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ANALYSIS OF GREENERY REDUCTION WITHIN IBADAN METROPOLIS AND ITS IMPLICATION ON TEMPERATURE

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ABSTRACT

This project examines the use of GIS and Remote Sensing in evaluating Greenery Reduction in Ibadan between 1972 and 2016 so as to detect magnitude of the changes that has taken place between these periods. Subsequently, the implications of foliage reduction on Temperature to determine heat island within Ibadan and used the result to suggest on how to sustain the Metropolis. In achieving this, imageries of 1972, 1984, 2000 and 2016 were classified into five classes which are Less built-up, Dense built-up, Light Forest, Dense Forest and Water. The quantitative assessment of the change shows a rapid growth in Less built-up features between 1972 and 1984 while between the period of 1984, 2000 and 2016 Light forest witnessed rapid reduction. Thermal Band of 2000 Landsat7 imagery and 2016 Landsat8 imagery were explored for Land Surface Temperature using NDVI to determine strength of vegetation. Further analysis was done on Global Weather data to see the effect of Temperature and the Rate of Precipitation on greeneries. The inference of this project is that degradation of vegetation cover is a determinant to Urban Heat Island (UHI). It was therefore suggested that there is need for proper planning and planting of trees so that Development will continue without hampering living in Ibadan.

KEYWORDS: Greeneries reduction, land surface temperature, Urban Heat Island, NDVI, Landcover.

INTRODUCTION

Impact of climate on urban greenery is incontestable, many anthropogenic influences such as rapid urbanization, institutional challenges and activities of city residents are often reported as contributing to the decline of urban greenery in African cities (Mpofu, 2013). Karl et al,(1988) estimated urbanization effects on the United States climate by using climate records and population data, their results showed that areas with high population were warmer than those less populated. (Mensah, 2014) indicate that the decline in urban greenery in cities in many African countries is contemporaneous mainly driven by rapid urbanization.

It has been observed that, there remain only few landscapes on the Earth that is still in their natural state. Due to human impact on the environment, the Earth's surface is being significantly altered in some manner. Also human presence on the Earth and his use of land has had a profound effect upon the natural environment. Thus, this has caused an observable pattern variation in the land use/land cover over time (Zubair, 2006).

The highest temperature reduction is observed where the foliage density is highest. Therefore, information on changes in greenery is important for optimal planning, selection, and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. (Adebayo and Bamidele 2000).

Turner (1987) stated that, there is an increase in awareness concerning the importance of sustainable urban development that is stimulating improvement in current methods of urban land usage, which is a complex interaction between physical, biological and social forces.

One of the initial major problem with environmentalist was to predict and model future with dynamics spatial data, but now Remote sensing and Geographic Information Systems (GIS), have been recognized as an effective tool for quantify urban growth at any desire scale (Yagoub, 2004).

Therefore using Remote Sensing and GIS techniques to evaluate greenery reduction and its implications on temperature changes in Ibadan metropolis will map the Landover change and determine trend of greenery reduction.

THE STUDY AREA

Ibadan city is located approximately on latitude 7^0 15' 00"N, longitude 3^0 45' 00"E and latitude 7^0 34' 00", longitude 4^0 05'00" E of the Greenwich Meridian. The name 'Ibadan' emanated from "Eba Odan" literarily meaning 'near the grassland' or 'the city at the edge of the savannah' in the South Western Nigeria, 128 km inland northeast of Lagos and 530 km southwest of Abuja , the federal capital, and is a prominent transit point between the coastal region and the areas in the hinterland of the country (Areola, O. 1994). It has a population of over 3.5

million, (National Bureau of Statistics Nigeria, 2014). . The mean total rainfall is 1420.06 mm, falling in approximately 109 days. There are two peaks for rainfall, June and September. The mean maximum temperature is 26.46^{0}C, minimum 21.42^{0}C and the relative humidity is 74.55% (Murphy and Lugo, 1986). There are eleven (11) Local Governments in Ibadan Metropolitan area consisting of five urban local governments in the city and six semi-urban local governments in the less city.

