CLIMATE CHANGE ADAPTABILITY AMONG URBAN RESIDENTS OF LOKOJA, NIGERIA

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Abstract

Land-use change owing to urban expansion has been identified as one of the elements that disturb the bio-climatic conditions of urban areas. Using ArcGIS, this study assessed Lokoja inhabitants' adaptive capacity to climate change. It also identifies areas in Lokoja that may be more vulnerable to thermal conditions using LST/Hot and Cold spot mapping and analyzes indigenous solutions to mitigate the effects of change in bio-climatic conditions using Factor Analysis to decongest variance. Between 2014 and 2018, the significant hot spot in Lokoja expanded from around 12% to 13% (that is approximately 37.93sq.km to approximately 41.18sq.km). Areas covered by the intermediate LST. Areas inside the intermediate LST zone grew at a rate of 11.12sq.km every year, totaling 44.46sq.km. The eigenvalues of the factors show that factor one has the highest eigenvalue of 11.285, and a combination of mitigating factors one (medication), two (ventilation), and three (taking enough water) contributes approximately 89.4% of the possible ways the effects of the thermal condition can be mitigated in urban centers. The complexity of urban layers arises from the intricate interplay of diverse physical, social, economic, cultural, and technological elements, shaping the multifaceted nature of urban environments worldwide, which is an additional issue that has led to an adaptation to climate change that is dependent on diverse actions carried out in Lokoja. Policymakers and environmental management in Lokoja are to explore developing phased green projects, primarily in the Central Business District (CBD) to lower the packets of Land Surface Temperature of hot areas and their explosion when appropriate.

Keywords: Climate Change, Land Surface Temperature, Adaptivity, Hot/Cold spot, Thermal condition

Introduction

The world is becoming more urbanized as a result of fast population increase and high rates of migration from rural regions, resulting in dense urban development globally. The requirement for adequate outdoor settings grows in tandem with the development in the quantity and density of urban structures affecting urban dwellers. The importance of the outside environment is linked to the creation of areas for daily travel and activities, which promotes urban liveability (Frank, Engelke & Schmid, 2003). In three ways, climate change has the potential to enhance flooding hazards in cities from the sea (increasing sea levels and storm surges); from rainfall - for example, greater rainfall or rainfall that lasts longer than usual; and from changes that boost river flows - for example, enhanced glacier melt. The IPCC Working Group II stated that severe precipitation events are quite likely to become more frequent, hence increasing flood danger, as well as accumulating evidence of enhanced runoff and earlier spring-peak discharges in many glacier- and snow-fed rivers. (Adger, Aggarwal, Agrawala, *et al.*, 2007).

Adaptive capacity is most simply comprehended in terms of a certain system's ability to adapt, in order to cope with a specific climatic hazard or combination of hazards. A territory, a community, a home, an economic sector, a corporation, a demographic group, or an ecological system are all examples of systems. The combination of a climatic hazard (example, a drought, windstorm, or extreme rainfall event) with the qualities of an exposed system - its sensitivity or socially constructed vulnerability - results in a certain consequence (Adger and Kelly, 1999; Pelling and Uitto, 2001 Brooks, 2003). The influence of partially manufactured climatic conditions, which are generated mostly by the area's building up, is one of the environmental stress factors on humans living in urban areas. The evaluation of thermo-physiologically the thermal and radiating environment of humans is an essential problem of bio-climatological study since it controls the fundamental energy balance of the body (Höppe, 1993). Profitable prospects, existing lifestyles, and use patterns in cities have had a negative influence on the environment, and the severe consequences of severe weather on many metropolitan areas each year highlight some of the hazards and vulnerabilities that must be addressed (United Nations, 2008).

One of the ecological pressure factors on humans living in the urban regions of North Central Nigeria and other urban areas throughout the world is the result of partly artificial climatic conditions molded mostly by urbanizing areas (Adedeji et al. 2010). Rapid urbanization has greatly accelerated economic and social development, and global cities are engines of economic growth and centers of innovation for the global economy and the hinterlands of their respective nations but urbanization has also created numerous environmental problems ranging from the local to the global scale including increased air and water pollution and decreased water supply local climate alteration and increased energy demands, insufficient housing and sanitation facilities and traffic congestion and a major reduction in natural vegetation production and carbon storage/sequestration. Thus, the identification and assessment of environmental impacts as a result of modern urbanization have become a top priority and many recent studies have been conducted with the goal of better understanding the impacts and issues related to urbanization as a catalyst for sustainable development (Cui, L., & Shi, J. 2012).

