Urban Sprawl Increase Decoyer of Urban Heat Island and the Catalyst of Global Warming

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Abstract:- The population explosion especially in the developing nations of the world makes urban sprawl a continuous issue in both mega and smaller cities in the said regions of the world. Sprawl in Ile-Ife is no difference and the crux of the research that is Urban Sprawl Increase Decoyer of Urban Heat Island and the Catalyst of Global Warming in Ile-Ife, Nigeria. The research made use of the Multi-date Landsat imageries of 1986, 2000 and 2017 (Landsat TM, Landsat ETM+ and Landsat OLI respectively) with spatial resolution of bam were used to assess the sprawl and land use/cover dynamics of the study area. GPS receiver was also used to capture the coordinates of features on ground. Daily temperatures of the study area were also sourced via internet. Results showed spatial pattern of land use/cover for the based years, land use/cover change analysis equally revealed spatial pattern of sprawl. Temperature readings supported tremendous increase in heat and plates of devastations in public buildings by storms also indicated the result of damages' made to forest. The research therefore concluded with its recommendations that there should be adequate planning which should be strictly followed in the study area. There should be afforestation at the fringes of the city and that there should be promulgation against trees felling within and the surroundings of Ile-Ife.

I. INTRODUCTION

There are many definitions on urban sprawl. The European Environmental Agency (EAA) described sprawl as the physical pattern of low-density expansion of large urban areas under conditions mainly into the surrounding agricultural areas. Sprawl is the leading head of urban growth and implies little planning control of land subdivision. According to Habibi and Asadi (2011) development could be patchy, scattered and strung out, with a tendency for discontinuity. Sprawl at times leap frogs over areas leaving agricultural enclaves (EEA, 2006). Downs (1999) is of the opinion that sprawl does not mean every kind of growth and it has a definite form that can be introduce as unlimited outward extension of development, low density residential and commercial settlements, leap frogs development, fragmentation of powers over land use among many small localities, dominance of transportation by private automotive vehicles, lack of centralized planning or control of land uses, widespread strip commercial development, great fiscal disparities among localities, segregation fo types of land use in different zones, and reliance on the trickledown or filtering process to provide housing to low income households. Bruechner (2000) refers urban sprawl to excessive spatial growth of cities. In their own submission, Gordon and Richardson (2000) said urban sprawl includes increasing in income inequality, joy insecurity, central-city decline, increasing housing costs, long commutes environmental problems, species extinction, loss of farmland, a sense of isolation, elevated blood pressure, muscle tension intolerance, psychological disorientation, and even Murder and Mayham. Pendall (1999) defined sprawl as "unplanned", uncontrolled, and uncoordinated single use development that does not provide for an attractive and functional mix of uses and or is not functionally related to surrounding land uses and which variously appears as low density ribbon on strip, scattered, leapfrog or isolated develop. To crown these various expressions on definitions up, Norton (1998) described sprawl as the deconcentration that involves low-density expansion of urban land uses into surrounding rural areas.

The progress of man from primitive stage to this present technological stage, has brought man to encounter with the global environmental problem of ecological decay, resource depletion, environmental pollution, etc. Of all the consequencies of environmental concern be devilling humans in this dispensation include Greenhouse effect and global warming, Ozone depletion, urbanization and its associated problems, degradation of land, air and water pollution, loss of biological diversity, large scale deforestation, depletion of natural resources and disposal (National Open University, (2008). This urbanization and its associated consequences are the cream of the study of urban sprawl. Urban expansion in the words of Manish, Aruna and Vivek (2012) is the horizontal and vertical outward extension of urban area over the adjacent agricultural land. It is a natural process that consumes several hectares of agricultural land. In their contribution to this subject, Atu, Offiong, Eja and Esien (2012) assert that urban sprawl is a common phenomenon and still remains the greatest threat facing agricultural land in Nigeria. as long as population explosion percists, urbanization will continue so also the urban sprawl. Abumere (2003) pointed out that most urban centres grew where there were initially farm lands due to the presence of highly fertile soils and agricultural viability of the area. Liu, Yohie and Haihong (2003) explained the process of sprawl as transformation of non-urban land into urban land being occupied by the residences, parks, offices, public buildings religion centres shops and factories, etc. such lands are transformed, it is always difficult to revert.

Urbanization is particularly rapid in the developing world as a result of mass movement of people out of rural dwelling for employment, socio-economic facilities, globalization and better life, etc. Urbanization does not take place in mega cities today, it is equally high in medium and small cities. Deshirbini and Martine (2007) observed that this poses numerous changes to the environment, notably the conversion of agricultural land to urban built up areas. On the causes of urban sprawl Bruckner and Fansler (1983) pointed at agricultural land price, commuting expenditure, income, etc. age indicators. Miezkowski and Mills (1993) found out that sprawl is a consequence of income and population growth, transportation system improvements, diversity in choice of users and competition for land.

