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Climate Change Impacts in a Rapidly Growing Urban Region – A Case Study of Ikeja, Lagos, Nigeria

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Abstract

Current planning strategies for future urban development often target issues such as housing, transport, water, and infrastructure; but very few strategies comprehensively consider the urban climate and its interaction with the built environment as well as the resultant effects. Thus, this research investigated the climate change impacts in an urban area with a view to recommend measures to manage the emerging effects of climate change. For the purpose of this study, the study area is Ikeja local government area- a rapidly growing urban centre with an annual growth rate of 50%. The research design adopted for the study was survey research which involved site visitation for data collection, and analysis. The local government was subdivided into 3 development zone from which the sample size of 450 was drawn using simple random sampling technique. Data was sourced from the respondents using questionnaire, spatial data was sourced from trusted online sources, alongside other secondary data. Collected data from questionnaire was analysed using Statistical Package for social sciences (SPSS) version 22 while the spatial data was analysed using ArcGIS version 10.5. The result of the analysis revealed that Ikeja Local Government Area was densely populated. Majority of its residents are educated with 43.8% of the respondent having tertiary education. According to the study, identified climate change impacts on households include flooding, health risk, high temperature and dryness of well. The results from the GIS land cover analysis revealed that built up area in Ikeja local government have increased form 10.75% of the total coverage of the local government in 1980 to 92.11% in 2019. Accordingly, the climate of the area is expected to be significantly impacted. Thus, it was recommended that the local government need to develop information based system to manage urban growth in the area, initiate vulnerability assessment of the city and engage in public awareness on the importance of land use planning in mitigating effect of climate change.

Keywords

Climate Change, Urbanization, Urban Growth, Flooding, Ikeja, Nigeria, GIS

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1. Introduction

Over the years, human activities have modified the environment. Substantial population growth, accelerated socio-economic activities and migration have exaggerated these environmental changes over the last decade. The impacts of these changes on urban climate have become evident in global, regional, and local trends in contemporary atmospheric temperature, humidity, rainfall records and other relevant climatic indicators [1].

The United Nation Department of Economic and Social Affair estimated that 55% of the world's population lives in the urban area and projected that the percentage will further increase to about 68% in 2050, with Nigeria, India and China contributing 35% of the estimated urban population growth [2]. Interactions between human population dynamics and the

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environment have often been viewed mechanistically, and increase in human population is believed to have significant effect on the environment which includes the climate of the area [3]

Climate change resulting from unmanaged urban growth and population increase pose a set of high risk [4] capable of impacting people, properties and the urban environment. Urban areas are expected to face major challenges in order to adapt to and mitigate the consequences of severe weather conditions which are as a result of climate change [5]. Cities differ with respect to the levels of risk that they will face and their ability to handle these expected blows. However, the consequences of this are very costly and always severe on urban communities [4]. Climate change impacts include increase in global temperature which brings disastrous consequences, endangering the survival of the Earth's flora and fauna, including human beings. The melting of the ice mass at the poles is another major impact of climate change on human environment. This in turn result to increase in sea level, producing coastal flooding [6] and threatening communities along the coast which ultimately has caused the total disappearance of some small islands along the coast. Climate change also intensifies the appearance of more violent weather phenomena such as: wild fires, drought, flooding from rivers and lakes, the death of animal and plant species, the creation of climate refugees and destruction of the food chain and economic resources; particularly in developing countries [7].

Lagos State with the population of 21 millon and population density of 13,000 residents per square kilometre is the largest city in Africa and one of the top 20 in the world [8]. The state is the premier metropolis in Nigeria and has experienced a much faster *growth* rate than any other *urban* centre in Nigeria. This study, thus, seeks to investigate the perceived effect of climate change and recommends strategies to reduce risks.

2. Materials and Method

2.1. Study Area

Ikeja is the capital of Lagos State. Lagos state is located between latitudes 6°23'N and 6°41'E; and longitudes 2°42'E and 3°42'E. Lagos State is bounded in the North and East by Ogun State, in the South by Atlantic Ocean/Gulf of Guinea, in the West by Republic of Benin (see Figure 1).

Previous studies revealed that the state has been experiencing rapid spatial growth. For instance, it grew from 3.85 km^2 in 1881 to 46.6 km^2 [9] in 1911; 52.3 km^2 in 1921 to 66.3 km^2 in 1931; 69.9 km^2 in 1952 to 69.9 km^2 in 1963; 85.44 km^2 in 1986 to 96.53 km^2 in 1990 [10]; and to 950.72 km^2 in 2006 [11, 12].