Inspiring people to use outdoor places is beneficial from a variety of perspectives, including economic, environmental, social, and individual physical situations (Frank et al. 2003). Among the factors of the quality of outdoor spaces, the ambient climatic conditions are given special consideration (Nikolopoulou, Baker, & Steemers, 2001).

In applied urban climatology, human bio-meteorological techniques play an essential role. Several thermal indices have been established in recent decades to quantify human comfort or heat stress in the human body based on energy fluxes between the body and the environment. The influence of partly manufactured climatic conditions, which are generated mostly by the area's building up, is one of the environmental stress factors on humans living in urban areas (Mayer & Höppe, 1987).

The focus of this paper is to assess Lokoja populations' adaptive ability to climate change. The objectives are to use Hot/Cold spot mapping to identify areas in Lokoja that may be more vulnerable to thermal conditions and to use Factor Analysis to assess indigenous techniques of locals to mitigate the consequences of changes in bio-climatic conditions.

Study Area

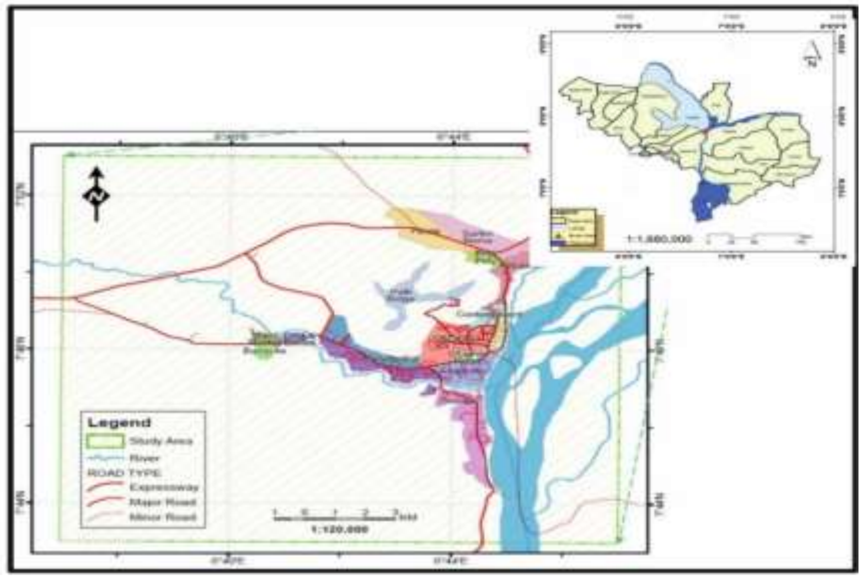

Figure 1: Kogi showing Lokoja and Lokoja Metropolis
Source: *GIS Lab. Department of Geography and Environmental Studies, KSU*

Lokoja is the capital city of Kogi State (Fig 1), and it is located at latitude 7°45'N-7°51'N and longitude 6°41'E-6°45'E, at an elevation of 45 to 125 meters above sea level. It is situated on the western side of the River Niger, at the junction of the River Benue, and is wedged between the River and Mount Patti. The city has a tropical climate with rainy and dry seasons and is located within the Guinea Savannah vegetation zone. Mount Patti is the town's primary physical feature, with various intermittent valleys and streams crisscrossing its width. Modern Lokoja was formed in 1857 (NPC Reference Bureau, 2006), but it rose to prominence when it became the capital of the British Northern Protectorate and subsequently the capital of Nigeria in 1914, following the merger of the Northern and Southern Protectorates (Ifatimehin et al. 2011). The town had 77,519 residents in 1991, which climbed to 196,643 in 2006. (NPC Reference Bureau, 2006). The town's population was anticipated to reach 246,101 in 2014, based on a 3.03% annual growth rate (Ukoje JE, Makanjuola MI, Oluleye EK, 2014).

Theoretical Framework

Identifying factors that may cause Change in thermal conditions, bioclimatic conditions and variables, people and areas that may be endangered by the exposure effect of climate change and the restriction of the effects are one of the major objectives of this research work, therefore major cause factors are Metabolic rate, Natural ventilation and Thermal comfort which is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation are discussed in line with the aim of this research.

