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# Assessing the Thermal Comfort Perception and Preferences of the Residents of Akure Metropolis, Nigeria

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**Abstract:** The temperature over Akure has been on the increase over the last few decades. This increase is not unconnected to the current global warming phenomenon. Hence, a study is required to assess the level of the perception and the varied preferences of the residents in Akure metropolis to the thermal environment. A survey questionnaire which constitute the primary dataset used for this study was administered in the study area which was divided into five landuse classes (Residential, Commercial, Industrial, Administrative and Institutional). The responses from the survey shows that 35% of the respondents felt hot as at the time of the survey, 25.5% felt warm, 23.5% were neutral, while 16% felt cool. Of the total respondents, a staggering 51% preferred the environment to be cooler as compared to 9% who preferred the environment to be warmer. 40% of the respondents stayed neutral on their preference. The study also showed that the respondents in the residential landuse perceived more hotness compared to respondents in other landuse classes.

**Keywords:** Outdoor thermal comfort, Thermal preference, Thermal perception, Akure metropolis

## 1. Introduction

The American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE, 1981), described thermal comfort as a state of the mind that actually expresses satisfaction or

contentment with the thermal environment, and it is usually subjective in nature. The impact of the urban micro-climate on the human thermal comfort is important. In an urban environment like Akure, the commonly prevalent high temperatures, especially during the dry season, that produces the urban heat island effect, also tend to aggravate the comfort/discomfort conditions of the city dwellers. High temperature causes human thermal discomfort. Rainfall and temperatures actually leads the pact of climatic variables that influence human well-being. The temperature of Akure between 1980 and 2011 shows an increasing trend indicating warming throughout the year (Ogunrayi *et al*., 2016). This increase in temperature will definitely affect the thermal sensations experienced by people living in Akure. Therefore, the knowledge of human discomfort conditions is necessary because many people particularly those who live in large cities like Akure have greater risk to morbidity and mortality due to higher air temperature than the surrounding countryside. Knowledge of the thermal climate of Akure is therefore vital for planning on health, urban development, tourism and migration, among other matters. On the other hand, recent studies have shown that the temperature trend over Akure has been on the increase (Ogunrayi *et al*. 2016) and this is a cause for worry, as Olabode (2015) showed in a study that heat-rash is one of the common heat-related skin diseases, especially in Akure where it has prevalent impact among the people. Akure has been termed one of the fastest growing cities in Nigeria, and this usually comes with a lot of pros and cons. The most visible effect of this is that the temperature trend over Akure had been on the increase according to studies (Ogunrayi *et al*., 2016). This increase in temperature trend is not unconnected with the urbanization of Akure.

### *1.1. Study Area*

The study area is Akure metropolis, the administrative capital of Ondo State. Akure became the state capital of Ondo State in 1976. It lies between longitude 5°06'E and latitude 7°37'N in the Southwestern Nigeria. It cuts across both Akure South LGA and Akure North LGA with an area of approximately 991 square kilometres (Ibitoye *et al*., 2017). It is bounded by Owo Local Government Area in the east and Ifedore Local Government Areas in the north, Ile-Oluji/Oke-Igbo Local Government Area in the west and Idanre Local Government Area in the south (Figure 1). The area towards Ado-Ekiti and Idanre are hilly and studded with large granite formation, rising to 410 meters and 496 meters above sea level respectively. These granitic formations are said to be of volcanic origin and they are underlained by basement complex rocks. These basement rocks are mostly impermeable gneisses and granites. The city has a population of 353,211 as at 2006 (Federal Bureau of Statistics, 2007) which would have grown to 474,686 by 2016, using the Nigeria Population Commission annual growth rate of 3% for urban centres in Nigeria. Akure and its environs experience a frequent annual rainfall of over 1500 mm with a short August break. The average temperature is about 22°C during harmattan (December-February) and

32°C in March. The vegetation is tropical rainforest and drained by River Ala and its tributaries. The increased relative political influence of Akure as a State capital since 1976, when Ondo State was created has been partly responsible for its rapid development. This is because, the decentralization exercise, which accompanied the policy that led to the creation of the State led to the creation of jobs, which attracted many people. According to the Koppen classification, the climate of Akure is classified as tropical, having wet and dry seasons. Characteristically, the wet season ranges between April and October, while the dry season ranges between November and March. Akure maintains a moderately warm humid tropical climate with high temperature. Maximum temperature of about 35°C is usually recorded in March.

