Exploring Public Perceptions Of Urban Heat Island In Maiduguri: A Preliminary Study

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Abstract

The Urban Heat Island (UHI) effect is a new challenge for the residents of this semi-arid city, which is plagued by heightened temperature and dryness and is still recovering from a ten-year insurgency that disrupted livelihoods and raised security concerns. This study assesses urban dwellers' awareness and perception of the UHI phenomenon, and how it affects their livelihood. which is a crucial component of modern urbanization. An in-depth comprehension of the UHI phenomenon and its effects is essential for guiding efficient planning and putting appropriate mitigation strategies into practice in a given locality. This study used a quantitative methodology, involving the distribution of 400 questionnaires and the analysis of the results using descriptive statistics in (SPSS) IBM SPSS Statistics 23. The participants indicated a low degree of familiarity and awareness regarding UHI, which is attributed to factors like inadequate education regarding the environment and limited communications being recognized as contributing factors. The high perception that human activity is the main factor contributing to UHI is consistent with scientific findings, highlighting the necessity of bridging the knowledge gap between the general public and scientific research. participants showed heightened comprehension of the health risks attributed to UHI, and a sizable portion reported receiving little information about UHI in educational settings. The study emphasizes the value of integrated urban planning, education, and communication in

addressing UHI-related issues for sustainable and resilient cities.

Keywords: Urban heat Islands, Urban dwellers, Perceptions, Awareness.

Introduction

The increasing effects of rising temperatures in cities across the globe have become a major concern for urban inhabitants and the environment. The rapid pace of urbanization and increased anthropogenic activities have caused an alteration in land use from open spaces to built-up areas that radiate heat. This change has caused the land surface temperature (LST) to rise noticeably, which has intensified the UHI effect (Cao et al., 2016; Ibrahim et al., 2020; Jannat & Alam, 2022; Maharjan et al., 2021; Weng et al., 2019). The Urban Heat Island (UHI) effect, a local phenomenon that is characterized by a significant increase in temperature in urban areas relative to their surrounding rural areas, is one of the main environmental effects of urbanization (Feng et al., 2023; Maskooni et al., 2021; Santamouris, 2020). Feng et al., (2023) equally asserts that, the most well-researched consequences of climate change that directly affects human populations is the phenomenon of urban heat island. Furthermore, Feng et al., (2023) affirms that, the UHI phenomena is a well-established phenomenon that has been observed in more than 400 cities globally.

The increasing number and size of cities, as well as the deterioration of urban settings in terms of both social and environmental quality, are some of the reasons behind the global focus on the challenges associated with living in urban areas. Urbanization, stimulated by population growth and economic development, has resulted in an accelerated change in the physical landscape of cities (Kim & Brown, 2021). Over the past few decades, there has been an unprecedented global rate of urbanisation due to rapid migration from rural to urban areas and population growth in cities. This trend is likely to continue in the years to come (Ishola et al., 2016).

It's been reported by (Profiroiu et al., 2020) that in 1950, only 751 million people were living in cities; today, there are over 4.2 billion urban dwellers worldwide, with over 863 million who reside in informal settlements, a number that is increasing by about 1 million every ten days (Acuto et al., 2018; Elmqvist et al., 2019). Also, the number of large cities with

populations of over 5 million urban dwellers is increasing, with over 30 "megacities" with its inhabitants exceeding 10 million (Saaroni et al., 2018). Studies have indicated that by 2020, the developing countries of Africa, Asia, and Latin America would be home to about three out of every four urban dwellers, as well as eight of the world's nine megacities (Azunre et al., 2019). This rapid urbanization and its concomitant sprawl, in both the global north and south, are endangering the urban climate's long-term viability. By the year 2050, over two thirds of the world's population 70 percent of all people will reside in cities, 90% of this growth will be in Africa and Asia (Ladan et al., 2022). Undoubtedly, a historic turning point was achieved in 2007 when the number of people living in cities worldwide overtook those living in rural areas for the first time. This embodies a significant shift in the demographic landscape (Miccoli et al., 2016; Coccolo et al., 2018; Elmqvist et al., 2019; Gelan & Girma, 2021). Given that cities are among the most complex man-made systems or mechanisms, the sustainability of the urban landscape and that of the urban dwellers is one of humanity's greatest concerns. Similarly, over the decade urban centers have emerged as critical to securing a long-term future. Economic, environmental, and social, urbanization now play a critical role in each of the three fundamental pillars of sustainability.

Urban Heat Island (UHI) is divided into two categories: surface UHI, which considers surface radiative temperature variations, and atmospheric UHI, which concentrates on effects in the canopy or boundary layers. (Rasul et al., 2016). In situ sensors, radiosonde devices, drones, and aircraft are used to monitor atmospheric UHI, whereas satellite-based surface UHI is being used more and more for spatiotemporal evaluations. Season, sunshine, land cover, and weather all have an impact on surface UHI, which varies significantly from day to night as a result of solar radiation. Conversely, four distinct UHI types were identified by Stewart & Mills, (2016), underscoring the intricacy of urban thermal patterns. i. Canopy-level UHI (CUHI), which focuses on the temperature of the near-surface air and is measured below roof height. ii. Boundary-level UHI (BUHI) measures air temperature far above building heights. iii. Surface UHI (SUHI), which includes the ground, walls, and rooftops is determined by measuring the three-dimensional city surface temperature, and iv. Substrate UHI (GUHI) is determined by the soil's temperature below the earth's surface. Gaining an understanding of the

different kinds of Urban Heat Islands (UHIs) that have been presented is essential to raising urban residents' consciousness and knowledge.