Theoretical frame is Strategies for vulnerability and adaptation assessment on climate and human systems are inherently intertwined and are influenced by relevant drivers which impose excitation on their state (e.g. solar radiation, ocean circulation, population trend and urbanisation). Distinctively, the climate system in terms of vulnerability creates exposure to climate variability, change and related hazards – including socio-ecological impacts; while the human system aggravates susceptibility to these hazards or impacts due to unsustainable trends via socio-ecological phenomena that alters the extent of exposure and susceptibility of sectors within these regions.

Study Methods

The ArcGIS 10.5 and IDRISIL software were used to perform various digital image pre-processing, processing, and analysis of all satellite data and images, which were properly selected from the Landsat archives for dry season months (i.e. November, December, January, February, and March) in the study, which aided the classification of Land Surface Temperature (LST) maps analysis. The ArcGIS hotspot analysis tool was used to detect statistically significant hot spots (aggregate of high-value raster values) and cold spots (aggregation of low-value raster values) using the Getis-OrdGi* statistic, which also employs the z-score and p-value. The statistical outcome revealed the amount of randomization of the observed spatial grouping. As a result, it informs of considerably hot locations, significantly cold areas, and areas that are neither notably cool nor hot (also known as intermediate zones) (Getis and Ord,1992 ESRI, 2012). The administration of surveys to understand people's opinions of mitigating the consequences of climate change was studied using Factor Analysis using SPSS, which proved a very explanatory tool in assessing people's responses and perspectives.

Results and Discussions

The Hot/Cold Spot maps provide a more objective picture of the LST pattern in the research region. First, it highlights places that are extremely hot/cold, not only because they are hot/cold, but because their nearby pixels are significantly hot/cold as well. Second, it x-rays the CBD and detects hot spots created there, as well as additional packets of similar hot spots across the Metropolis. As shown in Table 4.3, locations that are considerably cold with confidence higher than 95% were about 15% in 2014 but climbed somewhat to approximately 16% in 2015, whereas cold patches with a lower confidence level were essentially negligible: less than 2% for both research epochs studied.

The category of no major hot or cold region, which had the size of the pixels, is similar to the intermediate zone in the previous zonation technique provided. Thus, such locations can be concluded to be thermal transition zones, as they might narrowly become hot or cold places at confidence levels less than 95%. Thus, from around 65% of places in this zone in 2014 to approximately 63% in 2018, the percentage has decreased. On the other side, the group designated as hot spots stayed almost the same (7% of the research area) over the time under examination with confidence levels less than 95%.

However, there was a little shift and rise in the area considered to be the biggest hot spot in Lokoja Metropolis - with greater than 95% certainty as this climbed from roughly 12% to 13% (i.e. approximately 37.93sq.km to approximately 41.18sq.km) between 2014 and 2018. As a result of the continuing, there was a requirement to execute (further) a change detection analysis on the thermal surface of the research region bi-temporally in order to establish additional important information objectively.

The hottest temperature recorded throughout the research period was 38.05^{o}C in 2014, followed by 36.94^{o}C in 2018 and 34.06^{o}C in 2013. The lowest (minimum) temperature has increased by over 1.34^{o}C from 2013, 2014, and 2018 (20.13^{o}C, 21.85oC, and 23.19^{o}C, respectively). Locations occupied by water bodies such as rivers, streams, and so on, have the lowest LST values, whereas areas distant from the city hub (center) and the foot of the mountain have abnormally high LST values. It is obvious that the urban core is dominated by high LST values regardless of the season.