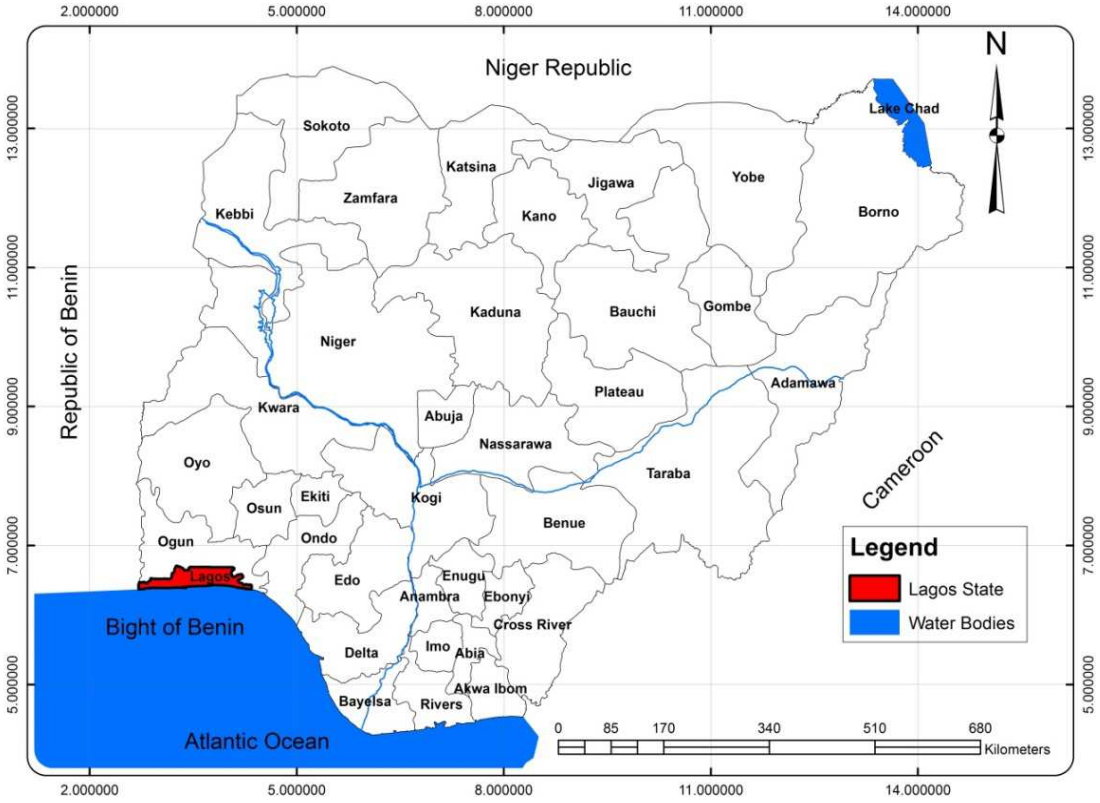

Figure 1. Map of Nigeria showing Lagos state.

Source: Divamaps, 2018.

Ikeja Local Government Area is located within 30° 30' West and latitude, 70°30' North. It lies in the mainland/upland area of Lagos State. The Local Government shares boundary with Agege, Alimosho and Ifako-Ijaye Local Government Area in the Western region, Kosofe Local Government Area in the Eastern region. Ikeja Local Government also maintains its Southern boundary with the Mushin and Oshodi/Isolo Local Government Areas and its Northern boundary coincides with the boundary of Lagos State with Ogun State (see Figure 2). Ikeja became the Local Government Capital of Lagos State in 1976 after the creation of 19 States in the country and since then, the Local Government has witnessed tremendous development; being the administrative, commercial and industrial hub of the state [12].