Over the past few decades, there has been a significant increase in the global population of cities and a rapid migration of people from rural to urban areas. Urbanization has accelerated as a result of this extraordinary trend, and this pattern is anticipated to continue in the ensuing decades (Ishola et al., 2016). The migration of individuals from rural areas to towns and cities and the continuous growth of the urban population have profound effects on societies all over the world. The continuous trend of urbanization presents a variety of opportunities and challenges, impacting social dynamics, infrastructure, resource management, and sustainability of the environment in cities. To foster resilient and dynamic urban environments in the future, cities need to acknowledge and address the complex effects of urbanization as they struggle to accommodate and maintain their expanding populations.

Although a great deal of research has focused on the impacts of Urban Heat Island (UHI) issues the wider scope of climate change, these studies have consistently demonstrated that there is a relationship between these two phenomena. Heatwaves are amplified by the interaction of UHIs and global climate change, which is especially noticeable during intense heat events, particularly on hot summer days. Due to this interaction, the thermal environment in urban areas is fundamentally transformed, which increases the risk of heat stress for residents (Shao & Kim, 2022). Understanding the interconnected dynamics between UHIs and global climate variability is essential for comprehending the changing challenges related to urban climates and for developing strategies that effectively mitigate their adverse effects on a local and global level. Likewise, it is imperative to note that urban heat islands (UHIs) are different from and not the causes or immediate effects of global warming. This assertion highlights the limited scope of UHIs, suggesting that while they may raise temperatures in cities, they are not the main causes of the more general phenomena of global warming or climate change. Urban heat islands, or UHIs, are impacted by human activity and urban infrastructure, but global warming is a broader, more pervasive trend linked to changes in regional or global climate patterns. A thorough understanding of the intricate interactions between both regional and global factors

influencing changes in the climate and temperatures requires an appreciation of this distinction.

Accordingly, the worst effects will fall on societies or nations least prepared to withstand expected climate realities in their socioeconomic and environmental systems. The emerging and poorer nations, especially the least developed ones, are predicted to be the main targets of these shocks (Mohammad & Bayat, 2023). This demonstrates how vulnerable these countries are, implying that their inadequate infrastructure, resources, and resilience may intensify the negative consequences of expected disruptions, putting them at a disadvantage relative to their more advanced countries (Heaviside et al., 2017; Mohammad & Bayat, 2023). The implications are profound, highlighting the critical need for focused interventions and safety nets to improve the most vulnerable countries' ability to adapt to future shocks. Therefore, given the urgency of the situation, targeted interventions and support systems are needed to increase the ability of countries facing increased vulnerabilities to adapt. This urgent need for action is highlighted by the particular case of Maiduguri, the research area, which is located in a hot, dry semi-arid region and is further complicated by an ongoing insurgency that has had a significant negative impact on the population's overall well-being, economy, and psychological well-being. Understanding how urban residents perceive and are aware of the urban heat island phenomenon is crucial in light of these multifaceted challenges. This knowledge is crucial for identifying necessary mitigating actions and formulating practical solutions that can be effectively applied to the distinctive issues faced by Maiduguri's urban populace.

The health and well-being of urban inhabitants are seriously at risk from this phenomenon, especially in large emerging metropolitan areas with limited resources (Heaviside et al., 2017). Rapid urbanization and the problems caused by UHI highlight how urgent it is to address these problems holistically while taking into account the particular vulnerabilities and limitations that cities in the global south face. Therefore, in this study, urban dwellers' perceptions of UHI's effects on their livelihoods and general well-being will be examined, along with their awareness and comprehension of the phenomenon. The specific aims include: To evaluate the awareness and knowledge of UHI among urban dwellers. Examine the extent to which locals are familiar with the causes, features, and effects of UHI. And assess residents’ perception

of the impact of UHI on their, livelihoods, and general well-being.

The study area

Maiduguri, the area under investigation is the Borno state capital, located in the semi-arid North-eastern region of Nigeria. It falls within latitudes 11˚04'N and 11˚44'N and between longitudes 13˚04'E and 13˚44'E covering an area of 543km^2. This urban centre is shared by four local government areas: Maiduguri Metropolitan Council, Jere, Konduga, and to a smaller extent Mafa Local Government Area, (Abubakar Biu et al., 2020; Waziri, 2009).

The Borno State Urban Planning and Development law (2001) defines Maiduguri as the state capital including the Maiduguri Metropolitan Council (MMC) and parts of Jere Local Government. It also includes parts of the Konduga, Magumeri, and parts of Mafa Local Government Areas (Kaka et al., 2019; Waziri, 2012). The jurisdiction is defined as areas encompassing a 25-kilometer radius of the Shehu's Palace. This legal framework defines the precise boundaries along with the administrative scope for Maiduguri's urban planning and development (Waziri, 2012).

Warm weather is consistently experienced in the study area, with monthly mean temperatures above 20°C. Extremes in daily temperature can vary greatly; in April, it can get as high as 47°C (Friday Nkwocha et al., 2020; Jimme et al., 2016). urban dwellers are seriously at risk for serious health challenges due to the region's extreme temperatures, which can reach 45°C in the summer (NiMet, 2022). Long stretches of high temperatures and low precipitation define the climate, which makes for a dry and warm atmosphere for the majority of the year.

