

IMPACT OF URBAN DEVELOPMENT ON CLIMATE CHANGE IN SOUTH-WEST, NIGERIA

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Abstract. The built environment or structural aspects of cities, streets, buildings, and infrastructure systems contribute significantly to the emission of greenhouse gases. 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. The research design adopted for the study was survey research which involved site visitation for data collection and analysis of collected data. 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, climate data was sourced from the Nigerian Metrological Agency (NIMET), 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 spatial data was analysed using ArcGIS version 10.5. The GIS land classification model that was used revealed that built up area in Ikeja local government have increased from 10.75% of the total coverage of the local government in 1980 to 92.11% in 2019 which is expected to have significant effect on the climate of the area. In conclusion, 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: *impact, urban development, climate change, South-West, Nigeria*

Introduction

Report from the United Nation Climate Change Program (UNCCP) revealed that the Earth's climate is presently changing, faster than it has been at any point in the history of modern civilization and these changes are caused primarily as a result of human activities (UNCCP, 2018). According to Arnfield (2013), 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.

The consequence of climate change includes 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 flooding and threatening communities along the coast which ultimately has caused the entire disappearances of some small Ireland along the coast. Climate change also intensifies the appearance of more violent weather phenomena, wild fires, drought, the death of animal and plant species, the creation of climate refugees and destruction of the food chain and economic resources, flooding from rivers and lakes, the creation of climate refugees and destruction of the food chain and economic

resources, particularly in developing countries (Acciona, 2019). In other to manage these consequences however, the International Panel of Climate Change (IPCC) has conceived several adaptation strategies which can be adopted by different countries or state based on their regional peculiarities.

There are growing evidences about the interaction of urban growth, development and climate (Fehrenbach et al., 2001). The impacts of urbanisation and human activities within the built environment on many aspects of local and regional climates are well understood within the urban climate community. Generalisations have emerged between the type and shape of cities and their influence on meteorological variables such as temperature, wind speed and large scale circulations (Arnfield, 2003). Climate change resulting from unmanaged urban growth poses a set of high risk, low probability events for cities (Weitzman 2008). Weitzman (2008) further poised that 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 severe on urban communities. A study by Kreibich et al. (2014) stated that 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.

In the case of the study area, Ikeja local government, there has been a tremendous development of Ikeja being the industrial and commercial hub of the State. This singular action of making this urban area a growth pole especially for the state has in turn created a resultant change in the climatic conditions of the area thereby having a commensurate impact on the spatial development of Ikeja. Hence, the aim of this research work is to examine the effect of urban growth on climate change in Ikeja, Lagos Nigeria with a view to assess the efficiency of the adaptation strategies put in place to combat the effect of climate change.

Materials and Methods

The survey research method will be employed for the purpose of this project work. This involves the collection of data in a consistent way. Survey research is useful for documenting existing community conditions, characteristics of a population, and community opinion. The survey research method comes handy as the tool is known for its effectiveness in: (1) determining the characteristics of a population or a community, (2) defining existing conditions in a community or region, (3) Documenting community opinion, and (4) comparing groups of communities. All these allow the detailed assessment of the effects of urban growth on climate change in Ikeja Local Government area, Lagos state which is the study area for this study. This research will focus on the totality of Ikeja Local Government, covering the totality of the residential, commercial, institutional and recreational Landuse in the area. Research data will be sourced from both primary and secondary sources. Primary data would be collected through administering questionnaires, field observation among others. Interview will also be conducted in government and private agencies to collect information relating to the study.

The research population for this study is the totality of the respondents for the study. This includes the inhabitants of the communities and agencies in charge of physical development and management of climate in the Ikeja Local Government Area. The result of the National Population Commission's 2006 Census put the population figure of Ikeja Local Government Area at 317,614 (UNESCO, 2018). Projecting this

population using the NPC approved national growth rate 3.18% (Eq. 1) puts the population of the Local Government area at 418 234.115 in the year 2018. This population was projected to 2019 to get the population of the local government. This was further subdivided to get the number of household in the local government given that questionnaire will be administered to each household, going by Demographic Housing Survey in 2013 by standard of 5 people per household. This will form the sampling frame for this study. The institutional frame, for the study includes the Ministry of Physical Planning and Urban development, Lagos State Environmental Protection Agency and the Nigerian Meteorological Agency.