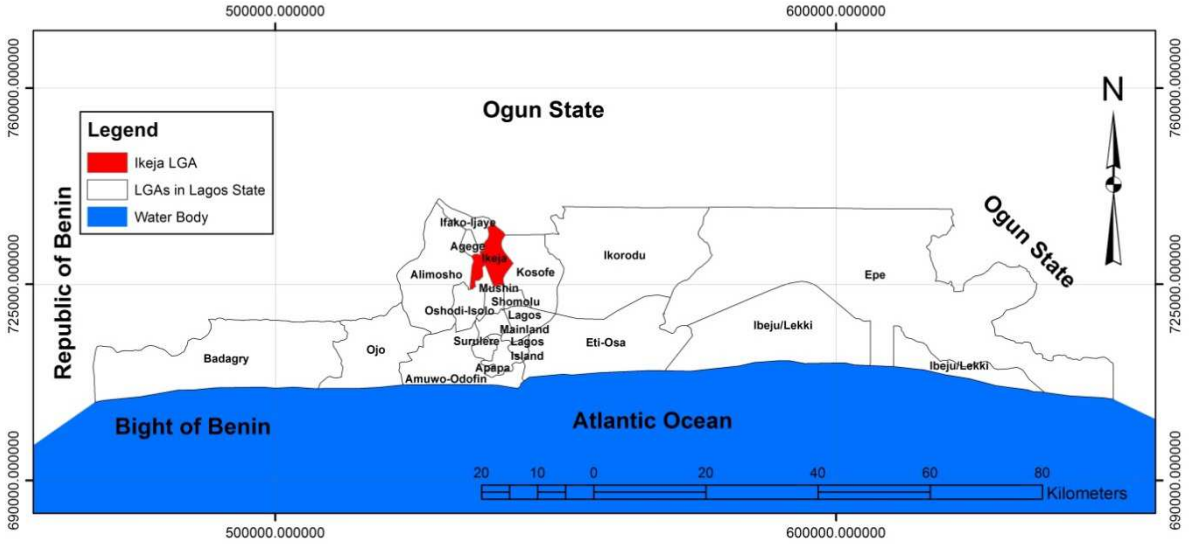

Figure 2. Map of Ikeja Local Government Area in its Regional Settings.

Source: Divamaps, 2018.

2.2. Method

The study relied on both primary and secondary sources of data. The authors, with the help of trained field assistants collected first-hand information from the residents of different residential zones in Ikeja Local Government Area. The primary data were sourced through the use of structured questionnaire. The questionnaire containing questions on the socioeconomic characteristics of the residents, and the perceived impacts of climate change experienced by the people, was used to elicit information from the sampled residents. The secondary data were sourced from reputable journals, textbooks, amongst others. Also relevant to this study, are spatial data (Table 1). For example, Google Earth images, Elevation data, and Landsat imageries. The last two were gotten from the United State Geological Survey's (USGS) server [13]. The spatial datasets were integrated together in ArcMap environment to generate the spatial trend of urban growth in the study area.

Table 1. Summary of Data Sources.

Dimension	Dataset Name	Unit	Resolution
Elevation	SRTM Version 3	Sq km	90m (Horizontal) 1m (Vertical)
Landuse	Landsat	Sq Km	1km
Satellite image	Satellite imagery	Km	30m

Source: Authors' compilation, 2019

The research population for this study is the totality of the respondents in the study. The result of the National Population Commission's 2006 Census put the population figure of Ikeja Local Government Area at 317,614 [14]. The 2006 population was projected using the NPC approved national growth rate 3.18%. This puts the population of the Local Government Area at 477,135 in the year 2019. The mathematical calculation is given below:

$$Pt = Po\ (1+3.18/100)^n$$

Where Pt = projected population

Po = base population of the area

n = number of years which projection is made

3.18 = NPC Lagos state growth rate, 2006.

Hence;

$$Pt = 317{,}614\ (1+3.18/100)^{13}$$

i.e. projected population from 2006 to 2019 (n=13 years)

Pt= 317,614 (1.3168)

Pt= 477,135

Therefore, present population as projected for Ikeja (2019) = 477,135 inhabitants.

In selecting the sampling frame, the study refines the subdivision presented in Adekunle (2017) [15]. Ikeja city was subdivided into 3 development zones: the core, transition and the periphery with population of 193,098; 125,778 and 52,092 respectively according to the State's National Population Commission in 2016. This population was projected to 2019 to get the population of the local government. Going by the Nigeria demographic and health survey of 2013 [16] standard of 5-person per household, the 2019 projected population was further subdivided to get the number of household in the local government given that the questionnaires were to be administered to each household. This informed the sampling frame for this study (see Table 2).

Table 1. Sampling Frame.

Development zones	Population in 2016	Population in 2019	Number of Household
Core	193,098	238,567	47,713
Transition	125,778	166,997	33,399
Periphery	52,092	71,571	14,314
Total	370,968	477,135	95,426

Source: Authors' computation, 2019

From the above research sample frame of 95,426 households, a sample size was taken in other to reduce cost and time for the research, given the homogenous characteristics of the residents in the core, transition and periphery of Ikeja Local Government Area. According to Statistics Canada (2003) [17], a sample of 0.5% is acceptable for frame between 50,000 and 100,000 for research within the field of social science. Thus, 0.5% of the household from each development zones were sampled for this study and a summation of which gives 475 households (Table 3).