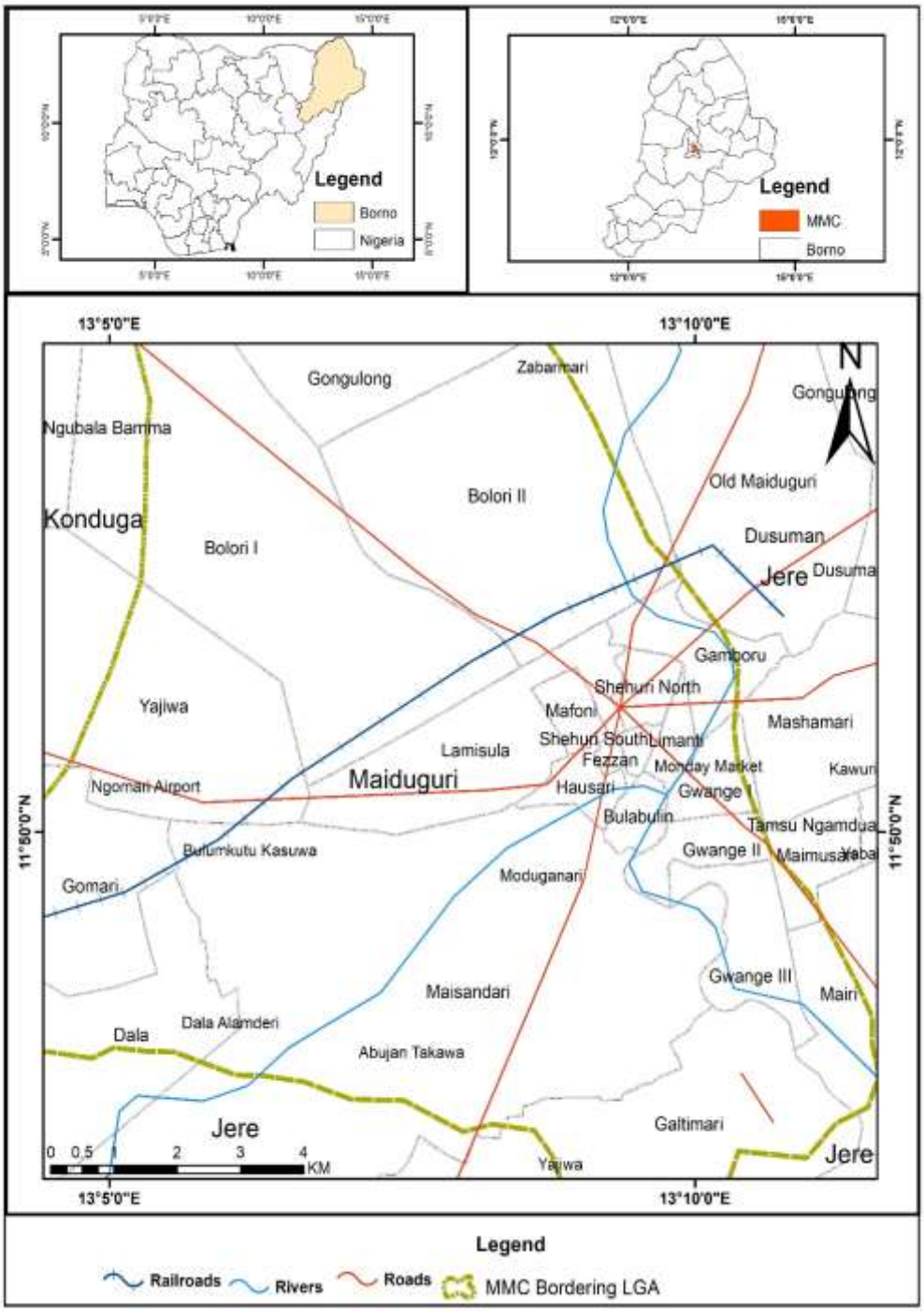


Figure 1. Map of Borno State showing Maiduguri the study area and its environs:

Source – GEONET Cast Unit, Department of Geography, University of Maiduguri,

Methodology

The research study employed both primary and secondary sources for data collection. Primary data was gathered through

the distribution of structured questionnaires to respondents, with a total of 400 questionnaires administered using stratified random sampling targeting heads of households across various wards in Maiduguri metropolis. Before the main survey, a pilot survey was conducted, and an exploratory factor analysis was performed to refine the questionnaire. All distributed questionnaires were successfully retrieved, ensuring a comprehensive dataset for analysis. Secondary data was obtained from diverse sources of reputable scholarly works.

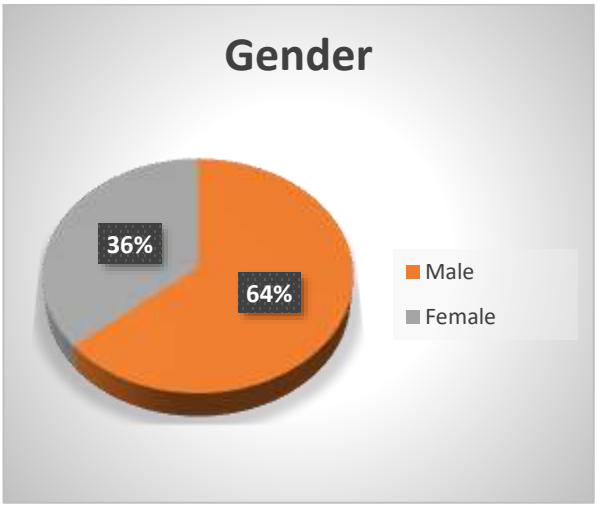
The study adopts a stratified random sampling method, where the population is divided into subgroups (strata) based on wards in the Metropolis. Each stratum represents a specific subgroup, and samples are independently drawn from each stratum. The focus is on adult inhabitants, particularly household heads, who are deemed to offer valuable insights. Wards serve as the primary strata, and within each ward, the primary sampling frame comprises adult residents, with an emphasis on household heads due to their potential for in-depth local knowledge. Respondents were selected randomly within each stratum (ward) using computer-generated random numbers. The Yamane formula is employed to determine the sample size, ensuring a representative selection of respondents across the 22 wards in the study are. This approach seeks to improve the universality of the study findings by gathering a variety of perspectives within the population