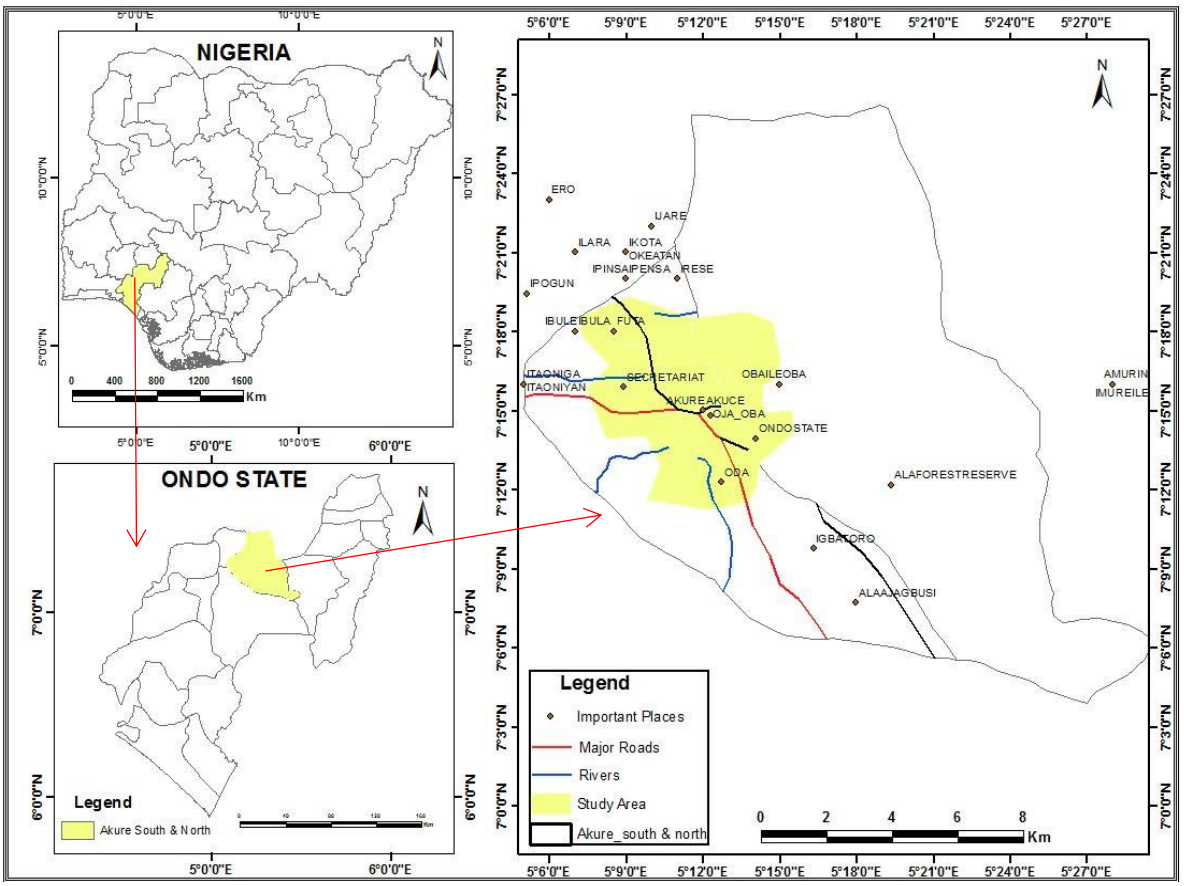


**Figure 1:** Location of study area

## 2. Materials and Methods

### *2.1. Materials*

This study made use of primary data. The primary data used for this research work was a survey questionnaire. This was used to access the various thermal preferences and perceptions of the residents in Akure metropolis. Data collection for examining the preferences of residents was based on subjective assessment in a field survey. The study area was divided into five different landuse areas, which were

visited to obtain different perspective view of the people concerning outdoor human thermal comfort within Akure metropolis. These landuse division include residential, commercial, administrative, institutional (tertiary) and industrial.