Table 3. Sampling Size.

Development Zone	Number of Household	Sample Size
Core	47,713	238
Transition	33,399	166
Periphery	14,314	71
Total	95,426	475

Source: Authors' computation, 2019

The simple random sampling technique was employed to select buildings where questionnaires were administered. Data collected with questionnaire was subjected to descriptive analysis which requires the use of statistical package for social sciences (SPSS) and Microsoft excel software. On the other hand, the spatial data were analyzed with ArcMap.

3. Results

3.1. Questionnaire Results

Socio-economic Characteristics

In the examination of the socio-economic characteristics of the people in the study area, the sex composition of the target population is important. In the case of the study area as presented from the analysis from questionnaire administration, the sex composition portrays that the males has a prominent presence in the population structure of households with a 53.1% responses compare to the females 46.9% composition.

As obtained from this survey, age structure within the study area shows that the working class that is; 18-34 and 35-36 form the bulk of the repondents with 43.70% and 40.10% respectively while the dependent population with age 65 and above constitute 16.2% of the respondents. The population structure diminishes from the youth to adult and then to the aged as presented in Table 4. with a mean age of 40 and standard deviation of 16 years, the skewness of age distribution of respondent is 0.59 which implied that it is positively skewed, this is a reflection of rural influx into the study area.

The result of the composition of the ethnic group of the respondents in the stydy area revealed that 46.4% of the respondents are Yoruba while, 36.4% and 17.2% are Igbo and Hausa respectively. The resullt of this analysis confirmed the UNESCO asserssion that Lagos state possesses strong attraction of migrants with heterogenous composition of more than 250 ethnic group [18].

The result of the analysis of field survey confirmed the result of a study carried out by Lagos State Bureau of Statisics (LBS) in 2011 [19] that revealed that Lagos state has the highest percentage of educated citizens in the country as presented in Table 4. Data collected revealed that all respondents in the study area have formal education with 43.8% having tetiary education, 32.2 and 24.0% having secondary and primary education.

Given the high influx of people from other part of the country into lagos state this have a big toll on the household size in the study area as presented in Table 4, 36.22% of the household head reponded that they have an house hold size betwwen 5-7, 28.89 and 28.44% have household of 8-11 and 1-4 repectively while 6.45% have household size greater than 11. This put the average household size in the study area at 7 and going by the result of the National health and demographic survey 2013 which puts the average household in the country at 5 and by implication household size in the study area is greater than the national average which is an indicator of urban growth [20]. The skewness of the household size is rightly skewed (0.18), it is therfore approximately skewed.

The attainment of Goal 1 and 2 of Sustainable Development Goals (SDGs) (No poverty and Zero hunger) hinges on the income level of the people. Goal 1 gives the benchmark of individuals living below $1.25 (NGN 456) a day as extremely poor and it is very difficult for a poor person to think about effictive management of the environment which in turn might have great concequence on climate change. Result of the field survey as presented in Table 4 revealed that the average monthly income of the respondent is NGN 30, 231 which is equivalent to NGN 1,008 per day which is above which gives room for household to spend more $1.25 (NGN 456) per day which is the United nations benchmack however, 6.22% of the responses still earns below 18,000 which is a monthly income that tends to be lower the United Nations benchmack of poor household. The skewness however is 0.18 which signifies the income in the study area is approximately around the mean.

The result of the field survey as presented in Table 4 revealed that of the mean length of stay of the residents interviewed for the study is 30.53 years and according to the National Aeronautics and Space Administration (NASA) the average study period for climate studies is 30 years. Thus, the responses from these respondents are valid for this the purpose of this work.

Table 4. Socioeconomic Characterstics.

	Frequency	Percentage (%)	Mean	SD	Skewness
Gender					
Male	239	53.10			
Female	211	46.89			
Total	450	100.0			
Age					
18-34	180	43.70			
35-65	197	40.10			
Above 65	73	16.20			
Total	450	100.0	40	16	0.59
Ethnic Group					
Yoruba	209	46.40			
Hausa	164	36.40			
Igbo	77	17.20			
Total	450	100.0			
Education					
No Formal Education	0	0			
Primary Education	108	24.0			
Secondary Education	145	32.2			
Tertiary Education	197	43.8			
Total	450	100.0			
Household Size					
1-4	128	28.44			
5-7	163	36.22			
8-11	103	28.89			
Above 11	62	6.45			
Total	450	100.0	7	3	0.18
Average Income per month					
0 - ₦18,000	28	6.22			
₦18,000 - ₦ 36,000	84	18.67			
₦36,001 - ₦ 54,000	197	43.78			
Above ₦54,000 ( )	141	31.33			
Total	450	100.0	₦30,231	10,005	0.18
Length of Stay					
Less than 10 years	46	10.22			
11 -20 years	72	16.0			
21- 30 years	102	22.89			
Above 30 years	230	51.1			
Total	450	100.0	30.53	6	0.09