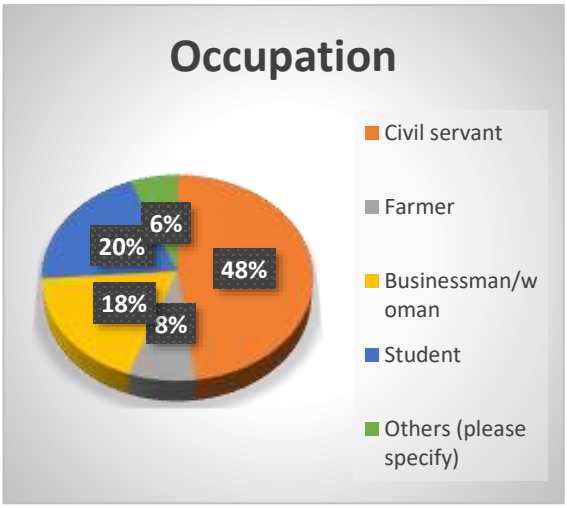
Data Analysis

The collected data underwent statistical analysis to draw insights into the awareness and understanding of the urban heat island phenomenon among the surveyed population. The researchers used a variety of statistical techniques with the Statistical Package for the Social Sciences SPSS (IBM SPSS Statistics 23). Descriptive statistical methods, such as calculating basic percentages, and visualising the data with pie and bar charts were both used in the analysis. Furthermore, frequencies were utilized to better understand the distribution of categorical variables, and measures like mean and standard deviation. Weighted average technique were used to give a numerical representation of the central tendencies in the data and for decision making. This multimodal strategy guarantees a close analysis of the research results, fusing numerical accuracy with visual cues to improve comprehension of the study results as a whole.

Socio-demographic Characteristics of Respondents

Participants' demographic information, including their gender, age, marital status, occupation, level of education, income, and length of stay, was gathered through a structured questionnaire used in the study. One of the most important steps in determining whether the data was suitable for factor analysis was to compute the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The resultant KMO value of 0.648 is higher than the generally recognized cutoff of 0.6. This suggests that the variables contained in the socio-demographic element of the questionnaire constitute a sufficiently cohesive and reliable foundation for additional analysis, indicating that the dataset is deemed suitable for factor analysis. The data's resilience bolsters the reliability of using factor analysis to identify significant patterns and connections among the sociodemographic traits of research participants.





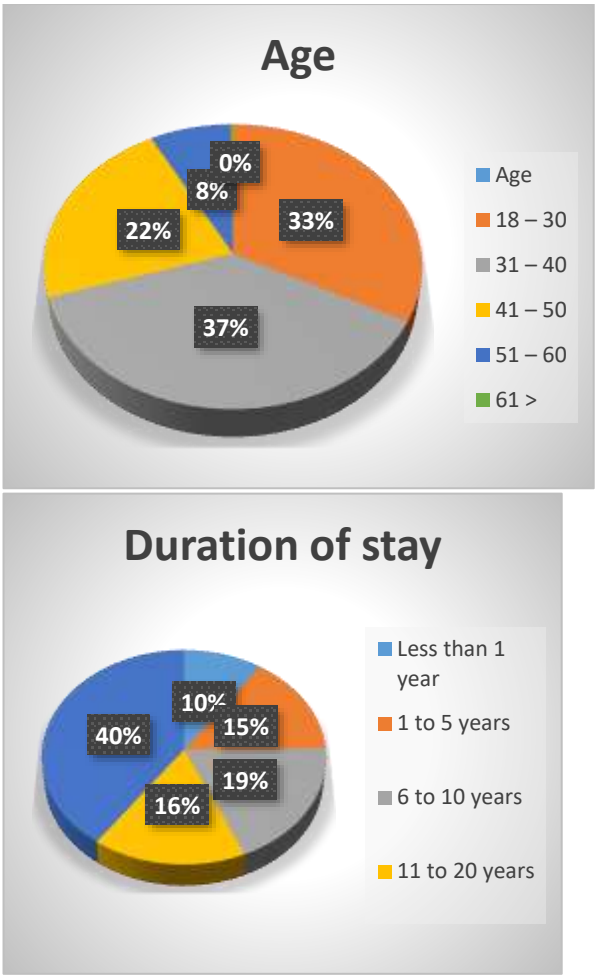


Figure 2. Graphical Presentation of Demographic Characteristics of urban dwellers

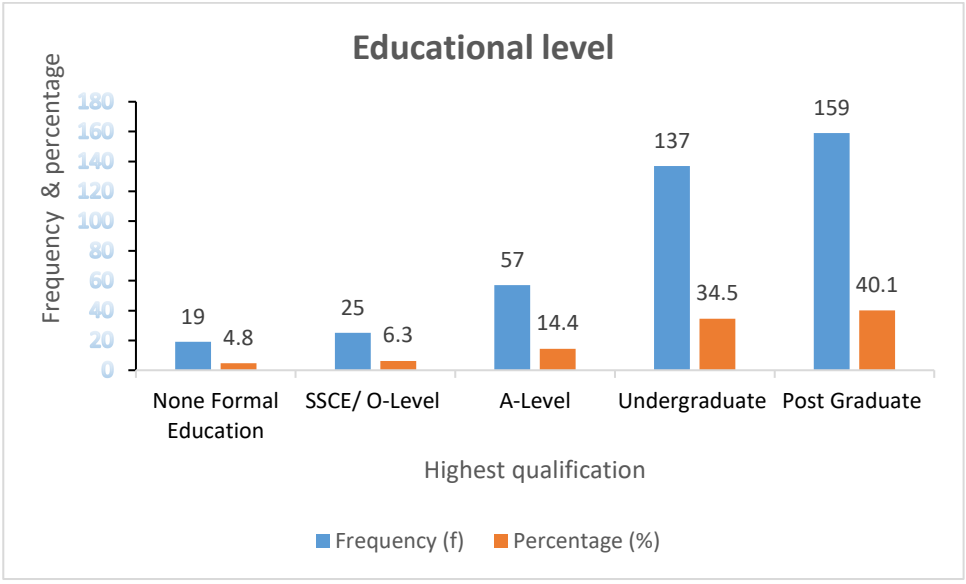


Figure 3.1 Graphical Presentation of Demographic Characteristics of urban dwellers