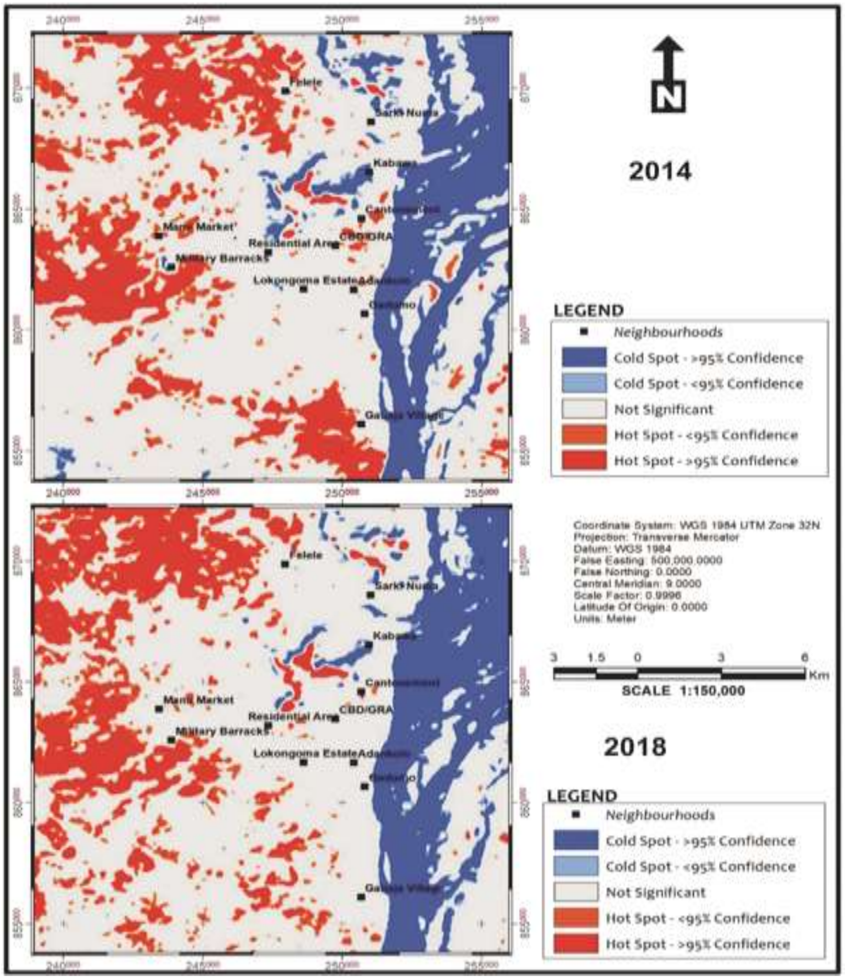

Figure 2: Hot/Cold Spot Analysis Lokoja
Source: *Author's GIS analysis*

Table 1: Lokoja Hot and Cold Spot Evaluation (2014 and 2018)

	LST Spot-Value	Area (Sq.km)	Percent	Area (Sq.km)	Percent
1	***Cold Spot - >95% Confidence***	52.437	16.275	48.545	15.067
2	***Cold Spot - <95% Confidence***	4.446	1.380	5.385	1.671
3	***Not Significant***	202.254	62.774	208.511	64.716
4	***Hot Spot - <95% Confidence***	21.876	6.790	21.817	6.771
5	***Hot Spot - >95% Confidence***	41.181	12.782	37.936	11.774
	Grand Total	**322.194**	**100**	**322.194**	**100**

Source: *Authors Computation/GIS Analysis*

In this categorization, Table 1 found hot places as a result of LST zonation based on equal interval evaluation. The grey bar indicates that cold and hot locations in Lokoja were less than 95% certain, indicating that not extremely hot or very cold spots exhibited little or no change in their spatial structure. However, the change detection reveals that regions that are very cold have increased, as have places that are significantly hot, with 3.89sq.km and 3.25sq.km, respectively. A deeper look at the parts that are not extremely hot or chilly is also noticeable. It indicates a modest decrease of roughly 6.26 square kilometers between 2014 and 2018. Although the LST zonation based on equal interval was able to depict areas that were hot and/or cold zones in Lokoja, it should be noted that the Getis-Ord hot/cold spot approach depicts areas that are statistically significant, making it more reliable to consider. It is also worth noting that the vagaries of LST, like air temperatures, do not follow a consistent pattern and alter on their own.

LST Zonal Change Detection

As seen in the chart and numbers above, there appears to be little or no change in certain LST zones/categories but significant variances in others.