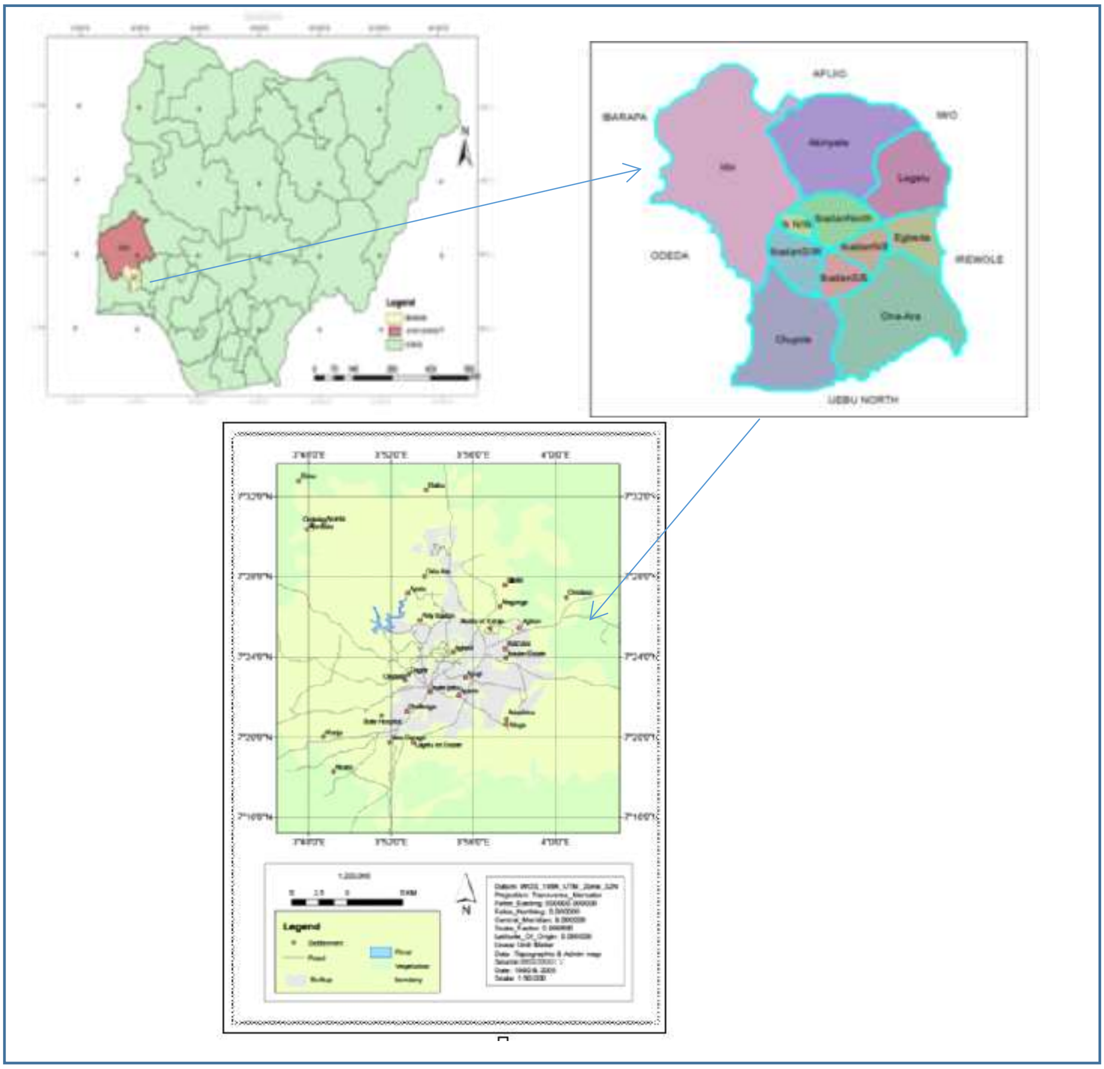

Figure 1: Map showing the study area (Ibadan Metropolis).

METHODOLOGY

To get reliable results, adequate attentions were paid in data collection, processing and analysis. Firstly, Data preparation were carried out using ERDAS Imagine on Landsat images (1972, 1984, 2000 and 2016) to evaluate change detection. Maps showing landcover was produced using ArcGIS software. Subsequently graphical analysis was done to show variation in landcover changes and temperature between 1972 to 1984 and 1984 to 2016.

Data used

The sources of data were secondary as stated in the Table below.

Table 1: showing data types and sources.