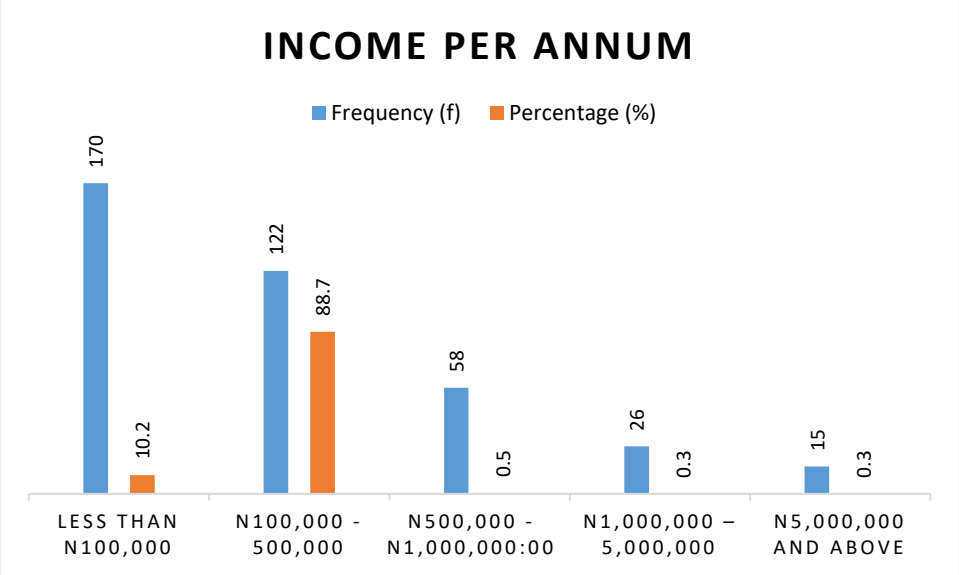


Figure 3.2 Graphical Presentation of Demographic Characteristics of urban dwellers

Demographic characteristics of urban dwellers

The socio-demographic characteristics of the respondents provide a detailed snapshot of the surveyed population. The sample exhibited an overrepresentation of men (63.8%) across all areas, encompassing both active and productive residents and households (Table 1). This skew towards middle-aged male participants suggests that men were more willing to participate in the survey, leading to their overrepresentation in the majority of the sample. This overrepresentation is attributed, in part, to cultural and religious inclinations within the urban populace. Specifically, cultural norms and religious practices, particularly in the context of married women, practically discourage interactions with strangers, especially adult males. This demographic skew highlights the importance of considering cultural and societal factors when designing and interpreting survey samples, emphasizing the need for diverse and inclusive representation in research efforts. With 90.2% of the respondents being under 50, the age distribution is biased towards people in this age range, indicating a comparatively young population. The fact that a sizable portion (61%) of this group is married reflects the significant role of families and respect for the institution in this community (Figure 2).

With (40.1%) of the population having completed a postgraduate degree and 5% having received non-formal

education, the reported findings demonstrate the educational diversity within the surveyed population. Significantly, all members of the community, regardless of their level of formal education, are literate, and many have committed the Quran to memory, demonstrating a strong Islamic influence ingrained in the community's history. This aspect of culture and religion has endured over time, existing before Nigeria was colonized. The rich Islamic heritage of Kanem Borno emphasizes the community's historical and cultural significance. All of these results highlight how important it is to recognize the distinct educational and cultural context of the community when establishing interventions or policies. A more nuanced understanding of the community's identity and values can be gained by acknowledging the significant influence of Islamic traditions and the dedication to memorizing the Quran. This thorough comprehension is essential for developing strategies that complement the unique qualities of the community and promote genuine involvement. The majority of participants (50%) work in the civil service, suggesting a significant number of people who work in the public sector. The fact that only 8% of them work as full-time farmers suggests that they don't rely heavily on agriculture as their main source of income

The finding that nearly all of the respondents (99%) of them earn less than 500,000 naira annually points to a notable prevalence of low income in the surveyed population. This income level may be correlated with lower socioeconomic status and is suggestive of financial constraints. Given the higher cost of living in urban areas, it is likely that a significant proportion of the populace experiences financial difficulties and may be classified as impoverished urban inhabitants, given the low-income range. It draws attention to the necessity of focused initiatives, policies, or interventions to address economic disparities and raise this population's standard of living. A significant proportion of the respondents more than (75%) have lived in the area for more than ten years, indicating that permanent residency is common in the area (Figure 2). This long duration suggests a close relationship and deep roots for most of the urban dwellers in the region. An in-depth awareness of the local dynamics, interpersonal relationships, and cultural subtleties can be facilitated by such an extended stay. Those who have lived somewhere for a long time are probably well-integrated into the community, so it could also be a sign of stability and a sense of belonging. Understanding the stability of the community, possible shared experiences,

and the effects of long-term residency on different facets of local life are all made possible with the help of this information. Taken together, these socio-demographic characteristics paint a picture of a predominantly youthful, literate, and married population with diverse educational backgrounds. The heavy reliance on civil service jobs, coupled with a minimal representation of full-time farmers and low annual income levels, suggests economic challenges within the community. The findings underscore the importance of understanding the socio-demographic context when designing interventions or policies to address the specific needs and challenges faced by this population.