Many scholars researched on the result of urban sprawl on reduction to agricultural lands Atu, Offiong, Eni, Eja and Esien (2012); Desherbiri and Martini (2007), conclusion on this is the drastic reduction on food supply Saver, et al. (2008); Redman and Jones (2020). Others highlighted its result to be on costs, such as increase in infrastructural cost Gordon and Richardson (2019). Few only mentioned its effect on environmental resources. The lacuna is many scholars among the literatures consulted did not think of linkage of urban sprawl to current global problem of climate change cum global warming.

II. STATEMENT OF THE PROBLEM

Geometrical increase in population or in other words population-explosions globally which is not only occurring in mega cities or urbans but also happening in smaller ones with overwhelming reparcaution in the environment of man. Urbanization and its major resultant urban spread into rural setting ferociously consuming its resources. This has become an outcry in the developing nations of the world, it is through this urban sprawl that these industrials regions consume environmental resources especially the forest which presently seems to be the solution of the world for global warming. This obdurate urban sprawl deforest virgin and secondary forest thereby spread urban heat island viz-a-viz increasing global warming and other piles of environmental difficulties. This is conspicuous focus of this research work in Ile-Ife sub-region of southwestern Nigeria.

III. AIM AND OBJECTIVE OF THE RESEARCH WORK

The aim of this research work is to assess on surveil the sprawl of Ile-Ife metropolis into the rural forest and agricultural land between 1986-2017. The specific objectives are to:
- find out the extent of the encroachment into the rural agro-forest land.
- to establish the effects of this sprawl.
- to profer useful control to this sprawl and curb its effects.

HYPOTHESES
- There is no significant different in the land use pattern over time.

IV. THE STUDY AREA

The study covered Ife Central and Ife East Local government areas. Ile-Ife is the core of the entire region comprises of Ife Central, Ife East, Ife North and Ife South Local Governments. As at 2006, Ile-Ife city contains a population of 644373 (Encyclopedia, 2019). The settlement is an ancient town in the South West of Nigeria and is believed to be ancestral home of the Yoruba race. It is located between latitude $7^0 31$'N to $7^0 34$'N and longitude $4^0 30$'E to $4^0 34$'E. Ile-Ife is the growth pole and core to her surrounding rural settlements that comprises of the region in line with the explanations of Francois Perroux Growth pole and Frieldmann in core pheriphery models. Like any urban, Ile-Ife functions more on tertiary and few small scale secondary activities. Ile-Ife is highly commercialized city that depends on her surrounding hinterland for its food supply. The geomorphic structure of Ile-Ife is indulating characterized by two types of soil which are deep clay soils on the upper slopes and sandy soils on the lower parts (Ajala and Olayiwola, 2013).
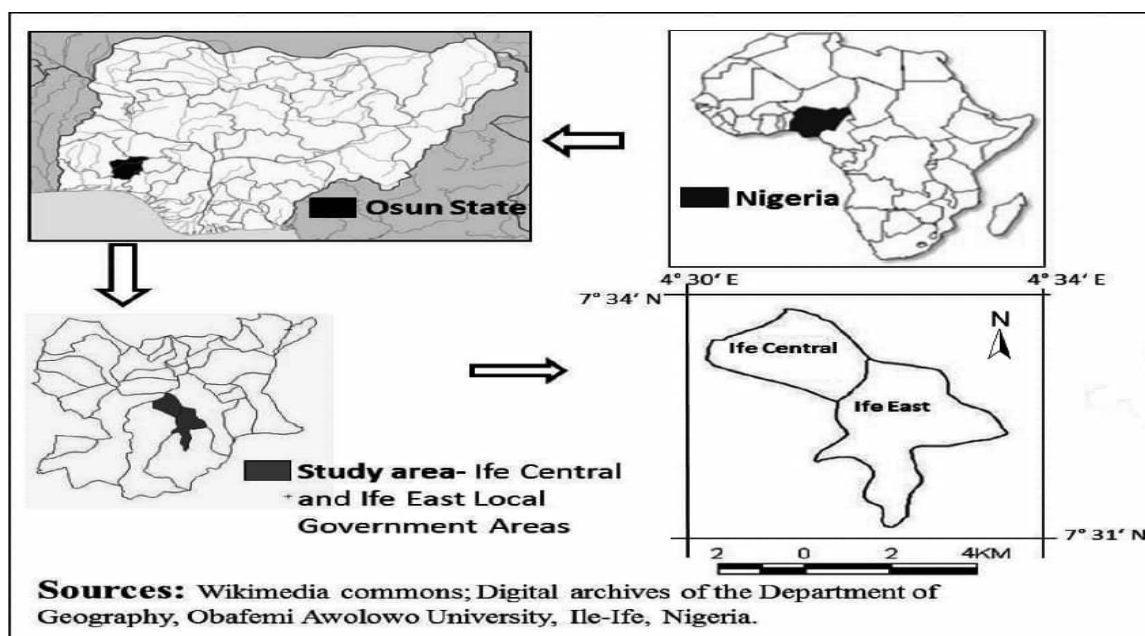
Map 1
(Map of Nigeria with Osun State inset)
(Map of Osun State with Ile-Ife city inset)