DATA	DATE	SOURCE	PURPOSE	SOFTWARE	ANALYSIS	EXPECTED RESULT

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Topo and Administrative map	1995 SCALE: 1:50000	OSGOyo/ RECTAS	Detailing	Scanner	Delineating existing features	Accurate softcopy map
LANDSAT MSS TM	1972 1984	GLCF	Greenery analysis	ERDAS 9.2,& ARCGIS 10.3	Classification	Change detection
LANDSAT 7 LANDSAT 8	2000 2016	GLOVIS	Thermal Dectection	ERDAS 9.2,& ARCGIS 10.3	Classification	Change detection
Weather Data	1979 - 2014	SWAT	Temperature & Weather Analysis	Microsoft Excel	Temperature & Weather Variation	Change Detection

Satellite Data process
The procedure involved downloading, manipulation and interpretation of imageries in order to enhance and increase visual distinction between features. It also involved increasing the amount of information that can be visually interpreted from the data. The Path and Row of the imageries downloaded are shown in the Table 2 below.

Table 2: showing Rows and Columns of the satellite images

Images	**Pixels per Line (Rows)**	**Lines Per Data File (Columns)**	**Path & row**
Landsat MSS 1972	3715	3329	205/055
Landsat TM 1984	6939	6389	191/055
Landsat7 ETM+ 2000	7512	8525	191/055
Landsat8 (2016)	7581	7761	191/055

In ERDAS Imagine 9.2, individual bands were subsequently loaded and were layers-stack to obtain a single Composite image. Subset were done to work within the projected area

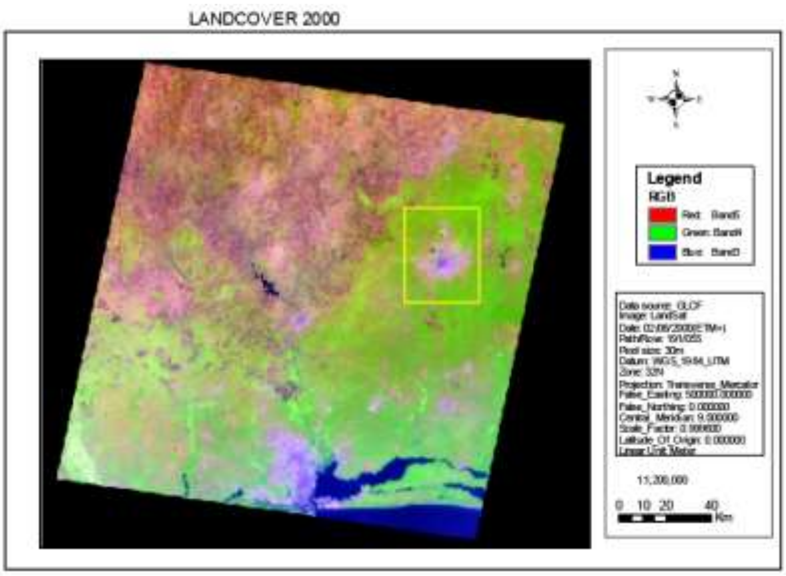

Fig 2: A scene of Landsat image showing Ibadan and environs1984

Table 3: showing co-ordinates of subsets

Upper coordinate	**Coordinates**	**Lower coordinate**	**Coordinates**
ULX	584504.28	**LRX**	616278.60
ULY	837045.72	**LRY**	792939.72
URX	616278.60	**LLX**	584504.28
URY	837045.72	**LLY**	792939.72

The coordinates above in Table 3.3 were used to create subsets of the Landsat MSS 1972,Landsat TM 1984, ETM+ 2000 and Landsat7 2016.

Development of a Classification Scheme
Based on the knowledge of the study area for some years and a brief reconnaissance survey as additional information for the study area, a classification scheme was developed for the area. Anderson et al., (1976) explain Classification scheme, as process that gives a broad land use/ land cover identification. Supervised classification was adopted which was based on the area shown in an image (Mather, 2004) and it allows the user to predefine spectral classes.