Source: Authors' Fieldwork, 2019

Climate Change Impacts

The residents in Ikeja Local Government Area were inquired about the effect of changes in climate in the activities of their household and the effects where ranked as strongly disagree, disagree, undecided, agree and strongly agree carrying a factor of 1, 2, 3, 4 and 5 respectively. The analysis of the responses obtained from the field survey as presented in Table 5 revealed the climate change impacts as well as their means

Table 5. Effects of Climate Change on Household.

Climate Change effects	Mean	Standard Deviation
Flooding	4.81	1.05
Dryness of river and well	3.91	1.30
Health risk	4.61	1.12
Higher temperature	4.88	1.06

Source: Authors' Field work

Figure 3. Flooded Road in the Study Area.

Source: Authors' Fieldwork, 2019

Figure 4. Flooded Building in the Study Area.

Source: Authors' Fieldwork, 2019

Findings as presented in Table 5 shows that the respondents in Ikeja Local Government all agree that climate change has an effect on their day to day activities (with mean ranging from 4.61 to 4.88) by causing flooding, abetted by the poor condition of drainage facilities. Thereby, impacting buildings (Figure 4) and access roads (Figure 3), leading to traffic congestion, health risk like spread of dengue fever, malaria, leptospirosis and cholera and high temperature. However, respondents were undecided as to the effect of climate change on dryness of river and wells as majority of responses make use of bore hole and pipe bore water which is not influenced by climate change easily having a mean of 3.91. The Standard deviation of the effect stands between 1.05-1.22 showing relative consistency in the responses of the sampled respondents.

3.2. Urban Growth Results

From the administrative boundary of Ikeja Local Government Area, the total area of the local government from its perimeter boundary was estimated at 49.92 sq. km. ArcGIS version 10.5 was used to analysed the Landsat 8 of Ikeja Local Government Area from 1980 to 2019 (i.e. 1980, 2000 and 2019) using the composite raster and image classification toolset. The result of the analysis (see Table 6) revealed that just 10.75% of the total land area in the area has been developed as at 1980 which was classified as built up area in the ArcMap analysis (see Figure 5) however by year 2000, the built up area in the local government has increased to 77.32% (see Figure 6) while in 2019, the result revealed that the total built up area amounts to 92.11% of the total land area in the study area (see Figure 7). The result of this analysis revealed that Ikeja local government has witnessed tremendous increase in the percentage of the built up area over the years which is a reflection of the high rate of urban growth in the study area from 1980 till date. The implication of this, however, is that increased urban development has led to the removal of natural vegetation which is supposed to release water vapour necessary for cloud formation, absorb and emit energy used to drive the weather of the area by controlling the humidity and temperature through transpiration.

Table 6. Analysis of landuse classification of Ikeja local government area from 1980-2019.

	1980	2000	2019
Built up Area (km^2)	5.37 (10.75%)	38.60 (77.32%)	45.98 (92.11%)
Vegetation	44.55 (89.25%)	11.32 (22.68%)	3.97 (7.89%)
Total	49.92	49.92	49.92