Apart from being a commercial centre, this ancient city is an important educational centre in the whole of Osun State even in southwest of Nigeria. She hosts the most prestigious University called University of Ife established in 1961 and rechristened Obafemi Awolowo University (Great Ife) in 1987. There is a private University called Oduduwa University, Private Polytechnic named Ife Polytechnic, two schools of Nursing, several private and public secondary schools, etc. Ile-Ife is also a centre of information, there are three (3) radio stations – Orisun FM, Crown FM, and Odua FM. There is also a branch of Nigeria Television Authority (NTA), a private television station is also under construction.

Means of transportation in Ile-Ife are trucks, buses, cars, tricycles, motorcycles, etc. There are numerous petrol filling stations even more than those existing in Osogbo the state capital. Ife has several branches of banks, different trading stores cum shopping malls. There are also series of community commodity markets. All these increase immigration into the city year in year out.

V. ANALYSIS OF URBAN SPRAWL IN ILE-IFE BETWEEN 1986 AND 2017

A. Materials and methods

The Multi-date Landsat imageries of 1986, 2000 and 2017 (Landsat TM, Landsat ETM+ and Landsat OLI respectively) with spatial resolution of 30m were used to assess the sprawl and land use/cover dynamics of the study area. As asserted by Lui and Coomes 2015, Landsat imageries are popular data sources for documenting changes in land use/cover due to their long history, reliability, availability and medium resolution. This study also used GPS receiver to capture the coordinates of features on ground, which were identifiable in the image data. These were used to generate ground control points (GCPs) that were used for eventual georeferencing of the satellite imageries.

VI. TECHNIQUES OF IMAGE PROCESSING

Both ILWIS Academic 3.3 and Erdas Imagine 9.2 software were used to process the image data. While Landsat TM 1986 and ETM+ 2000 were processed in ILWIS 3.3 Academic, OLI 2017 was processed in Erdas Imagine 9.2 because of compatibility. All the satellite data were geometrically corrected and enhanced into natural colour composite for better visual interpretation. In Landsat TM 1986, band 2 was assigned to red, band 4 to green and band 1 to blue (241) to generate natural colour composite. Whereas in Landsat ETM+ 2000, bands 342 in red, green and blue (RGB) generated natural colour composite. However, because of incompatibility of OLI 2017 in ILWIS Academic, the imagery was enhanced in Erdas Imagine. Through layer stacking operations, bands 432 was combined in OLI 2017 to produce natural colour composite in Erdas Imagine 9.2 software. Again, all the images were classified using supervised classification method and maximum likelihood algorithm technique to generate land use/cover dynamics of the study area.

In the study, five land use/cover classes were clearly identified using visual interpretation, spectral signatures of the image data and topographical map of the study area as a guide. These were used in the pixel training sites for eventual land use/cover mapping. These five classes include forest/agro-forestry; built-up area/urban; water body; rock outcrop and shrub/fallow/farmlands. The segment maps of the built-up areas were created for all the data years. They were polygonized and exported into ArcGIS 10.5 software to determine the pattern and extent of urban sprawl in the study area. In ArcGIS environment, all the segment maps were superimposed to establish the sprawling.

VII. ACCURACY ASSESSMENT

The confusion matrix in ILWIS 3.3 software module was used to determine the reliability and overall accuracy of Landsat TM 1986 and Landsat ETM+ 2000. This is a method to evaluate the performance of classifiers. This matrix shows a higher level of accuracy and the implication of this is that the results of the analysis were within the acceptable standard and were reliable for planning purposes. The accuracy assessment of Landsat OLI 2017 on the other hand was performed in Erdas Imagine. This is done by Error Matrix and Kappa Statistics. The overall accuracy of the classification and the kappa coefficient for all the classified imagery was within an acceptable standard.