### *2.2. Subject Sample*

A total of 200 valid copies of questionnaire were administered to different people in the different landuse sites visited and all the 200 copies were retrieved during the study period. The technique that was adopted in the sampling was Stratified Random Sampling. In other to determine the sample population, Slovin's formula was used:

$$n = \frac{N}{1+Nx^2} \quad (1)$$

Where n equals number of samples, N equals total population targeted and x equals error margin. Slovin's formula is used when there is no knowledge about the total population of the study area. A total population of 1000 was targeted at the margin error of 0.063% at the confidence level of 99.937%. Eludoyin (2014), stated that the responses from a tertiary institution could sometime be stronger than that of any other area in an urban settlement, with the probability that those in schools are likely to be more conscious and inquisitive than others within any study community. 90.5% of the respondents were adults between age ranges of 18years and 60 years. In agreement with Eludoyin (2014), 50 copies of the questionnaire representing 25% went to the tertiary institution (Ter), but 37 copies (18.5%) of the questionnaire went to each of the other landuse (residential (Res), commercial (Com), industrial (Ind) and administrative (Adm) classes.

### *2.3. Methods*

The subjective assessment was based on responses to a questionnaire survey, which was administered on days that there was no precipitation in Akure in August, 2017. The scope of the questionnaire was based on several studies, and conformed to the ASHRAE standard questionnaire for thermal comfort studies (ASHRAE, 2010). The questionnaire was divided into two sections. The first section of the questionnaire was based on socio-economic and demographic characteristics. The second section asked the respondents about assessed thermal sensation and thermal preference. This section which consist of the thermal sensation, adopted scaling method from the traditional ASHRAE 5-point scale (cold, cool, neutral, warm, hot). The thermal preference was based on 3-point McIntyre preference scale (warmer, neutral, cooler).

A contingency table was created in order for us to check the relationship between the thermal perception responses and the landuse classes. A chi square test was conducted to test for this relationship based on the hypothesis below at an alpha value of 0.05:

*$H_0$: There's no relationship between thermal perception and landuse type;*
*$H_1$: There's relationship between thermal perception and landuse type.*

## 3. Results and Discussion

### *3.1. Summary of Demographics*

Data on Thermal comfort collected was based on perception of the residents, the concept of thermal comfort and changes in the climate of Akure. Therefore, data analysis was based on the 200 sampled copies of the questionnaire. Results of demographic characteristics of the respondents are shown in Table 1 below.

**Table 1:** Summary of Demographic Characteristic

| S/N | Variable | Class | Score | Percentage |
|---|---|---|---|---|
| 1 | Gender | Male | 91 | 45.5% |
| | | Female | 109 | 54.5% |
| 2 | Age | < 18 years | 19 | 9.5% |
| | | 18-40 years | 120 | 60% |
| | | 41-60 years | 61 | 30.5% |
| | | > 60 years | 0 | 0% |
| 3 | Education | No education | 0 | 0% |
| | | Primary | 14 | 7% |
| | | Secondary | 61 | 30.5% |
| | | Tertiary | 125 | 62.5% |
| 4 | Duration of Years Spent in Akure | < 5 years | 0 | 0% |
| | | 5 - 10 years | 132 | 66% |
| | | > 10 years | 68 | 34% |

From the surveyed questionnaire, the result of the respondents on the study of thermal human comfort in Akure urban center shows that highest percentage of the responses obtained were not aware of the concept of thermal comfort (51%). However, about 49% of the respondents were knowledgeable in thermal comfort. Responses on significant change of climate from the past years shows that 73% of the respondents noticed significant change in the urban area, while 24.5% reported no significant changes of the present climate from past years.

*3.2. Thermal Perception*

Figure 2 shows the distribution of thermal perception based on the 5-point ASHRAE scale in which the highest number of respondents (35%) were clustered on the hot side of the scale; 25.5%, 23.5% and 16% of the respondents voted for warm, neutral and cool respectively. It was worthy to note that no respondent voted for cold during the survey period, despite the fact the survey was carried out during the rainy season (August, 2017).