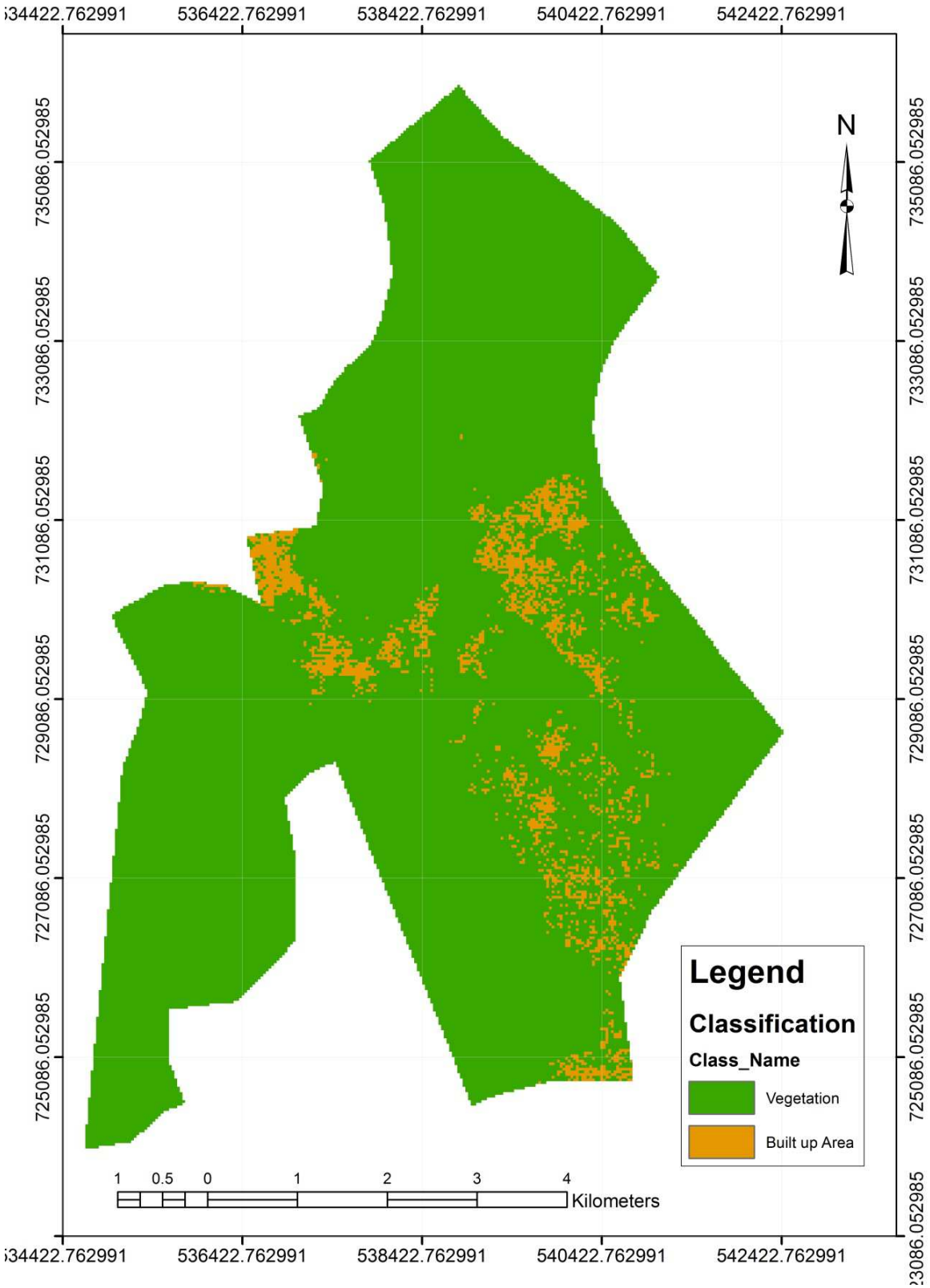

Figure 5. Map showing Image classification for 1980.