VIII. RESULTS

Class	npix	npix (%)	Area (m²)	Hectares
Agro-forestry	51505	63.40	185,418,000	18,541.80
Built-up Area	8374	10.31	30,146,400	3,014.64
Rock Outcrop	8123	10.00	29,242,800	2,924.28
Shrub/Fallow	12990	15.99	46,764,000	4,676.40
Water Body	246	0.30	885,600	88.56

Table 1: Land use/cover in 1986
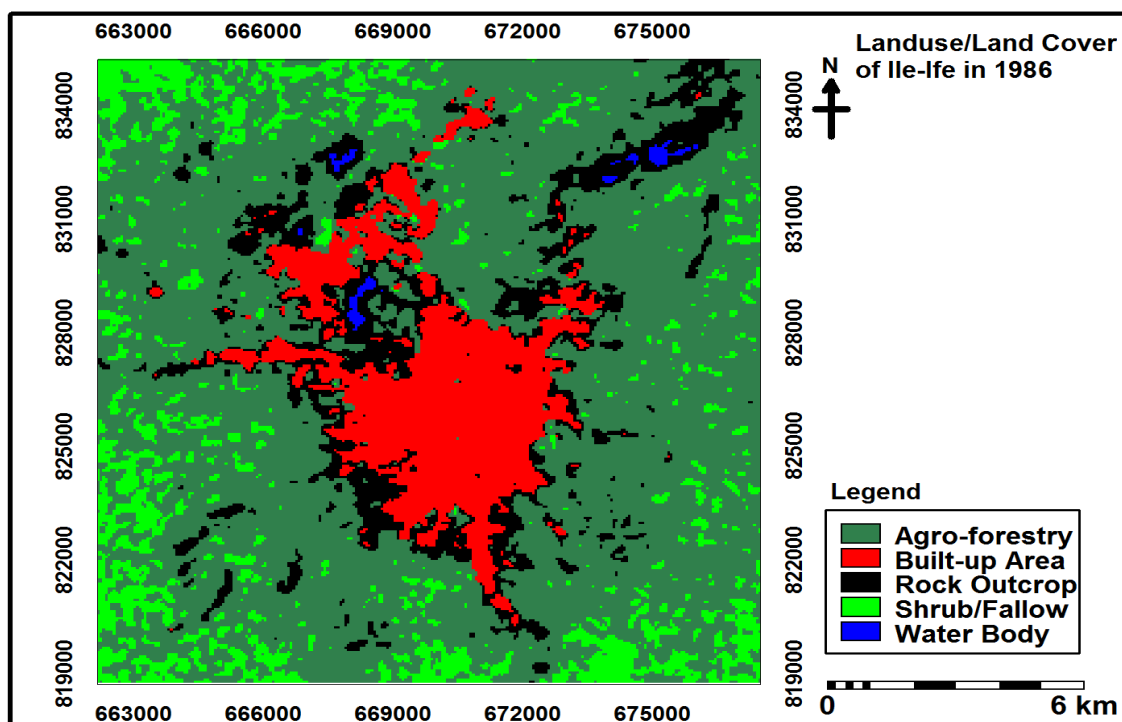
A. Pattern of land use/cover in 1986

Fig. 1: Land use/cover in 1986

Source: Authors Field work (2021)

B. Land use/cover in 2000

Class	npix	npix (%)	Area (m²)	Hectares
Agro-forestry	237575	73.04	213,817,500	21,381.75
Built-up Area	39328	12.09	35,395,200	3,539.52
Rock Outcrop	27714	8.52	24,942,600	2,494.26
Shrub/fallow	20188	6.21	18,169,200	1,816.92
Water body	452	0.14	406,800	40.68