Table 4: showing Landuse landcover classification scheme

CODE	LAND COVER CATEGORIES
1	Dense Built-up
2	Less Built-up
3	Water bodies
4	Light forest
5	Dense forest

Procedure of Land surface Temperature determination.
To determining Land Surface Temperature; Digital Number were converted to Radiance and Radiance to Satellite Brightness Temperature. These lead to determination of Proportion of vegetation Pv = $(NDVI-NDVI_{min}/NDVI_{max}-NDVI_{min})^2$ and Land Surface Emissivity e = 0.004Pv + 0.986

$$BT/1 + W * (BT/p) * \ln(e))$$

BT=Satellite Temperature, W= Wavelenght of Emmitted Radiance (eg 11.5 µm for Band 10), p = h*c/s = (14380k), h(plank constant) = 6.626 $x10^{-34}$j/s, s (Bothzmann constant) =1.38 $x10^{-23}$j/k, c (velocity of light) =2.99 $x10^{8}$m/s, e (emissivity).
Source:http://landsat.usgs.gov.

This process can be performed in Raster Calculator in ArcGIS 10.1 or ENVI software with Band Math.

RESULTS AND DISCUSSION
The results are presented inform of maps, charts and statistical tables.

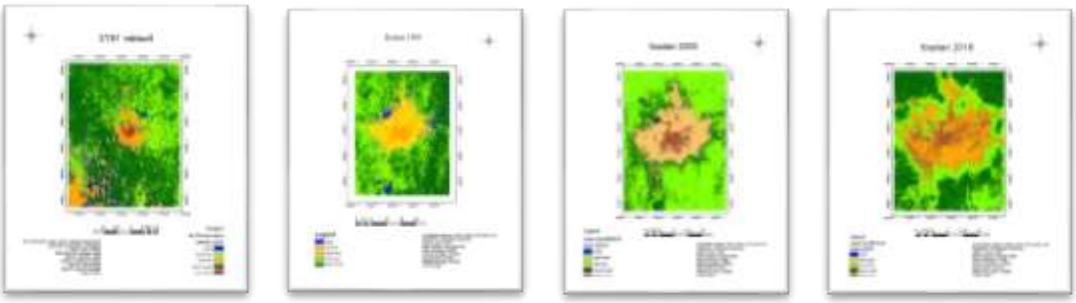

Fig. 3.1: showing classified Landsat image of 1972,1984,2000 and 2016

The landcover distribution of the study area of different years are presented in the table below.

Table 3. 1 : showing Land Cover Distribution (1972, 1984, 2000 and 2016)

LU/LC Classes	1972 (Hectares)	%	1984 (Hectares)	%	2000 (Hectares)	%	2016 (Hectares)	%
water	22687	1.455	69117	4.433	2371	0.152	1471	0.094
less built	51557	3,306	262368	16.826	334534	21.455	305880	19.617
dense built	3006	0.193	55718	3.573	60511	3.881	185365	11.888
light forest	693119	44.452	591465	37.93	842541	54.035	510370	32.732
Dense forest	788891	50.141	580592	37.235	319303	20.478	556174	35.669

TOTAL	1559260	100	1559260	100	1559260	100	1559260	100

A critical look and examination of the Table 3.1 above shows the total area Land covered of the study area to be 1559260Hectares.

In 1972 The Water body was (1.45%) and then increased sharply to 4.43% in 1984 possibly due to flood but eventually reduced to 0.15% and 0.09% in 2000 and 2016 respectively.

Less Built area of about 3.31% of the study area in 1972, increased to 16.83% in 1984 and also increased to 21.5% and 19.62% in year 2000 and 2016.

Dense Built, covered 0.19% in 1972 and increased throughout 1984, 2000 and 2016 with percentage of 3.57%, 3.88% and 11.89% respectively.

Light forest greeneries, which were about 44.45% in 1972, also reduced to 37.93% in 1984 but sharply increase in 2000 to 54.03% and reduced drastically 2016 to 32.7%.

Dense forest, with about 50.14% in 1972, reduced drastically to 37.23% and 20.4% in 1984 and 2000, but little increase in 2016 to 35.7%.

A critical look and examination of the 1984 compared with 1972 (total 94% of light and dense forest) shows reduction in forest to 75%, giving way to increase Less built and Dense built (3.31% to 16.82% and 0.2% to 3.57%).

For about period of 16years, between 1984 to 2000, classified images above clearly showed remarkable increase in Light built and Dense built-up area (37.23% - 54.03% and 3.57% - 3.88%), depicting the city growing both inwards and outwards.

2000 to 2016 which marks the beginning of Democracy government, It clearly shown that there is much reduction in Light forest (54.0% - 32.7%), again it shows that the interior is getting more crowded with Dense built increasing (3.88% - 11.88%).