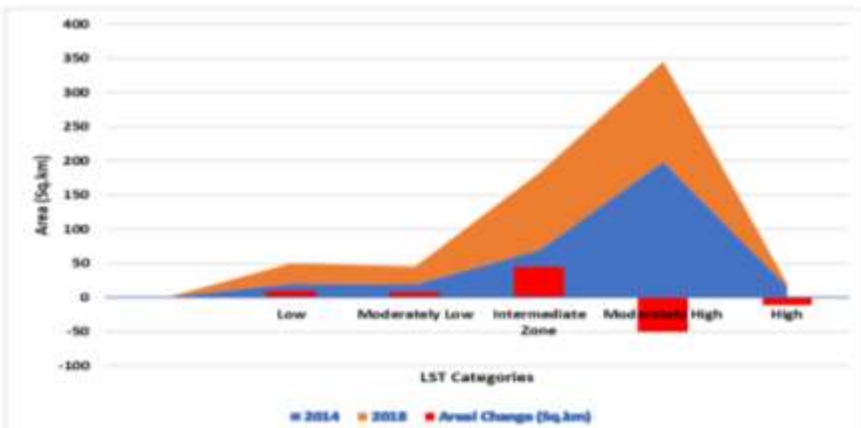

Figure 3: Change detection of LST Zones between 2014 and 2018
Source: *Authors Computation/GIS Analysis*

This section displays the findings of the change detection analysis performed on the images for the research epochs of 2014 and 2018. The data in Figure 2 clearly illustrates that there has been a significant drop in regions classified as Moderately High LST and a comparatively smaller reduction in areas classified as High LST. Areas in the low and moderately low LST zones, on the other hand, have grown, but not as much as the growth in the intermediate zone. It is worth emphasizing here that the intermediate zone denotes (in this study) an area that can suddenly be warm, moderate, or very chilly or warm, especially at the time of satellite data collecting. The entire picture has been given.

Table2: Result of LST Change Detection Analysis

S/No.	LST Zones	LST Zones (Sq.km)	Rate of Change
1	Low	9.336	2.334
2	Moderately Low	7.419	1.855
3	Intermediate Zone	44.458	11.115
4	Moderately High	-49.830	-12.458
5	High	-11.383	-2.846
	Total		

Source: *Authors Computation/GIS Analysis*

The result presented in table 2 clearly shows that there has been a significant reduction in the Lokoja LST as the values extracted from the satellite data of 2014 and 2018 were observed, presenting a clear picture that indicates that even if temperatures are expected to rise, as sighted in the claims of climate change put forward by the IPCC (2001), the situation in Lokoja tends to be different or even better. Over a four-year period, about 11.38 square kilometers of high LST zones were reduced, while areas classified as moderately high LST zones decreased by approximately 49.83 square kilometers.

The greatest departure was seen in this category, which amounts to a loss of around 12 square kilometers of moderately high regions in the Metropolis per inhabitant. Areas inside the intermediate LST zone grew at a rate of 11.12sq.km every year, totaling 44.46sq.km. It may be determined that the majority of the dramatic fluctuations in LST were accommodated in the intermediate zone, which might be moderately low or moderately high at any moment in time. Furthermore, hot/cold spot mapping proved useful in determining the relevance of each zone and its relative dominance. This method detected the considerably hot and cool places in the Lokoja area, however Figure 4 shows a more unbiased detail thanks to the change detection algorithms.

Figure 4 clearly depicts a different outcome than the one displayed before in the LST zonation based on equal interval evaluation. The grey bar indicates that cold and hot places in Lokoja that were less than 95% confident, i.e. not very hot or cold, showed little or no change in their spatial distribution. However, the change detection reveals that regions that are very cold have increased, as have places that are significantly hot, with roughly 3.89sq.km and 3.25sq.km, respectively. A deeper look at the locations that are not extremely hot or chilly is equally eye-catching. It indicates a modest decrease of roughly 6.26 square kilometers between 2014 and 2018. Although the LST zonation based on equal intervals was able to display hot and/or cold zones in the study, it should be noted that the Getis-Ord hot/cold spot technique reveals statistically significant regions.

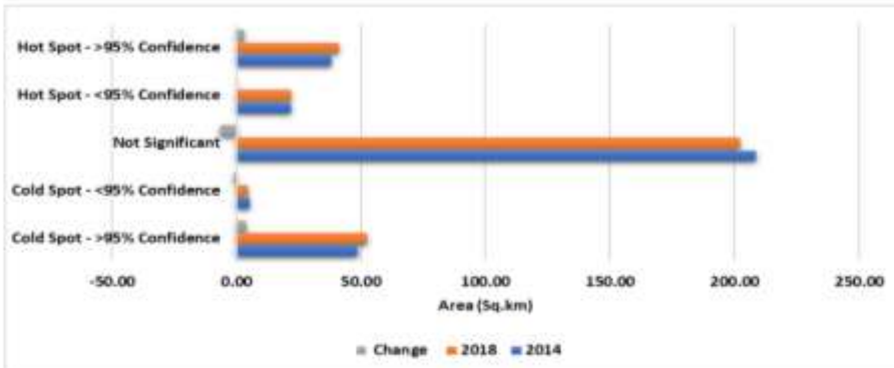

Figure 4: Change detection analysis for Hot/Cold spots between 2014 and 2018 (Lokoja)
Source: *Authors Computation/GIS Analysis*