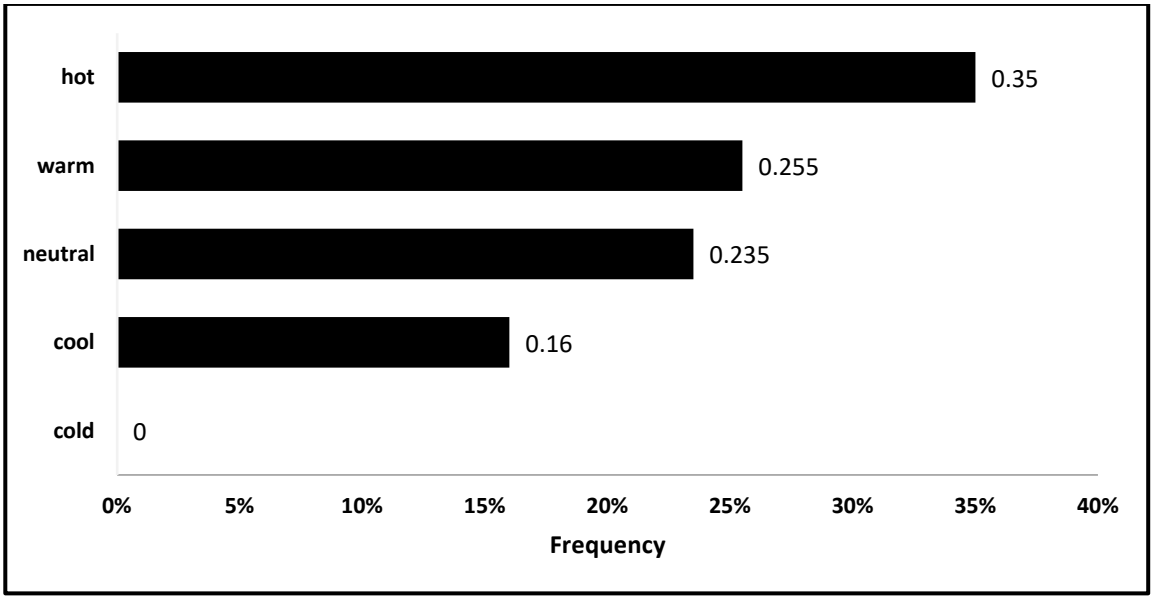


**Figure 2:** Distribution of Thermal Perception

*3.3. Thermal Preference*

In Figure 3 shows the result of thermal preference shows that 51% of the respondents obtained, preferred the environment to be cooler, 40% preferred no change to their environment and only 9% preferred to be warmer during the study period in Akure.