Trend and Rate of greenery reduction
Thus as population densities increases the communities mature more and more, leading to landmass been occupied.

The result shows percentage of gain in Built ups and lost in Greeneries within 12years and 1st and 2nd 16years and as well difference in Annual rate per year

Table 3.2: showing Land use land cover change of Ibadan and its environs: 1972- 2016

LC Classes	**1972-1984**		**1984-2000**		**2000-2016**		**Annual Rate of change per year**		
	Area (Hectares)	**%**	**Area (Hectares)**	**%**	**Area (Hectares)**	**%**	**72-84 %**	**84-2000 %**	**2000-2016 %**
water	46430	7.489	-66746	-10.174	-900	-0.124	0.899	-1.628	-0.020
less built	210811	34.007	72166	10.999	-28654	-3.961	4.080	1.759	-0.634
dense built	52712	8.503	4793	0.730	124854	17.258	1.020	0.117	2.761
light forest	-101654	- 16.398	251076	38.269	-332171	-45.915	-1.967	6.124	-7.346
Dense forest	-208299	- 33.602	-261289	-39.826	236871	32.741	-4.032	-6.372	5.239
Total	619906	100	656070	100	723450	100	12	16	16

Statistics from the Table 3.2 above indicate Water reduction (7.49%, -10.1%, -0.12%) in 1972-1984, 1984-2000, and 2000-2016

It also suggested that, Ibadan city has a central growth from 1972 to 2016 (8.50% to 17.26%) for Dense built, indicating crowdness and increase in temperature in the core. and Less built area gain reduction in temperature because of reduction in Less built (34.01% to -3.96%) for 1972 to 2016.

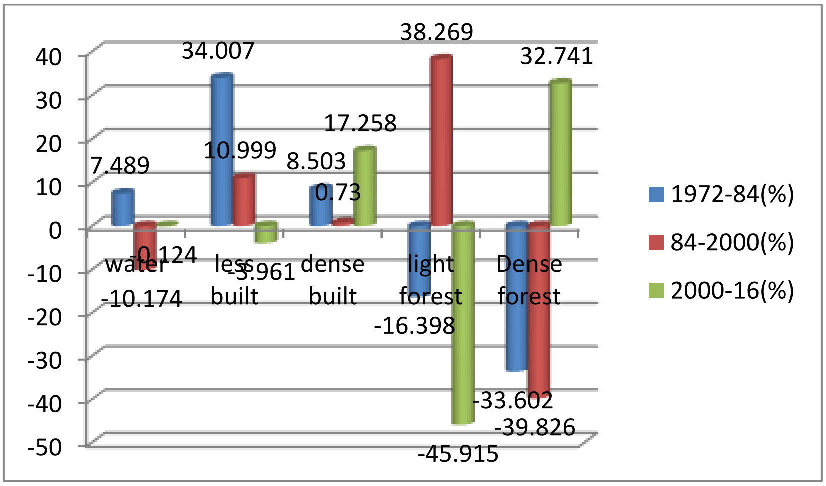

FIG 3.2: Showing Differences between Landcover bar chart from 1972 to 2016

These Built-up spatial entities increased and replace Forest entities that reduced.
Dense forest (37.19%, -52.425 and 32.74%) and Light forest (38.89%, 28.18% and -45.92%) reduced from 1972 to 2016. The forests reductions are more pronounced in 1984-2000 and 2000-2016 as indicated in the chart above. Fig 3.2