The survey population's transportation habits and car ownership data show a variety of patterns (Table 1). Roughly 28.5% of people are car owners, which is a sizable but not majority group. On the other hand, a significant 67.3% utilize public transport, demonstrating the widespread use of shared transport options. Additional information about vehicle kinds reveals that 42.3% of people own cars and 31.4% own tricycles, mostly for business use. This dual ownership points to a combination of community-based income-generating and personal transportation assets. When it comes to how far people commute to work, most people (44.6%) travel between 0 and 15 km, which suggests that a sizable percentage have relatively short commutes. In the meantime, 15.4% commute 30 to 45 km, and 30.5% commute 15 to 30 km. This provides a detailed picture of the commuting patterns over a range of distances. All of these results highlight how different the people surveyed had in terms of preferences and modes of transportation.

In the context of environmental concerns and urban dwellers' lifestyle choices, as shown in the findings on ownership of cars and transportation behaviours have significant implications for mitigating urban heat islands (UHIs). The strong inclination towards shared transport modes, which can reduce the release of heat and traffic-related accumulation of heat if they are environmentally friendly, is indicated by the substantial choice for public transport (67.3%). The dual ownership pattern highlights the mix of income-generating and personal transportation assets, with 31.4% owning tricycles for business use and 42.3% owning cars. This creates a need to balance the negative environmental effects. Tricycles, which are frequently used for short trips, have the potential to leave a different environmental impact than cars,

which can contribute to localised heat due to their varied fuel types and emissions. Promoting eco-friendly modes of transport is essential for mitigating UHI effectively.

The distribution of commute distances reveals that a substantial percentage (44.6%) travels short commutes of between 0 and 15 km, which have lower emissions and less vehicle activity and contribute less to UHI. The 30.5% who commute 15 to 30 km, however, require special attention, highlighting the necessity of addressing longer commutes to reduce elevated heat emissions. In the end, knowing transport patterns and preferences offers insightful information for UHI mitigation plans that emphasise the effects on the environment as well as urban dwellers' lifestyle choices. Optimizing commuting distances and promoting environmentally friendly, energy-efficient, and shared modes of transportation are crucial strategies for building resilient and environmentally conscious urban communities.

The survey result shows more than 60% of the respondents use electronic appliances frequently, especially cooling systems, which has some consequences for attempts to mitigate urban heat islands (UHIs). Positively, the widespread use of cooling technologies indicates that residents are actively involved in activities that can lower temperatures. If these electronic appliances are energy-efficient, they may help mitigate the warming effects of UHI. Nevertheless, there might also be adverse effects. These cooling systems' use could lead to higher overall energy consumption and, as a result, higher release of greenhouse gases, which could make environmental problems worse if they mainly rely on non-renewable energy sources.

This study confirms the results of another study by Sahu et al., (2014), which likewise claims that using electrical appliances to create artificial comfort raises the temperature and degrades the atmosphere. Both studies show how this method depletes natural resources, increasing greenhouse gas and air pollution emissions and having a detrimental effect on people's comfort and health. All of these studies point to a pressing need for alternative solutions to reduce the negative environmental effects of using these kinds of appliances and to create a home that is healthier and more environmentally conscious.

Awareness and Understanding of Urban Heat Island Phenomenon

The study intends to use a weighted average technique to evaluate respondents' opinions of the urban heat island phenomenon. We will weigh each question on the questionnaire according to how important I think it is to compute this. We will calculate the mean score for each item, multiply it by the associated weight, add up the weighted scores, and divide the total by the number of items. With more weight given to items deemed more important in offering insights into respondents' overall knowledge and understanding of the urban heat island phenomenon, this method allows for a more nuanced analysis. Cronbach's alpha was used in this study to assess the reliability of the internal consistency of the responses on awareness and understanding questionnaire; the resultant coefficient was 0.804. This suggests that the questionnaire items have a good degree of reliability, giving confidence in the consistency of responses.

Ethical considerations.

The Sultan Idris Education University Malaysia Research Ethics Committee (RMIC) gave the study methods (No: 2023-0210-01) ethical clearance after a careful review. The study's objectives and methods were fully disclosed to the participants. Every participant gave their informed consent before the questionnaires were administered. They were also informed that their identity would be kept confidential in any publications arising from the data results.

Table 1. Responses on Awareness and Understanding of Urban Heat Island Phenomenon

Strongly Disagree 1		**Disagree 2**		**Undecided 3**			**Agree 4**	**Strongly Agree 5**
Statements	**1(%)**	**2(%)**	**3(%)**	**4(%)**	**5(%)**	Mean	SD	Decision
To what extent do you agree with the statement: I have heard of the urban heat island phenomenon.	66 (17.1)	47 (12.2)	80 (20.7)	150 (38.9)	47 (11.1)	3.15	1.27	Low perception

To what extent do you agree with the statement: 'I have some ideas about the phenomenon referred to as the 'urban heat island.	41 (10.3)	76 (19.0)	81 (20.4)	154 (38.8)	45 (11.3)	3.22	1.18	Low perception
To what extent do you agree with the statement that urban heat island is a natural phenomenon?	51 (13.1)	77 (19.8)	59 (15.2)	142 (36.6)	59 (15.)	3.21	1.29	Low perception
To what extent do you agree that human activities are responsible for the emergence of the urban heat island (UHI)	36 (9.1)	47 (11.8)	73 (18.4)	114 (36.3)	97 (24.4)	3.56	1.23	High perception
I heard about the urban heat island in the print media, social media, and or Television	40 (10.2)	50 (12.8)	71 (18.1)	165 (42.1)	66 (16.8)	3.43	1.21	High perception
Have you heard anything about urban heat islands (UHIs) in your educational experiences?	57 (14.5)	60 (15.2)	76 (19.3)	136 (34.5)	65 (16.5)	3.23	1.29	Low perception
To what extent do you agree that urban heat island leads to increased temperatures in cities?	39 (9.9)	37 (9.4)	63 (16.0)	140 (35.6)	114 (29.0)	3.64	1.26	High perception

Urban heat islands increase the threats to human health posed by thermal stress.	40 (10.1)	38 (9.5)	79 (19.8)	133 (33.4)	108 (27.1)	3.58	1.26	High perception
The urban heat island phenomenon is an important issue for the urban populace.	39 (10.0)	48 (12.3)	63 (16.1)	158 (40.4)	83 (21.2)	3.51	1.23	High perception
Urban heat island (UHI) has become one of the major problems associated with the urbanization and industrialization of human society.	36 (9.0)	52 (13.0)	61 (15.3)	151 (38.0)	99 (24.8)	3.67	1.24	High perception

Note N = 400.