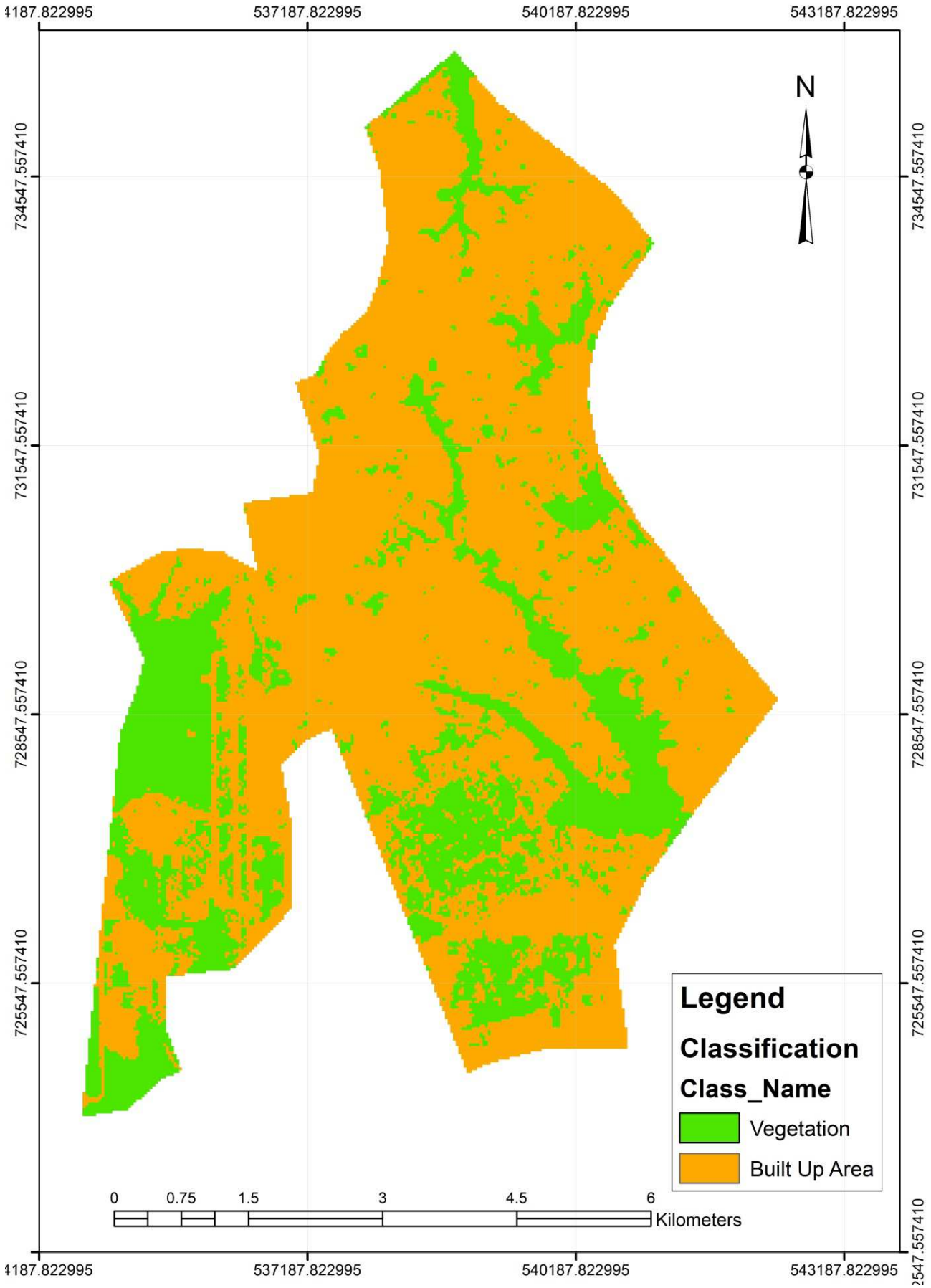

Figure 6. Map showing Image classification for 2000.