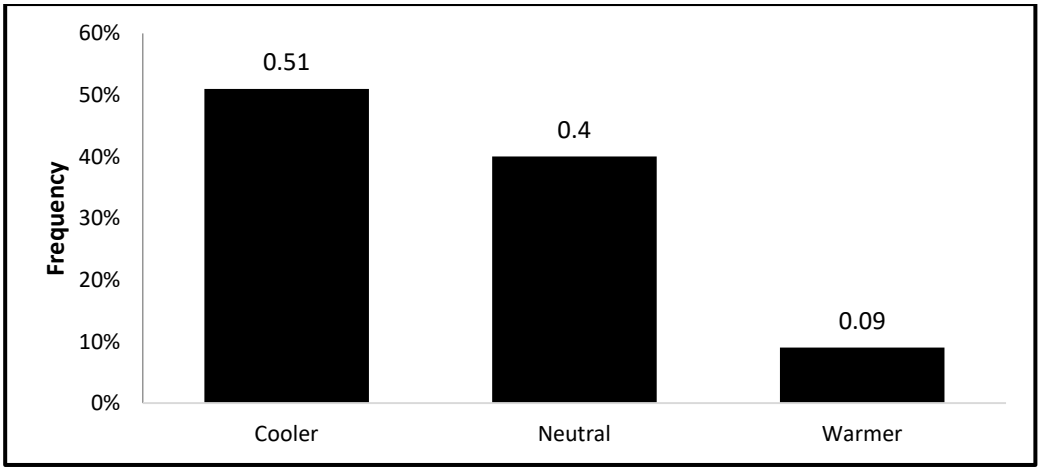


**Figure 3:** Distribution of Thermal Preference

*3.4. Distribution of Thermal Perception across Landuse*

Figure 4 shows the distribution of the thermal perception experienced by the residents of Akure across the five landuse classes (administrative, commercial, industrial, residential and tertiary institution) that was assessed during the survey. It shows that the respondents in the residential landuse claimed to perceive more hotness than all the other landuse classes. Followed by the commercial landuse class, the tertiary landuse class and the industrial landuse class respectively. A contingency table was also constructed as shown in Table 2.

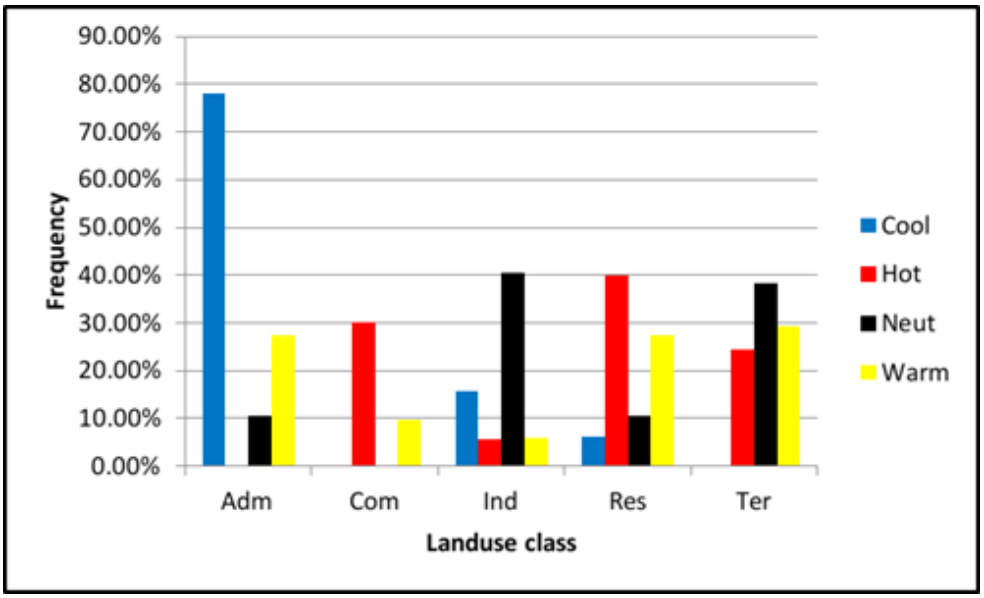


**Figure 4:** Distribution of Thermal Perception across Landuse

**Table 2:** Contingency table for perception across landuse

| Row Labels | Adm | Com | Ind | Res | Ter | Grand Total |
|---|---|---|---|---|---|---|
| **Cool** | 25 | 0 | 5 | 2 | 0 | 32 |
| **Hot** | 5 | 21 | 4 | 8 | 17 | 70 |
| **Neutral** | 0 | 0 | 19 | 5 | 18 | 47 |
| **Warm** | 14 | 5 | 3 | 14 | 15 | 51 |
| **Grand Total** | 44 | 26 | 31 | 49 | 50 | 200 |

A chi-square test was carried out on the contingency table, using Microsoft excel package, in other to test for our hypothesis. The chi-square test returned a p-value of 5.3344E-18, which is way smaller than our alpha value of 0.05. Thus, the null hypothesis $H_0$ was rejected and the alternate hypothesis $H_1$ was accepted, which means that the result of the thermal perception across the different

landuse classes is not just random, but there's actually a strong connection between the landuse classes and the thermal sensation perceived by the respondents.

## 4. Conclusions

This study has examined the different perceptions and preferences of the residents of Akure metropolis using questionnaire. The findings gotten from this study have fulfilled the aim this research. The results showed that many people responded to experience hot thermal sensation. The study reveals that the environment of Akure might not be comfortable for most dwellers.

## Potential Conflicts of Interest

The author hereby declares that there was no conflict of interest in the process of carrying out this study.

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