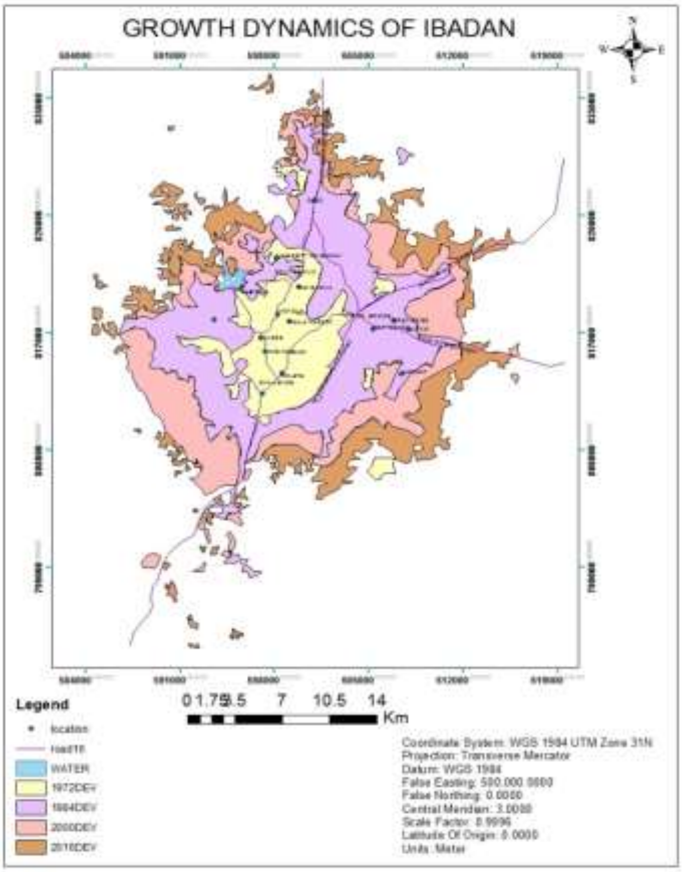

Fig. 3.3: Growth of Ibadan 1972 and 2016

Implication of greeneries reduction on Temperature
For Land Surface Temperature, 2000 Landsat7 ETM+ has Band 6 as the only Thermal band and 2016 Landsat 8 ETM+ has band10 and band11 for thermal band.

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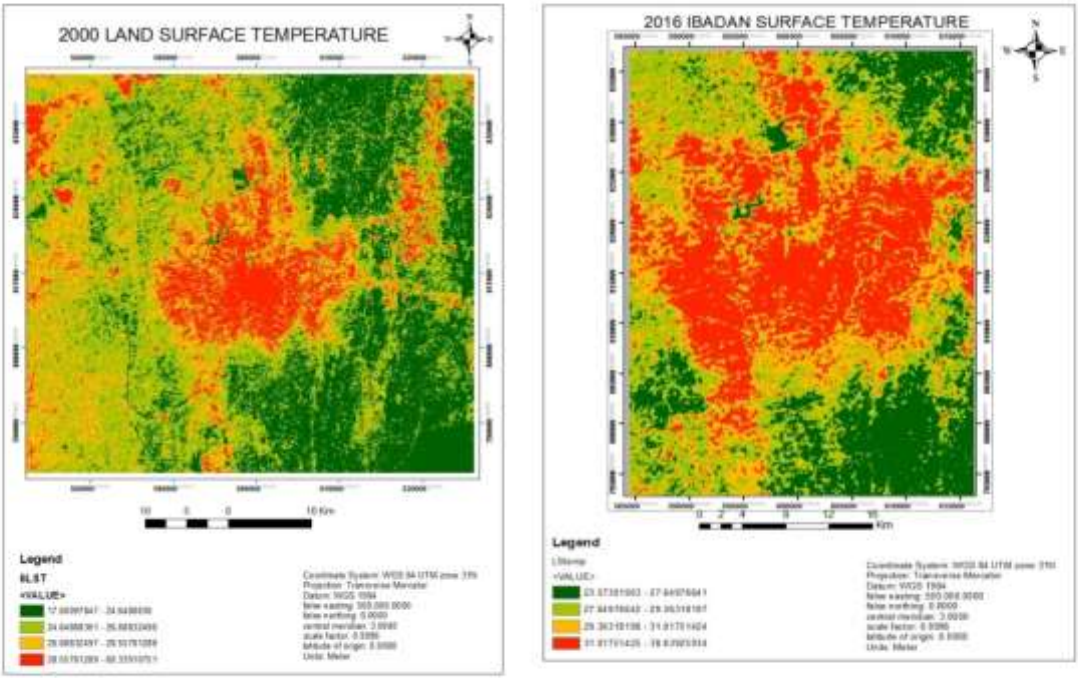

FIG 3.4: Showing Differences between Land Surface Temperatures of 2000 to 2016

The minimum limit of temperature between year 2000 and 2016 of Ibadan (17^{0}C – 24.6^{0}C) and (23.5^{0}C – 27.6^{0}C) compare with maximum (28.5^{0}C – 60.3^{0}C) and (31.0^{0}C – 38.6^{0}C) which infers an increase in Temperature due to reduction in Vegetation and increase in Urbanization such as Buildings, Roads and bear surface