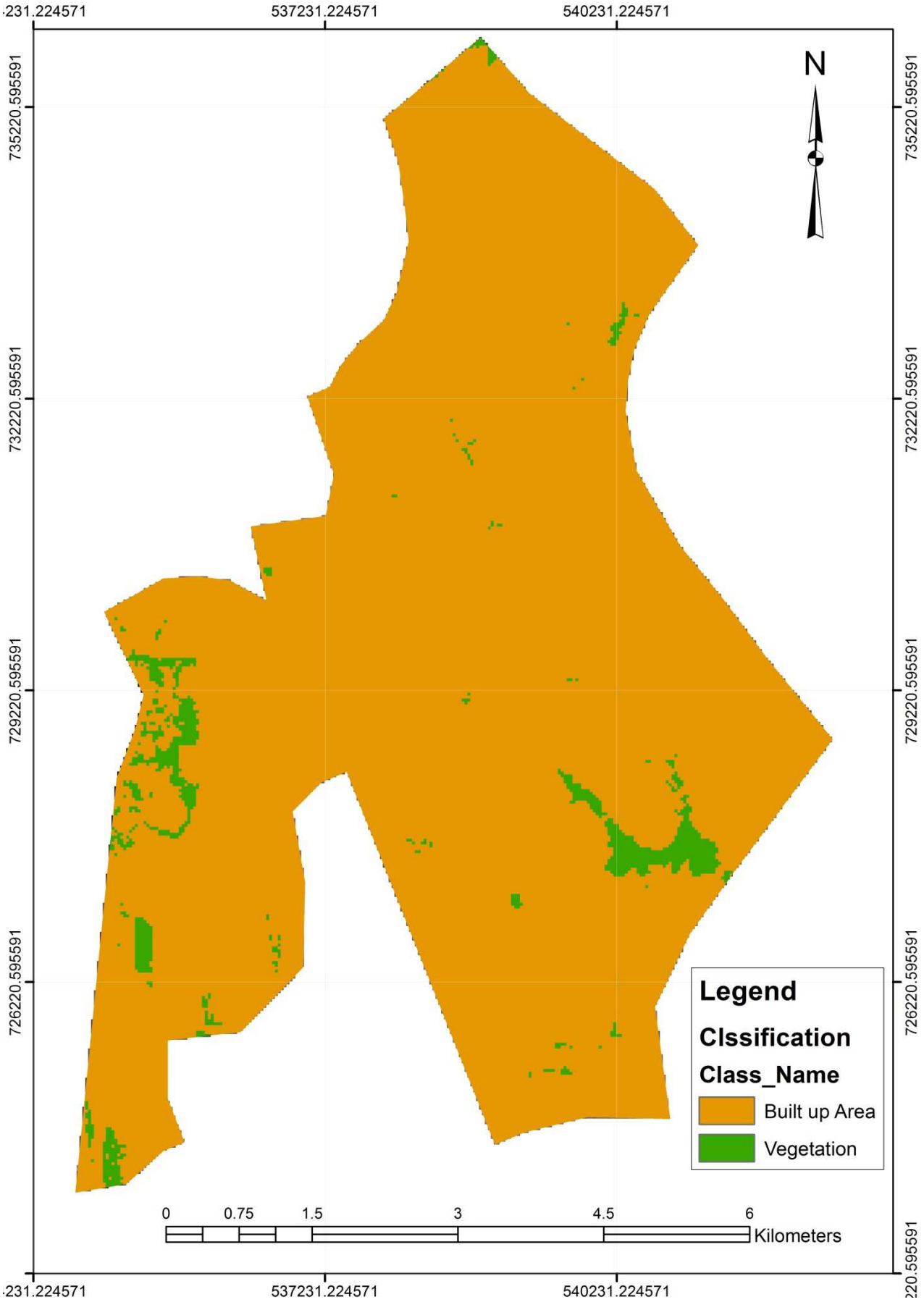

Figure 7. Map showing Image classification for 2019.

4. Discussion

Planning for future urban growth and development amidst threats from climatic conditions is a difficult task for urban planners. Given the present state of urban development in Ikeja Local government area and the combined threat of global warming and the climate, strategies need to be developed to incorporate initiatives that can marry a change in climate with the need for land use planning of Ikeja. Planning professionals need to incorporate climate change scenarios (that could also include urban heat island scenarios) into both short term planning decisions and longer term strategic regional planning decisions, using a more integrated approach than is currently adopted in modern day planning strategies.

Analysis of the data collected for the study revealed that although majority of the residents in the study area are lettered with 43.8% of the respondent having tertiary education and also earning judiciously high income with about 80% of the respondent earning above the national minimum wage. The GIS analysis of the trend of Land use and Land Cover change revealed that development in Lagos state has grown rapidly over the years from 10.75% of the total land area in 1980 to about 92.11% in 2019 leaving just 7.89% of vegetation in 2019. The consequence of this on the change in the atmospheric condition of the state is quite significant as issues such as flooding, dryness of river and well, health risk as well as high temperature have been identified by the respondents.

5. Conclusion and Recommendations

This study revealed that urban growth in the study area has increased tremendously over the years and this is already taking a spell on the climate of the area resulting in adverse effect on the both physical environment and socio-economic activities of the people in the study area. This call for urgent action in the area in other to reinstall balance in the study area, thus, recommendation has been made based on the result of the analysis of the field survey. Adopting the stated recommendation will help minimize adverse effect of climate change in the study area while preventing event that can result in future disruption of environmental elements, social ties and economic activities. Thus, the following recommendations are proposed;

1. Development of a database on current climatic conditions: An important part of this is considering the impact of past extreme climatic conditions and components as well as other disasters on each area of Ikeja. This should seek as much detail as possible; drilling down to include "small disasters" (disasters that do not get included in international disaster databases) as well as serve as data-bank for private individual who seek detailed information concerned with climatic conditions and land use of Ikeja
2. Initiate risk/vulnerability assessments for the city which must include much geographic detail as possible: This needs to link hazard maps with details of what is currently located within the hazardous zones as well as identifying population groups or settlements most at risk and activities that may pose particular risks (for instance areas in the study area that are liable to flooding due to its topography or other land factors). The assessment could influence the development of climate change coping mechanisms in the study area and beyond.
3. Adoption of public awareness programmes towards land use development and planning: One major avenue that can be adopted to further help the process of development in Ikeja and minimize the effect of climatic change on land use development is the engagement of the public in awareness programmes that is directed at intimating the general populace about the impending effects of climatic changes on land use development as well as tips and easy mitigating strategies that can be adopted to reduce and manage climate change impacts.

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