It is also worth noting that LST impulses, like air temperatures, aren't uniform or follow a set pattern; they fluctuate on their own. This is also why the study used thermal bands collected around the same month during the dry season. As a result, the substance of the study, which is concentrated on recognizing the regions that may be more vulnerable to the thermal condition in Lokoja, was undertaken to disclose the link that exists between thermal condition and climate change in the urban segment in the study area.

Analysis of Residents to Curbing the Effects of Climate Change in Lokoja

Table 4 shows residents' reactions to mitigating the impacts of bioclimatic conditions in the research region, and all of the responses were major ways in which bioclimatic conditions may be mitigated in the study areas except medicine. Therefore, Air conditioner (mean = 3.9495); heat absorber in the kitchen (mean = 2.6889); greening the environment (mean = 3.9365); reduction of non-evaporation materials around the house (mean = 3.8550); use of green infrastructure (mean = 3.8909); controlled urbanization (mean = 3.8388); Controlled vehicular activities (mean = 3.8355); alternative sources of cooking energy (mean = 3.9381); adoption of wind-generated electricity (mean = 3.9300); adoption of solar energy as the primary source of energy (mean = 3.8241); waste management (mean = 3.8697); tree planting (mean = 3.3.9137); and the creation of open spaces (mean = 3.8111) were all accepted as methods of mitigating the effects of climate change. Medication, on the other hand, was dismissed as a means of mitigating the impacts of bioclimatic conditions based on the computed mean.

Analysis of residents to curb the effects of Thermal conditions in Lokoja

Table 3 shows residents' reactions to mitigating the impacts of bioclimatic conditions in the research region, and all of the responses were major ways in which bioclimatic conditions may be mitigated in the study areas except medicine. Therefore, Ventilation (mean = 3.9414); taking enough water (mean = 3.9609); special clothing (mean = 3.8648); building modification (mean = 3.8681); air conditioner (mean = 3.9495); heat absorber in the kitchen (mean = 2.6889); greening the environment (mean = 3.9365); reduction of non-evaporation materials around the house (mean = 3.8550); use of green infrastructure (mean = 3.8909); controlled urbanization (mean = 3.8388); controlled vehicular activities (mean = 3.8355); alternative sources of cooking energy (mean = 3.9381); adoption of wind-generated electricity (mean = 3.9300); adoption of solar energy as the primary source of energy (mean = 3.8241); waste management (mean = 3.8697); planting of trees (mean = 3.3.9137); creation of open spaces (mean = 3.8111) were all accepted as ways of curbing the effects of Climatic condition. However, medication was rejected as a way of curbing the effects of bioclimatic conditions based on the calculated mean.

Table 4 shows the principal component analysis and it was used to summarize the responses of the residents to curbing the effects of the bioclimatic condition. The result of the analysis revealed that the whole response was summarized into three (3) factors as indicated by the eigenvalues. Factor one (medication) recorded the highest eigenvalue of 11.285 followed by factor two (ventilation) which recorded a 1.892

eigenvalue while factor three (taking enough water) recorded an eigenvalue of 1.271. however, the rest factors (4 - 18) recorded eigenvalue less than one and are therefore not significant.