Again Average weather temperature from SWAT (Global Weather and Atmospheric Temperature) shows increase within year 1980 to 2014 at minimum Ibadan (21.382^{0}C – 21.84^{0}C) compare to the maximu (31.922^{0}C – 33.327^{0}C). Reference Table3.3 and Figure 3.5

Table 3.3: Showing Average Temperature and precipitation of Ibadan

	1980	1985	1990	1995	2000	2005	2010	2014
min	21.382	20.895	21.895	21.59	21.139	21.886	22.324	21.84
max	31.922	32.751	33.305	32.361	35.284	34.316	33.487	33.327
Average(^{0}C)	26.652	26.823	27.6	26.9755	28.2115	28.101	27.9055	27.5835
Rainfall (mm)	1837.838	1700.818	1794.584	2082.84	687.312	1622.10	1359.55	786.243

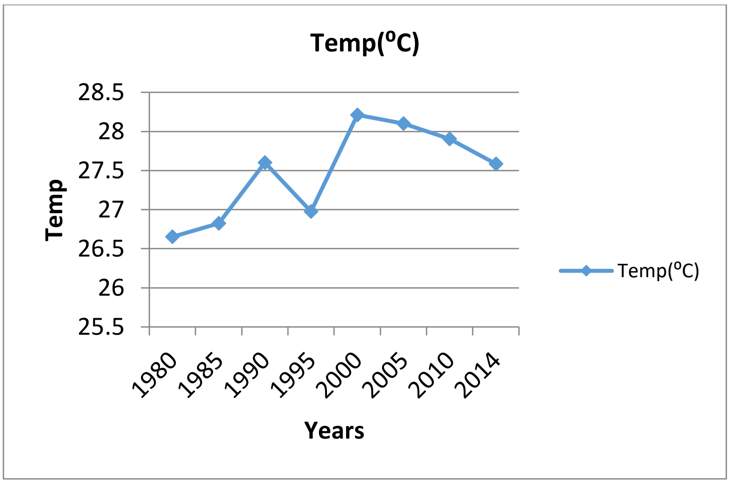

Fig 3.5: Showing Average Temperature chart from 1980 to 2014

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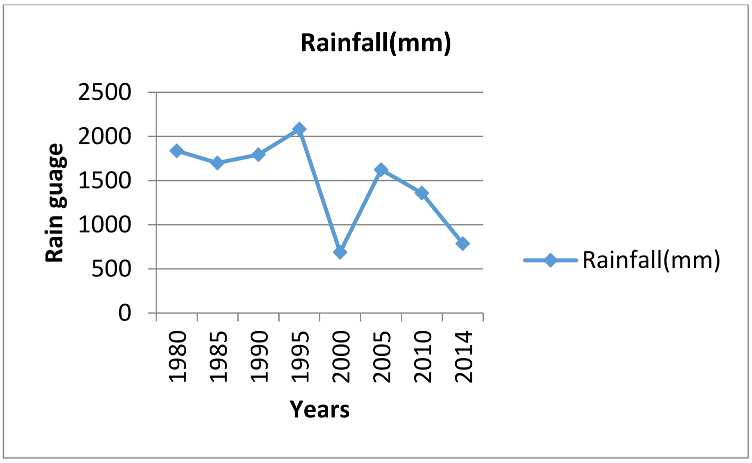

Fig 3.6: Showing Average Rainfall chart from 1980 to 2014

Reference to Figure 3.5 and Figure 3.6 showing sharp increase in Temperature in year 2000and decrease in light forest this due to shortage in rainfall within the year, but increase in temperature althrough.