Given:

$$P_t = P_o (1 + 3.18/100)^n \quad (\text{Eq. 1})$$

where P_t = projected population; P_o = base population of the area, which is 317,614; n = number of years which projection is made, whereby projected population from 2006 to 2019 ($n=13$); and 3.18 = NPC Lagos state growth rate, 2006.

So, by taking the Eq. 1, the calculation are as followed;

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

$$P_t = 317,614 (1.3168)$$

$$P_t = 418\,234.1152$$

Therefore, present population as projected for Ikeja (2019) = 418 234.1152

Sampling frame involves the identification and segregation of the study population into units and investigated structure. According to UNESCO (2018), Ikeja city can be subdivided into 3 development zones: the core, transition and the periphery with population of 193,098, 125,778 and 52,092 in respectively according to the state's national population commission in 2016 (*Table 1*).

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	16 997	33 399
Periphery	52 092	71 571	14 314
Total	370 968	477 135	95 426

From the above research sample frame of 95,426 households, a sample size is 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 in 2003, a sample of 0.5% is acceptable for frame between 50,000 and 100,000 for research within the field of social science. Thus this will be adopted for this study, 0.5% of the household from each development zones will be sampled for this study and a summation of which gives the sample derived from the three development zones will make up the sample size for the study (*Table 2*).

Table 2. Sampling size.

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

The sample technique to be used for this study is the simple random sampling. This will involve the listing of the data delineation area in each development zones in the local government and using SPSS random number generator buildings will be randomly selected for all the data delineation area in the development zone to make up the sample size for the study. This will remove any form of bias in selection of the sample size and help ensure that the selected sample will give a true representation of what is obtainable in the totality of Ikeja Local Government Area.

The instrument will be used in collection of data and information which will be used for the realisation of the aim of the research. For this research, four research instruments will be employed namely questionnaire, interview guide, Global Positioning System (GPS), and aerial imageries. Procedure for data collection for this study is in two stages i.e. data collection before going to the field and data collection on field. The first stage of data collection before going to the field: The Google satellite imagery of Ikeja local government area will be downloaded in batches form the year when Nigeria gained independence from 1960, the post-colonial era when Lagos State was the capital of Nigeria in 1980, when the capital of Nigeria was moved to the Federal Capital Territory (FCT), Abuja of 2000 and the present year of 2019. This is to determine how development has taken place in space over the year. The google satellite imagery for 2019 will then be digitized to divide the local government into data delineation area so as to know the building unit to administer the questionnaire. This will serve as the property map to guide the researcher and the research assistance during questionnaire administration. A thorough internet search will then be conducted to collect any relevant information to ensure that all necessary information about the study online has been captured by the researcher before going to the field.

The second stage which is the collection of primary data will be collected from the site by the researcher with the help of 3 trained research assistants out of which 2 will be residents in the local government who understands the terrain and other geography of the area while the third research assistant will be a final year student in the Federal University of Technology who is conversant with the use of the Global Positioning System (GPS). With the help of the research assistants who are native of the community 475 questionnaires will be administered within a period of a week and with the help of third research assistant that is conversant with the use of GPS, the coordinate of different infrastructures and landmarks relevant to the study will be acquired. Thereafter, the researcher will proceed to the offices of the agencies in charge of urban development and Climate Change (Nigeria Meteorology Agency and Ministry of Environment) to conduct interview on the effects of urban growth on climate change.

Data collected from all sources during the process of data collection were subjected to statistical method of data analysis which includes the use of statistical package for social sciences (SPSS) and Microsoft excel software. This statistical method of data analysis (descriptive) helps to calculate collected information from target population and hence the representation of analyzed data in tables, charts, graphs and percentages. The result from these analyses represents the attributes and characteristics of the variable that is been researched in the study area and hence used to make inferences on

the effect of climate change on land use planning and development. Spatial data will be analyzed using GIS.