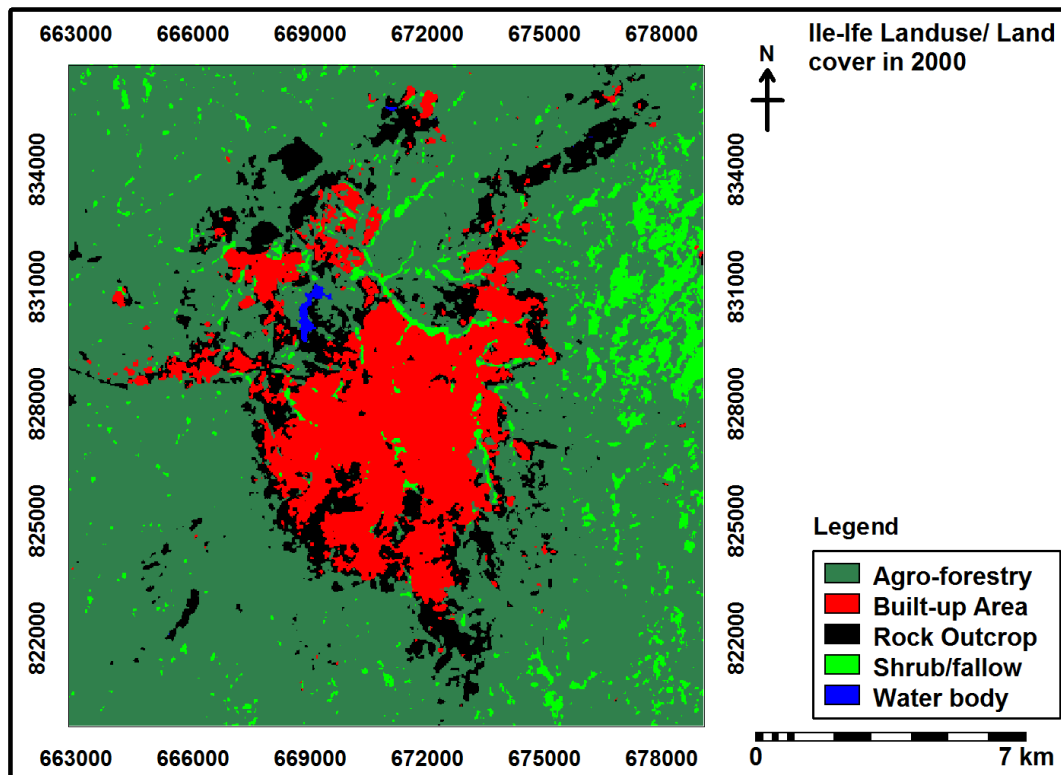Table 2: Land use/cover in 2000

C. Pattern of land use/cover in 2000

Fig. 2: Land use/cover in 2000

Source: Authors Fieldwork (2021)

Class	npix	npix (%)	Area (m^2)	Hectares
Agro-forestry	168566	51.97	151,709,400	15,170.94
Built-up Area	79064	24.38	71,157,600	7,115.76
Rock Outcrop	51674	15.93	46,506,600	4,650.66
Shrub/fallow	16921	5.22	15,228,900	1,522.89
Water body	8123	2.50	7,310,700	731.07