Weighted average = Sum of variables (weight) / sum of all weights

Decision = Weighted average = 34.2/10 = **3.42.**

Discussions

In light of the statement regarding awareness of the urban heat island phenomenon, participants indicated a low level of perception (Table 1). The resulting average ratings suggest a prevailing lack of awareness among the participants regarding the urban heat island phenomenon. This implies that, as a group, participants generally do not perceive themselves as well-informed or conscious about this environmental phenomenon. The urban heat island phenomenon refers to the elevated temperatures observed in urban areas compared to their rural counterparts, often attributed to human activities and alterations to the natural environment. The indication of a low average perception of awareness among participants

underscores a potential gap in public knowledge regarding this phenomenon.

The limited awareness of the urban heat island phenomenon among participants can be attributed to a multifaceted array of factors, encompassing inadequate environmental education, insufficient media coverage, regional disparities in the intensity of urban heat island effects, communication breakdowns in information dissemination, a perceived lack of relevance in daily life, and the competing priorities faced by individuals. A distinct challenge arises when considering urban dwellers who have endured the devastating impacts of insurgency for over a decade, as their unique circumstances may further impede their access to environmental information. Aghamohammadi et al., (2022) emphasize that active participation in mitigation efforts is largely dependent on stakeholders having a thorough understanding of how Urban Heat Island (UHI) affects society, the economy, and the environment. This is consistent with the survey's findings, which point to some variables that may have contributed to participants' low level of awareness, including poor environmental education, a lack of media coverage, regional variations in the effects of UHI, a breakdown in communication, a perception that the topic is unimportant in day-to-day life, and conflicting priorities. According to both sources, it is critical to address these issues to raise awareness among stakeholders and perspectives and promote focused and efficient action plans to mitigate the effects of UHI.

Similarly, the respondent's assessment of their perceived familiarity or knowledge with the urban heat island (UHI) phenomenon was deemed to be limited as the result obtained shows low perception (Table 1). The purpose of the question was to find out how much individuals thought they understood the idea of UHI. Without delving into the particulars of the respondent's real knowledge or expertise on the subject, it essentially concentrated on their subjective evaluation of their awareness or familiarity with the topic. This suggests that to improve respondents' and similar populations' awareness and understanding of UHI, focused educational initiatives or interventions may be necessary. In the same vein, the respondent demonstrated a low level of perception of what an urban heat island (UHI) is (Table 1). The inquiry sought to ascertain the respondent's viewpoint regarding the causes and origins of urban heat islands (UHI) by posing the idea as either a naturally occurring phenomenon or possibly impacted

by human activity. The results of this study align with those of Aghamohammadi et al.'s study conducted in Malaysia (2022), wherein approximately fifty percent of the participants linked Urban Heat Island (UHI) to higher temperatures in urban areas as opposed to their rural counterparts. The results of both studies show that participants' awareness and comprehension of UHI are comparable, underscoring a common understanding that there is still an opportunity for growth in this area. This acknowledgment suggests that to effectively address the phenomenon, there is a collective need for improved education and awareness initiatives. The results are essential for comprehending how much the general public knows about urban heat islands (UHIs). They emphasise the critical importance of improving low awareness through education and the need for well-informed conversations on mitigation efforts and focused environmental education initiatives.

The survey results indicate that a significant majority of respondents hold the belief that human activities are responsible for the emergence of the urban heat island (Table 1). This measurement captures the prevailing perspective among respondents regarding the role of human actions in the formation of UHI. The question, which attributes the emergence of UHI to human activities, serves to assess individual beliefs, opinions, or attitudes regarding the extent of anthropogenic influence on urban heat islands. In this case, the respondents overwhelmingly perceive humans as being wholly responsible for the phenomenon, reflecting a strong acknowledgment of the connection between human activities and UHI formation. This finding is remarkably consistent with the research conducted by Ibrahim et al., 2019; Sahu et al., (2014), which highlights the critical role that human activity plays in contributing to the development of Urban Heat Islands (UHI). The opinions of the respondents are consistent with previous studies, highlighting a widespread understanding of how human actions impact the dynamics of urban temperature. This consensus between scientific findings and public viewpoints emphasizes how important it is to increase public awareness to address how human activity affects UHI. Our findings' consistency with those of other studies has important ramifications for improving sustainable methods to reduce the effects of urban heat islands (UHI) and directing urban planning practices.

The survey's findings show a noteworthy pattern in how participants felt about the sources that first introduced

them to the concept of urban heat islands (Table 1). This question does a good job of assessing the different media platforms, print, social media, television, etc. that people have used to learn about urban heat islands. By examining these sources, the question sheds light on the efficiency of different means of communication in spreading knowledge about environmental issues, especially urban heat islands, and serves as a useful gauge of the impact that media has on public awareness. By using these results, researchers can gain a deeper understanding of the influence and reach of media outlets, which can help them make more informed strategic decisions about educational programs and outreach associated with urban heat islands.

On the other hand, the results of the survey illustrate that, in the context of their educational experiences, the majority of respondents felt they were not exposed to or aware of information about urban heat islands, indicating low perception (Table 1). The inquiry particularly looks into whether participants have come across or heard about urban heat islands in the context of formal education, including fieldwork, field trips, and classroom interactions. These responses provide insightful information about the extent to which academic institutions support public education and awareness-building regarding environmental phenomena such as urban heat islands. The academic discipline and study level of the respondents are two possible influences on this pattern.