Results and discussions

This study examines the effects of urban growth on climate change using Ikeja, Lagos as a case study. Hence, the essence of this data collection and analysis is to ensure the understanding of the implications and magnitude of consequential effect of urban growth on climate change in Ikeja Local government in Lagos state. In other to achieve this, data was collected in other to assess the socioeconomic characteristics of the people in the study area, then the spatial trend of urban growth in Lagos state after which the indigenous knowledge of the people on climate change was also assessed in other to know the level of their preparedness and assess the level of adaptation to climate change in Ikeja local government. The results of the analysis are discussed based on the socioeconomic characteristics in *Table 3*.

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 have a prominent presence in the population structure of households with a 53.1% responses compare to the females 46.9% composition (*Table 3*).

As obtained from this survey, age structure within the studied area shows that the working class that is 18-34 and 35-36 form the bulk of the respondent in the study area with 43.70% and 40.10% respectively while the dependent population with age 65 and above constitute 16.2% of the responses. The population structure diminishes from the youth to adult and then to the aged as presented in *Table 4.1*. 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 respondent in the study area revealed that 46.4% of the respondents are Yoruba while 36.4% and 17.2% are Igbo and Hausa respectively. The result of this analysis confirmed the UNESCO assertion that Lagos state possesses strong attraction of migrants with heterogeneous composition of more than 250 ethnic group (UNESCO, 2018).

The result of the analysis of field survey confirmed the result of a study carried out by Lagos State Bureau of Statistics (LBS) in 2011 that revealed that Lagos state has the highest percentage of educated citizens in the country as presented in *Table 4.1*. Data collected revealed that all respondents in the study area have formal education with 43.8% having tertiary 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 4.1*, 36.22% of the household head responded that they have a house hold size between 5-7, 28.89 and 28.44% have household of 8-11 and 1-4 respectively 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 (World Bank, 2017). The skewness of the household size is rightly skewed (0.18), it is therefore 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 effective management of the environment which in turn might have great consequence climate change. Result of the field survey as presented in Table 4.1 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 benchmark however 6.22% of the responses still earns below 18,000 which is a monthly income that tends to be lower the United Nations benchmark 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 1 revealed that of the length of stay of the residents interviewed for the sturdy is 30.53years 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. Also given the standard deviation of the length of stay (3) this implies that the variation in the length of stay of the respondent is not so high.

Table 3. Socioeconomic characteristics.

Category	Frequency (N)	Percentage (%)	Mean	SD	Skewness
Gender					
Male	239	53.10			
Female	211	46.89			
Age					
18-34	180	43.70			
35-65	197	40.10	40	16	0.59
>65	73	16.20			
Ethnic group					
Yoruba	209	46.40			
Hausa	164	36.40			
Igbo	77	17.20			
Education					
No formal education	0	0			
Primary Education	108	24			
Secondary Education	145	32.2			
Tertiary Education	197	43.8			
Household size					
1-4	128	28.44			
5-7	163	36.22	7	3	0.18
8-11	103	28.89			
>11	62	6.45			
Average income per month					
0- ₦ 18,000	28	6.22			
₦18,000- ₦ 36,000	84	18.67	₦30,231	10,005	0.18
₦36,001- ₦ 54,000	197	43.78			
> ₦ 54,000	141	31.33			
Length of stay					
<10 years	46	10.22			

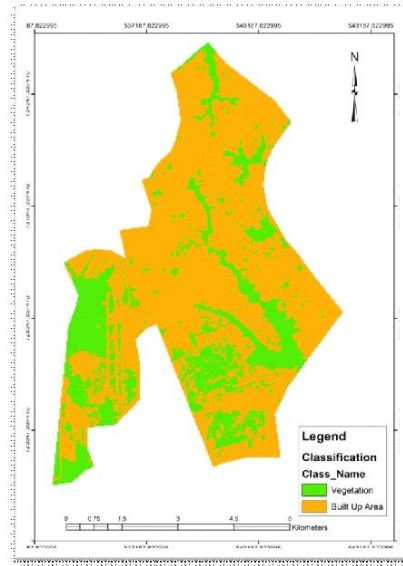


Figure 2. Image classification for 2000.