Table 3: Residents Perceived Responses to Curbing the Effect of Thermal Discomfort

	SD	D	A	SA	Mean	Std.	Decision
Medication	314 (51.1%)	110 (17.9%)	70 (11.4%)	120 (19.5)	1.9935	1.18719	Rejected
Ventilation	6 (1.0%)	5 (0.8%)	8 (1.3%)	595 (96.9%)	3.9414	0.36101	Accepted
Taking enough water	3 (0.5%)	5 (0.8%)	5 (0.8%)	601 (97.9%)	3.9609	0.28861	Accepted
Special clothing	11 (1.8%)	15 (2.4%)	20 (3.3%)	568 (92.5%)	3.8648	0.52317	Accepted
Building modification	4 (0.7%)	8 (1.3%)	53 (8.6%)	549 (89.4%)	3.8681	0.42421	Accepted
Air conditioner	4 (0.7%)	7 (1.1%)	5 (0.8%)	598 (97.4%)	3.9495	.33167	Accepted
Heat absorber in the kitchen	197 (32.1%)	97 (15.8%)	20 (3.3%)	300 (48.9%)	2.6889	1.35506	Accepted
Greening the environment	5 (0.8%)	8 (1.3%)	8 (1.3%)	593 (96.6%)	3.9365	.36691	Accepted
Reduction of non-evaporation materials around the house	6 (1.0%)	9 (1.5%)	53 (8.6%)	546 (88.9%)	3.8550	.46069	Accepted
Use of green infrastructure	7 (1.1%)	7 (1.1%)	32 (5.2%)	568 (92.5%)	3.8909	.43443	Accepted
Controlled urbanization	7 (1.1%)	16 (2.6%)	46 (7.5%)	545 (88.8%)	3.8388	.50614	Accepted
Controlled vehicular activities	9 (1.5%)	19 (3.1%)	36 (5.9%)	550 (89.6%)	3.8355	.53642	Accepted
Alternative sources of cooking energy	8 (1.3%)	5 (0.8%)	4 (0.7%)	597 (97.2%)	3.9381	.39086	Accepted
Adoption of wind generated electricity	6 (1.0%)	6 (1.0%)	13 (2.1%)	589 (95.9%)	3.9300	.37886	Accepted
Adoption of solar energy as the primary source of energy	9 (1.5%)	17 (2.8%)	47 (7.7%)	541 (88.1%)	3.8241	.53735	Accepted
Waste management	9 (1.5%)	16 (2.6%)	21 (3.4%)	568 (92.5%)	3.8697	.50378	Accepted
Planting of trees	6 (1.0%)	9 (1.5%)	17 (2.8%)	582 (94.8%)	3.9137	.40876	Accepted
Creation of open spaces	15 (2.4%)	10 (1.6%)	51 (8.3%)	538 (87.6%)	3.8111	.57700	Accepted

Source: *Author's computation/Analysis*

Decision rule: mean = 0.5 – 1.4 Strongly Disagree (SD)
1.5 – 2.4 Disagree (D)
2.5 – 3.4 Agree (A)
3.5 – 4.5 Strongly Agree (SA)

Table 4: Total Variance Explained on the likely responses of residents to curbing the effects of thermal condition

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.285	62.693	62.693	8.189	45.492	45.492
2	1.892	10.513	73.206	4.373	24.297	69.789
3	1.271	7.060	80.266	1.886	10.477	80.266
4	0.947	5.264	85.530			
5	0.645	3.583	89.113			
6	0.417	2.315	91.428			
7	0.314	1.746	93.173			
8	0.259	1.438	94.611			
9	0.230	1.279	95.890			
10	0.187	1.038	96.929			
11	0.176	0.979	97.908			
12	0.105	0.583	98.491			
13	0.087	0.485	98.976			
14	0.065	0.363	99.338			
15	0.042	0.231	99.570			
16	0.032	0.179	99.748			
17	0.028	0.158	99.906			
18	0.017	0.094	100.000			

Source: *Author's computation/Analysis*

Table 5: Rotated Component Matrix on the responses

		Component		
		1	2	3
1	Medication	0.112	-0.022	-0.912
2	Ventilation	0.683	0.519	0.154
3	Taking enough water	0.530	0.639	0.139
4	Special clothing	-0.045	0.701	-0.311
5	Building modification	0.899	0.193	-0.068
6	Air conditioner	0.509	0.765	0.088
7	Heat absorber in the kitchen	0.048	0.032	0.915
8	Greening the environment	0.603	0.758	0.124

9	Reduction of non-evaporation materials around the house	0.899	0.303	-0.054
10	Use of green infrastructure	0.738	0.358	0.027
11	Controlled urbanization	0.785	0.353	0.022
12	Controlled vehicular activities	0.761	0.210	0.028
13	Alternative sources of cooking energy	0.503	0.595	0.101
14	Adoption of wind generated electricity	0.646	0.689	0.096
15	Adoption of solar energy as the primary source of energy	0.946	0.217	-0.047
16	Waste management	0.865	0.344	0.007
17	Planting of trees	0.582	0.723	0.134
18	Creation of open spaces	0.889	0.315	-0.069