It has been observed from the survey's findings, that participants have a more acute understanding of urban heat islands concerning how they affect the well-being of the urban populace (Table 1). This result offers insightful information about the participants' perceptions and beliefs about the possible health risks connected to urban heat islands. The high level of awareness demonstrates a level of consciousness about the environmental and public health implications of elevated temperatures in urban areas and suggests that the respondents are aware of the links between urban heat islands and health outcomes. This result might be a sign of a population of respondents who are knowledgeable and involved in the problems caused by urban heat islands.

According to the survey's findings, participants have a more acute understanding of urban heat islands concerning how they affect people's health. This result offers

insightful information about the participants' perceptions and beliefs about the possible health risks connected to urban heat islands. The high level of awareness demonstrates a level of consciousness about the environmental and public health implications of elevated temperatures in urban areas and suggests that the respondents are aware of the links between urban heat islands and health outcomes (Table 1). This result might be a sign of a population of respondents who are knowledgeable and involved in the problems caused by urban heat islands This is consistent with a 2019 study by Santamouris, which found that the interaction between local Urban Heat Islands (UHI) brought on by fast urbanisation and global climate change poses a major threat to human well-being. This concern is supported by your study's findings, which show that people are more aware of the negative health effects of UHI. The increased consciousness highlights the pressing need for urban overheating to be addressed in city planning. All things considered, your research contributes valuable information to the ongoing discussion about creating resilient and sustainable cities, particularly by highlighting the participants' acute awareness of the health hazards associated with urban heat islands (UHI).

The survey's findings show that respondent's perceptions of the significance of the urban heat island phenomenon in metropolitan settings are highly developed. According to this finding, respondents have strong opinions about the importance of urban heat islands as a problem for the environment in urban areas. The high degree of perception might be a result of knowledge about the possible negative effects of high temperatures in urban areas on the environment, public health, and the sustainability of urban areas as a whole. Simwanda et al., (2019) highlight UHI challenges in metropolitan areas, including heightened energy consumption, increased emissions, compromised water quality, and impacts on human health and comfort, which aligns with the respondent's opinions. This underscores the urgency of researching and addressing UHI's impacts on the well-being of urban environments and residents. Policymakers, urban planners, and environmental advocates who want to address and prioritize issues regarding urban heat islands in city planning and development may find this information to be helpful.

According to the survey results, participants also demonstrate a high degree of perception when it comes to the

importance of the urban heat island as a threat related to industrialization and urbanization. This result points to a strong consensus among respondents, indicating a mutual understanding of the significant influence of urban heat islands concerning industrial activity and urban development. Urbanization and industrialization contribute to environmental challenges, including air pollution, global warming, industrial waste, and rising urban temperatures, as asserted by studies (Azmi et al., 2021; Saaroni et al., 2018). Elevated urban temperatures are linked to the Urban Heat Island effect, emphasizing the need for sustainable urban development to address environmental and well-being concerns.

Looking at the overall result and discussions it aligns with global sustainability agenda, the study's emphasis on the significance of comprehending the urban heat island (UHI) phenomenon for urban sustainability greatly aligns it with the Sustainable Development Goals (SDGs), especially SDG 11 (Sustainable Cities and Communities). By pointing out the need for better environmental education to address participants' lack of awareness, it also supports SDG 4 (Quality Education). Furthermore, by emphasizing the need for cooperative efforts among researchers, legislators, educators, and media channels to successfully deal with environmental challenges like UHI, the study supports SDG 17 (Partnerships for the Goals). The study offers insightful information highlighting the importance of collaboration and education in creating resilient and sustainable cities.

Conclusions

The urban inhabitants generally have little awareness on the UHI phenomenon, the study emphasizes the imperatives of thorough and focused educational programs to raise public awareness as well as an understanding of the city's heat island event. minimizing the environmental, well-being, and sustainability difficulties posed by urban heat islands requires addressing knowledge gaps, enhancing communication as well as easily accessible information dissemination and incorporating UHI concerns into urban planning. In turn, this might provide individuals the ability to decide for themselves and adopt actions that minimise the effects of urban heat islands. Furthermore, participants' agreement that human activity is the primary cause is consistent with the scientific community, underscoring the need to close the knowledge gap between the general public and research. The study highlights how important it is to address issues related to Urban Heat

Islands (UHI) to build sustainable and resilient cities. The research emphasizes the value of communication, education, and integrated urban development. It also highlights the cooperation between stakeholders, media outlets, legislators, including the urban poor, and professionals to advance urban sustainable development techniques and boost public awareness.

Recommendations.

- A comprehensive environmental education program should be developed and implemented to address the observed need for more awareness regarding the urban heat island (UHI) phenomenon. These initiatives should focus on a range of demographic groups and highlight UHI's causes, effects, and methods for mitigation. And a collaborative effort among all stakeholders, working together, educational institutions, local government, and non-governmental organizations can be beneficial in providing proper information and helping urban dwellers acquire a better understanding of UHI.
- The study suggests incorporating UHI concerns into urban development and planning policies as a means of addressing the widely accepted importance of UHI as an environmental challenge. Strategies like green infrastructure, sustainable building techniques, and urban design solutions that minimize the impact of UHI should be given top priority by policymakers and urban planners. The integration process guarantees a comprehensive strategy for urban development that emphasizes public health, environmental sustainability, and general well-being.
- A qualitative research method should be used to complement the quantitative findings. Deeper understanding of the socioeconomic and cultural elements influencing awareness along with strategies for adaptation can be gained through qualitative research. Interviews and focus groups may uncover subtle viewpoints that quantitative surveys could have overlooked, improving our understanding of UHI in this context.

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