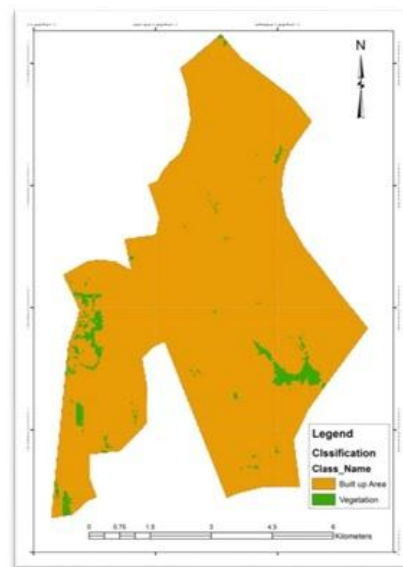


Figure 3. Image classification for 2019.

According to United Nations (2019), Indigenous knowledge is an important ingredient in implementing the goal number 13 of the Sustainable Development Goals (Climate Action). *Table 4* expressively present the responses of the residents on the indigenous knowledge of climate change as just 27% of the respondent replied that they are not knowledgeable about the concept of climate change while the remaining 73% replied that they are already familiar with the phenomenon. The high awareness of climate change can be linked to the fact that majority of the resident in the study area are learned as presented in *Table 4*, when the indigenous knowledge of climate change was compared against the level of education of responses 80% of the respondent that have just primary education are not preliminary knowledge of climate change while 64.1% of respondent with tertiary education are knowledgeable of climate change. The respondents were further asked of how they got to hear about the phenomenon (*Figure*

1) and majority replied that they learnt of it through media which includes radio, television, newspaper and socio media platforms (33%) and 38% learnt of it from family member. Also the prominent ecological indicators of climate change in the study area according to the responses from the field survey is excessive rainfall as revealed by 52% of the respondents, while 22% and 14% of the respondent replied excessive sunshine and dryness of local river as the ecological indicator respectively and the remaking 5% replied) Loss of vegetation species as the ecological indicator of climate change.

From the data obtained from the Nigerian Metrological Agency (NIMET) it is evident that the climate in the study is changing and there is possibility for future changes. Thus, the resident in Ikeja local government area were inquired of the effect of these changes in climate in the activities of their household and the effects where ranked as strongly disagree, Disagree, undecided, agree and strongly agree caring 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*.

Findings as presented in *Table 5* shows that the respondent in Ikeja Local Government with mean ranging from 4.61 to 4.88 all agree that climate change has effect on their day to day activities by causing flooding and giving the poor conditions of the drainage leading to flooding of building and access road consequently causing traffic congestion in the local government, causing 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 well 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 respondent.

Table 5. Knowledge of climate change against level of education.

	Yes	No	Total
No formal education	-	-	-
Primary education	2.6	14.1	16.7
Secondary education	6.3	9.2	15.5
Tertiary education	64.1	3.7	67.8



Figure 4. Flooded road in study area, 2019.



Figure 5. Flooded building in study area, 2019.

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 reveal that although majority of the residents in the study area are learned 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 and 73.0% of respondent being knowledgeable of the phenomenon climate change and its consequences they have not been able to adequately plan their city to accommodate the increasing urban growth as the vegetation in the study area have drastically reduced over the year, from 89.25% in 1980 to 7.89% in 2019. This has been consequential in the study are as the respondents complain of several diverse effect of climate change already dominated in the study are like flooding of road and building as a result of excessive rainfall and also health risk as revealed by 34 and 30% of the respondents respectively.

Conclusion

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 sanity in the study area, thus, recommendation has been made based on the result of the analysis of the field survey. Adopting the above 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 element which ultimately affect the climate. Since the climate change is already having adverse effect on the residents of Ikeja local government and these effects are heightened by uncontrolled urban growth

in the study area, thus the recommendations are proposed to help manage urban growth and climate change in Ikeja Local government and maintain harmony in the study area; (1) development of an information based system on current conditions; (2) initiate risk or vulnerability assessments for the city with as much geographic details as possible; and (3) adoption of public awareness programmes towards land use development and planning.

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