Author's computation/Analysis

Table 5 summarizes the responses according to the three criteria. Medication, ventilation, building modification, reduction of non-evaporation materials around the house, use of green infrastructure, controlled urbanization, controlled vehicular activities, adoption of solar energy as the primary source of energy, waste management, and the creation of open spaces are all part of factor one. Furthermore, component two summarizes taking enough water, specific clothes, air conditioner, greening the environment, alternative sources of cooking energy, adoption of wind-generated power, and tree planting, whilst factor three is just the heat absorber in the kitchen. This indicates that reactions to potential strategies of mitigating the consequences of bioclimatic conditions in the research locations can only be effective if they are implemented in concert.

As shown in Table 9, the R2 of 0.894 indicates that a combination of mitigating factors one, two, and three provides approximately 89.4% of the conceivable ways the impacts of climatic conditions can be mitigated in the research locations. Thus, the remaining 10.6% may be explained by factors not included in this study. The analysis also reveals that curbing factor one (= 0.513; t = 67.583; p = 0.000), curbing factor two (= 0.182; t = 23.983; p = 0.000), and curbing factor three (= -0.040; t = -5.274; p = 0.000) were statistically significant and can be used to mitigate the effects of climate change in the study areas.

Existing studies that agree with this study's findings despite using different approaches and methods include Ifatimehin, Adeyemi, and Saliu (2013), who use in situ climate data - Temperature, Rainfall, and Relative humidity - to determine Lokoja's thermal discomfort index and residents' perceptions. Musari, Sojobi, Abatan, and Egunjobi (2015) described the periods caused by heat stress across five states in Nigeria's north-central area. For the examination of the five urban towns in the north-central area, the temperature-humidity index (THI) and wind chill index (WCI) were used. Balogun, Ntekop, and Daramola (2019) investigated the influence of urbanization on human bio-climatic conditions in Akure using basic indicators such as the thermo-hygrometric index (THI), discomfort index (DI), and relative strain index (RSI).

The study's consequence is that the effervescent LST methodologies utilized in the experiments reveal deviation and disorderliness in metropolitan areas. The complexity of urban layers is an additional challenge that has led to climate change adaptation that is mostly dependent on diverse actions carried out in urban centers. The drift between man's activities, ecosystem regulatory services, and humidex comfort level, while variations in thermal comfort through LST may have come from climate variability established over the research period, which led to varied forms of adaption by inhabitants.

Conclusion and Recommendations

The study employed geospatial technologies to locate locations in the study area that are more prone to heat conditions, which is one of the primary indices of climate change Factor Analysis in evaluating the Adaptive Capacity Among Lokoja Urban Residents. It also reveals that the contribution of urban residents to climate change is dependent on several variables such as vegetal cover and it is dependent on urbanization such as land use, physical expansion, and couple with man's activities, leading to the resident's unease which causes them to find the weather unconducive on several occasions, particularly during the dry season when people experience high temperatures and harsh weather.

Climatic Conditions in Nigeria may be ascribed to local climatic changes and climate disparities through time, which have already had a quantitative impact on its natural systems, such as a rise in different thermal disease-related difficulties and defining life cycle timing and the amount to which urbanization could impact the Land Surface Temperature the research region, particularly as other surface descriptors may do. Some of these factors include geography, distance from paved highways, bodies of water, and industry, among others. As a result, the objectivity of this study, as well as its simplicity, is an attempt to deploy a new method to understanding the dynamics of hot/spot analysis and, consequently, air temperatures in urban regions, which will benefit urban managers and climatologists in developing simulation models.

As a result of the findings, the following suggestions are made: Adapting modern construction technology and standards to depict future climatic conditions and extreme weather occurrences. Building flood defenses and raising the level of dykes in the risk region, an extra all-inclusive research, including additional surface descriptors, should be carried out to identify other characteristics that have a major influence on the LST/Hot and Cold spots of Lokoja or other locations. The government and environmental management in Lokoja should consider developing phased green schemes, primarily in the Central Business District (CBD), to lower the increase of Land surface Temperature of hot spots and their explosion whenever possible.

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