
3. V. Sivakumar. (2014), Urban Mapping and Growth Prediction Using Remote Sensing and GIS Techniques, Pune, India, *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *Volume XL-8*, *2014 ISPRS Technical Commission VIII Symposium*, *09 – 12 December 2014*, *Hyderabad*, *India*
4. C .Pedro, G. Jean-Paul, and P. Macro (2005), Monitoring Urban growth Using Remote Sensing, GIS, and Spatial Metric, Remote Sensing and Modeling of Ecosystems for Sustainability II. Edited by Wi Gao, David R. Shaw, Proc. of SPIE Vol. 5884 (SPIE, Bellingham, WA, 2005). *Doi:10.1117/12.614852*
5. D. H. Mohammed , M. A. Ali (2014), Monitoring and Prediction of Urban Growth Using GIS Techniques: A Case Study of Dohuk City Kurdistan Region of Iraq , *International Journal of Scientific & Engineering Research, Volume 5, Issue 1, January 2014 ISSN 2229-5518*
6. D. Furberg (2014), Satellite Monitoring of Urban Growth and Indicator-based Assessment of Environmental Impact, Licentiate Thesis in Geoinformatics, *Royal Institute of Technology (KTH), Department of Urban Planning and Environment, 100 44 Stockholm, Sweden*.
7. M. N. Bhalli and A. Ghaffar (2015), Use of Geospatial Techniques in Monitoring Urban Expansion and Land Use Change Analysis: A Case of Lahore, Pakistan, *Journal of Basic & Applied Sciences, 2015 Volume 11*

8. A. Saxena, M. K. and M. Choudhary (2016), Analysis of Urban Growth using Geospatial Techniques, *International Journal of Earth Sciences and Engineering ISSN 0974-5904, Vol. 09, No. 06, December, 2016, pp. 2855-2861*
9. M. A. Mahboob, I. Atif, and J. Iqbal (2014), Remote Sensing and GIS Applications for Assessment of Urban Sprawl in Karachi, Pakistan, Science, Technology and Development 34 (3): 179-188, 2015, ISSN 0254-6418 / DOI:10.3923/std.2015.179.188
10. C. H. S. Chong (2017), Comparison of Spatial Data Types for Urban Sprawl Analysis Using Shannon's entropy, A Thesis Presented to the Faculty of the USC Graduate School University of Southern California In Partial Fulfillment of the Requirements for the Degree Master of Science Geographic Information Science and Technology

11. I. R. Hegazy and M. R. Kaloop (2015), Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governorate Egypt, *International Journal of Sustainable Built Environment (2015) 4, 117–124*
12. M. A. Ade and Y. D. Afolabi (2012), Monitoring Urban Sprawl in the Federal Capital Territory of Nigeria Using Remote Sensing and GIS Techniques, *Ethiopian Journal of Environmental Studies and Management Vol. 6 No.1 2013*
13. A. G. Yeh and U. Xla (2001), Measurement and Monitoring of Urban Sprawl in a Rapidly Growing Region Using Entropy, Photogrammetric Engineering *and* Remote Sensing

14 Christopher Small1 and Roberta Balstad Miller (2000) Spatiotemporal Monitoring of Urban Vegetation, *Lamont Doherty Earth Observatory Columbia University, Palisades, NY, USA.small@ldeo.columbia.edu, (914) 365-8354.*
15 Christopher Small1 and Roberta Balstad Miller (2012) Digital Cities II: Monitoring the Urban Environment from Space, *Lamont Doherty Earth Observatory Columbia University, Palisades, NY, USA.small@ldeo.columbia.edu, (914) 365-8354*
16. Mark J Miner, Robert A Taylor, Cassandra Jones, & Patrick E Phelan (2017) Efficiency, economics, and the urban heat island, Environment & Urbanization, *International Institute for Environment and Development (IIED), Vol 29(1): 183–194. DOI: 10.1177/0956247816655676, www.sagepublications.com*
17. C. Rinner and M. Hussain (2011) Toronto's Urban Heat Island—Exploring the Relationship between Land Use and Surface Temperature, *Remote Sens.* 2011, *3*, 1251-1265; doi:10.3390/rs3061251
18. E. Melaas, J.A.Wang, D. L. Miller and M. A. Friedl (2016) Interactions between urban vegetation and surface urban heat islands: a case study in the Boston metropolitan region, *Environmental Research Letter.* 11 (2016) 054020, doi:10.1088/1748-9326/11/5/054020, IOP Publishing Ltd
19. Enete, Ifeanyi. C (2015) Urban Heat Island Research of Enugu Urban: A Review, International *Journal of Physical and Human* Geography Vol.3, No.2, pp.42-48, June 2015, European Centre for Research Training and Development UK (www.eajournals.org)
20. Oleson K. W. , Bonan, G. B. Feddema J. and Jackson T. (2011) an examination of urban heat island characteristics in a global climate model, *International Journal of Climatology.* **31**: 1848–1865 (2011) DOI: 10.1002/joc.2201
21. Patricia Gober , Anthony Brazel , Ray Quay , Soe Myint , Susanne Grossman-Clarke , Adam Miller & Steve Rossi (2009) Using Watered Landscapes to Manipulate Urban Heat Island Effects: How Much Water Will It Take to Cool Phoenix?, *Journal of the American Planning Association*, 76:1, 109-121, DOI: 10.1080/01944360903433113
22. Peng Fu & Qihao Weng (2017) Responses of urban heat island in Atlanta to different Land-use scenarios, *Theoretical and Applied Climatology* DOI 10.1007/s00704-017-2160-3
23. Rafiq Hamdi (2010) Estimating Urban Heat Island Effects on the Temperature Series of Uccle (Brussels, Belgium) Using Remote Sensing Data and a Land Surface Scheme, *Remote Sens.* 2010, *2*, 2773-2784; doi:10.3390/rs2122773
24. M. S. Moeller (2004), Remote Sensing for the Monitoring of Urban Growth Patterns, *IIS, ASU, International Institute for Sustainability, Arizona State University, Tempe, AZ 85287-3211*
25. F.I. (2018), Advanced Remote Sensing Application, PhD lecture notes for 2016/2017 Section, Department of Geoinformatics and Surveying, University of Nigeria, Enugu Campus (unpublished).