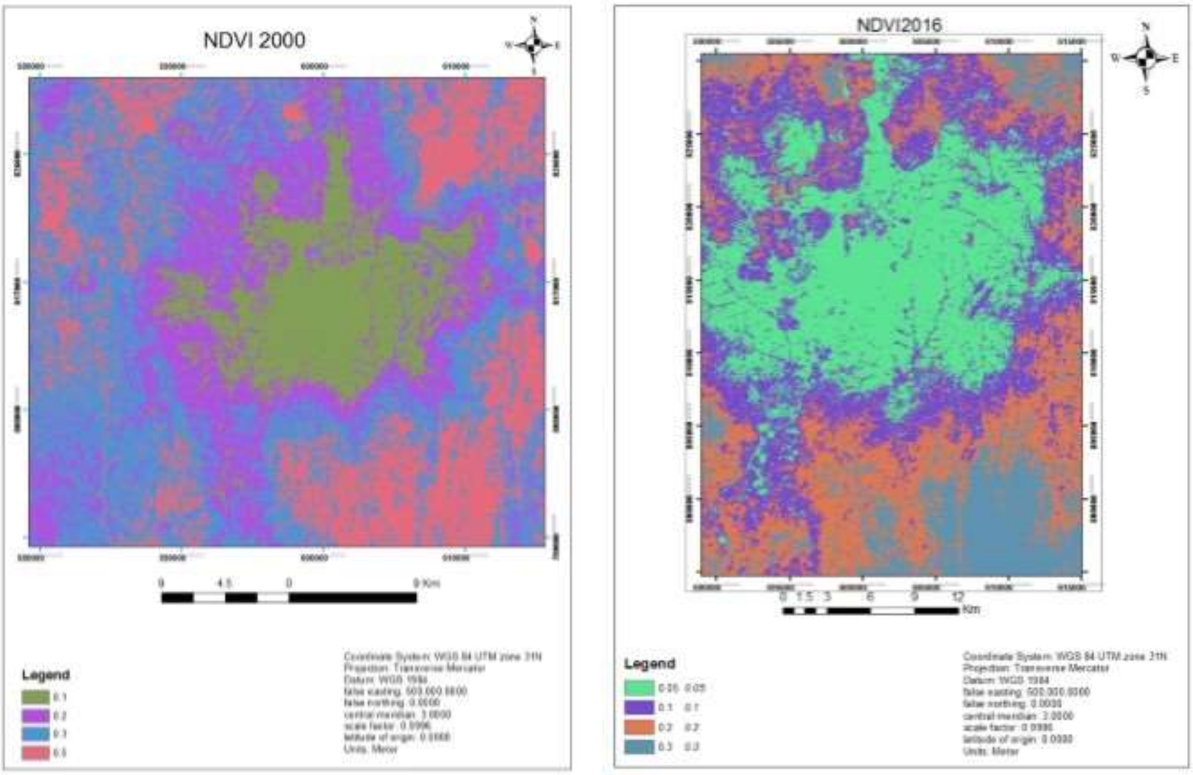

Fig 3.7: Showing NDVI Comparism between 2000 and 2016

Table3.4: Showing Vegetative Reduction and its healthy status

landuse	2000area	2016area	NDVI2000	NDVI2016
Dense Built	1969.29	2630.43	0.1	0.05
Less Built	2688.93	4035.42	0.2	0.1
Light Forest	5391	4468.14	0.3	0.2
Dense Forest	3221.82	2137.05	0.5	0.3

With the Rainfall and Temperature graph compared with NDVI result it shows that there was a drought in 2000 and temperature was very high.

FINDINGS

With Greeneries reduction, this situation has negative implications on Ibadan in terms of temperature and other associated problems.

The finding indicate that: Waterbody has reduced due to buildings from 1.455% to 0.094% Builtup both Dense and Less Dense has increased from 1972 to 2016 (3.499% to 41.49%) and replace greenery that experience reduction (94.59% to 68.39%) showing deforestation

Also with the range of sixteen years 2000 to 2016, temperature has increased from min of (24.6^{0}C to 27.6^{0}C) and max of (28.5^{0}C to 31.0^{0}C) indicating heat island It is therefore suggested that there is need for proper planning and planting of trees so that Development will continue without hampering living in Ibadan.

CONCLUSION

This project used classification to address growth in Ibadan and to examine the spatial pattern of Urban landcover changes in using remotely sensed data and GIS techniques.

The Project also used other source to confirm increase in temperature in Ibadan relevant to greenery reduction for period of forty-four years.

The degradation of vegetation cover is one of the determinant factors for heat island, other conditions that increase pressure on land by man's activities required caution and planning for sustainability.

RECOMMENDATION

Based on this study it is recommended that; the destruction of forests and agricultural land for highways and industries, should be controlled and regulated by state and federal Government

In as much as Greenery reduces and appropriate urban traffic speeds. Urban street trees should be planted along edges of road in other to help motorists guide their movement and assess their speed reductions.

A properly shaded neighborhood, Orchards and Landscaping should be introduced since Greenery lowers urban air temperature, because Asphalt and concrete streets and parking lots are known to increase urban temperatures.

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