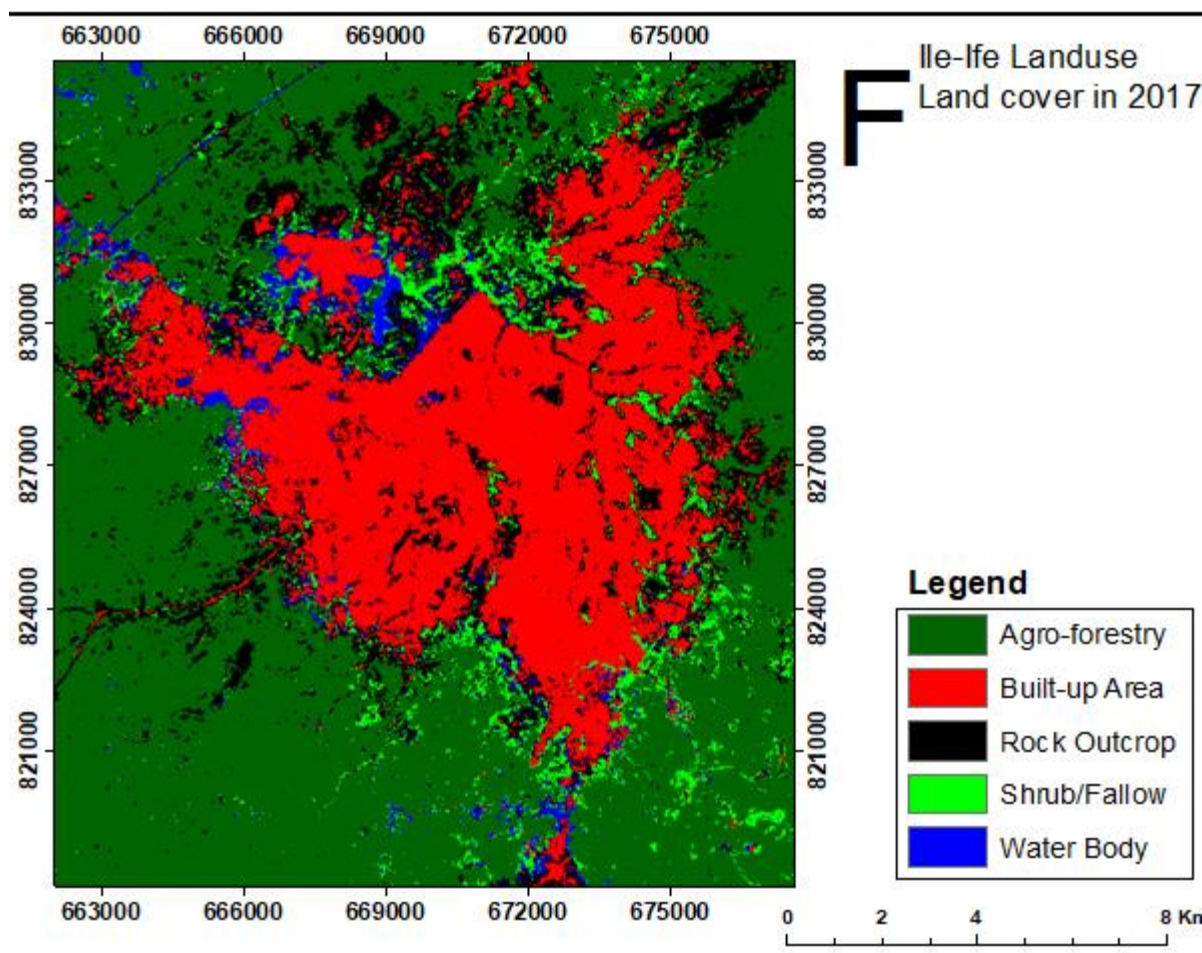Table 3: Land use/cover in 2017

Fig. 3: Land use/cover in 2017

Source: Authors Fieldwork (2021)

IX. ACCURACY ASSESSMENT

Image Data	Year	Average Accuracy (%)	Average Reliability (%)	Overall Accuracy (%)
Landsat TM	1986	81.92	74.62	86.77
Landsat ETM+	2000	97.20	97.73	97.17
Landsat OLI	2017	Kappa coefficient - 87.85%		Kappa statistics - 0.826

Table 4: Land use/cover Accuracy Assessment

Change detection analysis

Land use Type	Land use in 1986		Land use in 2000		% change (1986-2000)	Land use in 2017		% change (2000-2017)	
	Area (ha.)	%	Area (ha.)	%		Area (ha.)	%		
Agro-Forestry	18541.80	63.40	21381.75	73.04	9.64	15170.94	51.97	-21.07	(-) ve
Built-up area	3014.64	10.31	3539.52	12.09	1.78	7115.76	24.38	12.29	(+) ve
Rock Outcrop	2924.28	10.00	2494.26	8.52	-1.48	4650.66	15.93	7.41	(+) ve
Shrub/Fallow	4676.40	15.99	1816.92	6.21	-9.78	1522.89	5.22	-0.99	(-) ve
Water body	88.56	0.30	40.68	0.14	-0.16	731.07	2.50	2.36	(+) ve

Table 5: Land use/cover change between 1986 and 2017

X. ANALYSIS OF URBAN SPRAWL OF ILE-IFE BETWEEN 1986 AND 2017
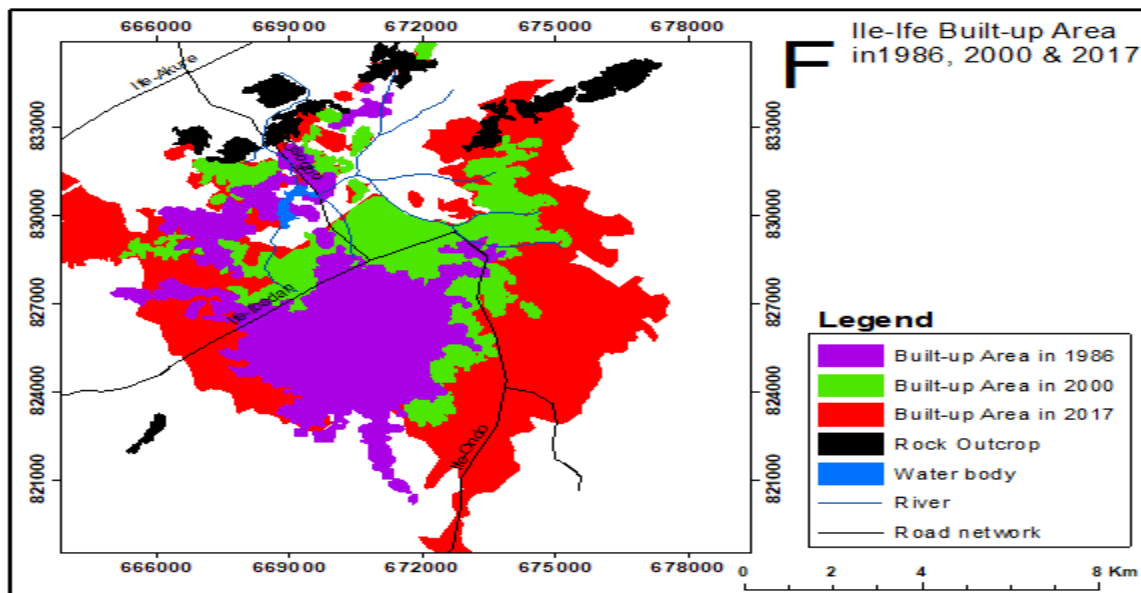

Fig. 4: Urban sprawl of Ile-Ife between 1986 and 2017

Source: Authors Fieldwork (2021)

XI. DISCUSSION OF THE ANALYSIS

On the change detection analysis as revealed in table 5, two levels of changes in land use/cover between 1986 and 2000 and between, 2000 and 2017 were shown. Between 1986 to 2000 Agro/Forestry cover increased in hectres from 18541.80 to 21381.75 which is from 63% to 73.04. This was a positive increase of 9.64%. The meaning of this is that the population of people of Ile-Ife was at minima. Farm lands/Forest areas were not yet encroached to and used as built-up area. Though the built-up area equally increased from 3014.64 to 3539.52 which is from 10.31% to 12.09% respectively. The increment in built-up area possibly affected shrub/fallow within and at the fringe of the town, the rock outcrop which can be probably broken to accommodate buildings and the water body especially the swampy or water logged within the town which were possibly used for petro filling stations and central market, etc. All those land use/covers apart from Agro/Forest and Built-up areas had negative change.

Between 2000 – 2017, there was a drastic negative change in Agro/Forestry land use from 73.04% to 51.9% which was a significant negative change of 21.07% and a significant positive increase in Built-up area of 12.29%. This shows that the city has started sprawling into Agro/Forestry covers in different directions as shown on the map. Rock outcrop also had positive increase of 7.41, since

land has been continued to be subjected to open surface there are tendencies for agents of denudation to set in which would eventually lead to more rock out crop of Alakowe hill, O.A.U hill, Koola hill etcetera as shown in the map on figure 4. Suburb still have negative change of 0.99. The water body is having positive change of 2.36. Reason for this is not far fetched, vegetation and farm lands that have became built-up areas would definitely increase water erosion and thereby increase sizes of the treams that run across the city such as Opa, Ogboku, and Esimirin, etc.

Finally, the analysis of ANOVA i.e. Analysis of Variance used in SPSS version 16 as expressed in table 6, and 7 showed a significant difference (K = 0.046, P = 0.00) in the level of land use pattern in the study area over time.

XII. IMPLICATION OF THE STUDY

There are grave consequences of this sprawl in the study area. In the first premise, there has been a grevious effects of storm in many places in Ile-Ife. This seems to have become yearly occurrences. Storms often cart away the roofs of houses, shops, schools and other public buildings. Plates shown here under were photographs of blocks of classrooms taken in two public secondary schools viz Oluorogbo High School and Oranmiyan Memorial Grammar Schools. The list is endless.

Plate 1: The block of classroom damaged by storm and abandoned due to incessant destructions year in and out in Oranmiyan Memorial Grammar School, Ile-Ife.

Plate 2: The block of classroom outrighty carted away by storm in Oluorogbo High School, Ile-Ife

Plate 3: Building under rehabilitation after being damaged by storm at Oluorogbo High School, Ile-Ife

The second consequence of this urban sprawl into the green environment is the increase in urban heat island of Ife. An urban heat (UHI) is a metropolitan area which is significantly warmer than its surroundings. The main causes are changes in the land surface by urban development along with waste heat generated by energy use and increase in carbon dioxide in the atmosphere. This has been causing discomfit on the heath of people in Ife-Ife recently.
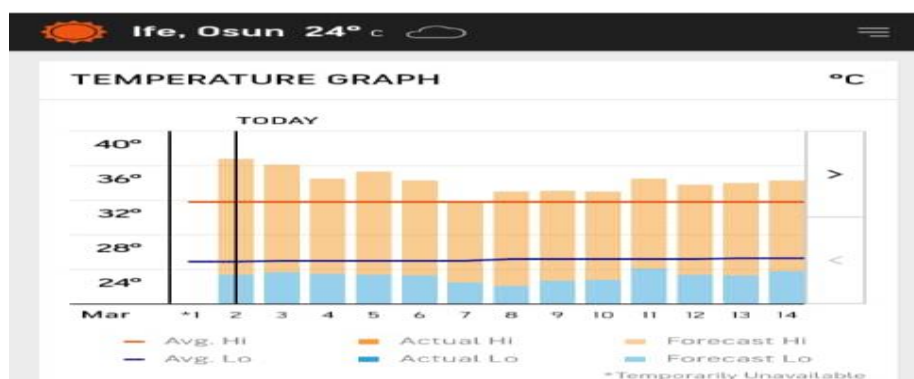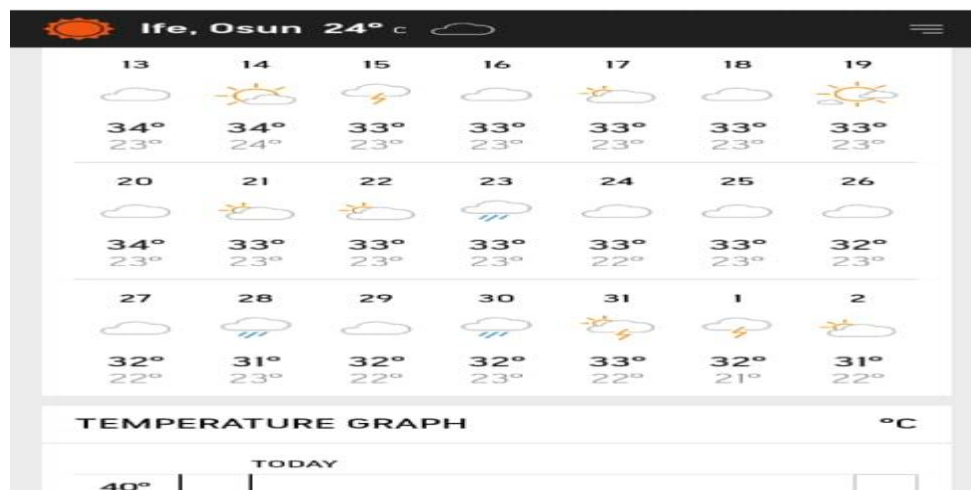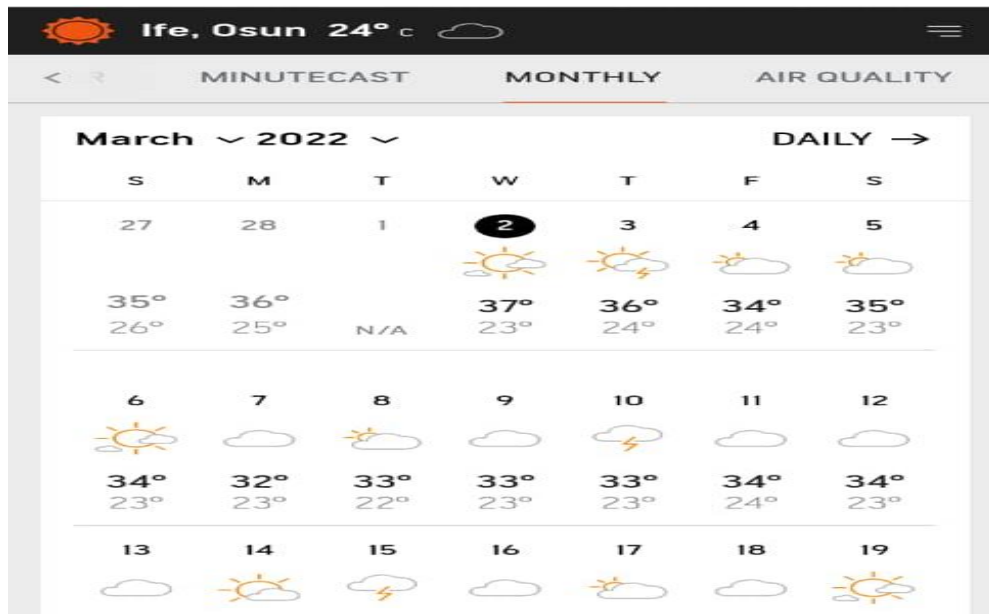

Fig. 5

Source: www.accurateweather.com....ife cited March, 2022

XIII. CONCLUSION

Having gone through the nitty-gretty of urbanity sprawl of Ile-Ife into its green environment in different sections of the city. There is therefore no doubt as it has been researched into that this continuous sprawling is bringing untold environmental problems especially of Urban Heat cum global warming with current repercussions of illness associated with environmental high heat and storms damaging house roofs, poles, and other public properties.

RECOMMENDATIONS

To ameliorate this situation in Ife and her region for now and possibly abolish it in the future, there is therefore the need for proper modern planning in Ile-Ife. At the same time we need conservation of forest resources all around the city which should be backed by government promulgation. People should also be encouraged to plant tress either at the frontage or back of their houses. There should be law against unnecessary trees felling within and outside Ife city.

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