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ASSESSMENT OF URBAN THERMAL COMFORT OF RESIDENTS AND ITS COPING STRATEGIES IN ABUJA, NIGERIA

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ABSTRACT

Urbanization has driven rise in temperature and variation in cities around the world. The study assesses the thermal comfort of residents in Abuja. The study uses questionnaires administration to assess the thermal perception of residents which was compared to universal thermal comfort index (UTCI) and GIS to determine the heat stress spot within the study area. The result shows that residents within the FCC, Gwagwalada and Kubwa falls experience moderate heat stress environment with recorded

Introduction

The 21st century is known to be an urban century and by 2050, about 2.5 billion people are expected to live in urban areas with up to 90% of the population will be in Asia and Africa, particularly in India, China, and Nigeria (United Nations Department of Economic and Social Affairs, 2019). Rapid urbanization results in multiplication of built-up area particularly in metropolitan cities. This expansion has brought about changes in temperature rise with has result in the thermal discomfort of residents within and around the cities (Bhatt *et al.,* 2005; Usman, 2012). It also affects the community's closeness and the city's livability and vitality. Urban growth entails considerable additions of urban infrastructure and a larger population of urban residents vulnerable to crises or stresses, such as extreme heat (Pelling & Garschagen, 2019). The impact of such development leads to direct changes to city-scale climate, which manifest as the urban heat and thermal discomfort of resident as a result of temperature changes over time. According to the World Health Organization (WHO, 2018), urban dwellers are now exposed to extreme heat due to increasing climate change and urban growth. About 125 million people are exposed to heat waves between 2000 and 2018 in Europe, which results in over 70, 000 deaths (Åström *et al.,* 2019). Studies have shown that urban heating as a result of urban growth could result to

mean temperature of 31.4°C, 31.7°C and 31.1°C. The study also reveals that 95.8% of residents in, Kubwa (93.9%) and FCC (89.7%) uses wind shades/shades, air conditioning and fan to regulate their thermal comfort. The study recommends that biophilic design should be adopted by the FCTA administration to help mitigate LST and improve the livability of the resident of the FCT.

Keywords: Thermal Comfort, Urbanization, Temperature Change, Residents

thermal discomfort of residents, if adequate mitigation measure are not put in place (Buller *et al.,* 2018; Liu *et al.,* 2019; Nazarian *and* Norford, 2021). This study therefore, seek to assess the thermal comfort of resident in FCT, Abuja Nigeria.

Effect of Urbanisation on Thermal Comfort

Literature reveals that the temperature distribution within the city and suburbs has been significantly altered due to the effect of urbanisation which significantly outweighed the effect of maritime influence in the formation and maintenance of heat islands (Shravankumar *et al.* (2001). Devi (2006), discovered that the intensity of the heat island varies between 2°C and 4°C, and the intensity is higher during the winter season compared to the summer and monsoon seasons and that the formation of the UHI is controlled by topography and urban morphology in a study in Visakhapatnam. According Emmanuel (2005), who investigated the thermal comfort of urbanization employ 30 years of climate data, the variations in land cover in the city were linked to differences in thermal comfort. Urbanisation has significant impact on temperature rise due loss of vegetative cover. Thus, the thermal characteristics of urban fabrics has a considerable impact on the overall surface temperature and alter the inhabitant's thermal comfort. Robaa (2011), looked at the impact of urbanisation and industry on outdoor thermal human comfort in the Cairo revealed that urbanisation and industrialisation processes are to blame for a rise in human hot uncomfortable sensations, which impedes human activities in cities. According to Giannopoulou *et al.* (2011), the incidence of high air temperatures is dependent on rising urbanisation and industrialisation, as well as increased anthropogenic heat flows and a lack of vegetation in Athens. In Bahrain City, a study of the impact of urbanisation on the thermal behaviour of newly constructed surroundings reveal 2-5°C increase in urban temperature. Urban activity such as ongoing construction projects, shrinking green spaces, and sea reclamation, contributes to the rise in temperature (Radhi *et al.,* 2013). Thus, the combined impact of urbanisation and climate change on heat stress resulted in an increased risk of heat-stress conditions, with significantly more frequent bad circumstances in metropolitan regions (Argüeso *et al.* 2015).

Materials and Method

The study employed the used of Structured questionnaires to address environmental factors that affect the thermal comfort of the residents in the study area and mechanism adopted by to mitigate extreme heat stress. Also, GIS method was used to identify areas that were considered as thermal stress environment. The indoor and outdoor temperature was measured with the aid of handheld Extendi Psychrometer RH300, digital anemometer (AVM 07), Micro therma thermometer and Kestrel weather meter.

Results and Discussion

Assessment of Thermal Comfort of Residents of the Study Area

Table 2 summarizes the results of the microclimatic parameters of the stud area. The indoor and outdoor temperature measured shows that the mean minimum temperature recorded within the FCC is 27.4°C and mean maximum at 35.4°C, while the minimum temperature recorded in Gwagwalada is 27.2°C and maximum at 36.2°C and Kubwa with the record of the minimum temperature of 27.3°C and maximum temperature of 34.9°C. Compare the observed temperature with the physiological equivalent temperature (PET) benchmark in Nigeria and thermal heat index to ascertain the level of the thermal condition of the residents of the study area shows moderate heat stress in FCC, Gwagwalada and Kubwa with recorded mean temperature of 31.4°C, 31.7°C and 31.1°C and31.1°C respectively (See Figure 1). These findings corroborate with the study by Akande and Adebamowo (2010), Omonijo & Matzarakis (2011), and Adaji *et al.* (2015) which claimed that hot and humid climate can affect thermal comfort and the overall well-being of people. The result suggest that the average heat index temperature of the FCC is 51°C, Kubwa 47°C and Gwagwalada at 53°C revealed a level of heat disorder. At this condition, the residents could suffer heat cramps and heat exhaustion are likely; heatstroke is probable as well with continued activity (Park and Nagy 2018).

Table 2: Recorded temperature in the study area (2019-2020)

Study area	AvMin$_{Temp}$ (°C)	AvMax$_{Temp}$ (°C)	Mean (°C)	Mean Humidity	THI (°C)	PET thermal sensation	Remark
FCC	27.4	35.4	31.4	30	51	Warm	Moderate Heat Stress
Kubwa	27.3	34.9	31.1	23	47	Warm	Moderate Heat Stress
Gwagwalada	27.2	36.2	31.7	17	53	Warm	Moderate Heat Stress

Source: Authors Analysis, 2022

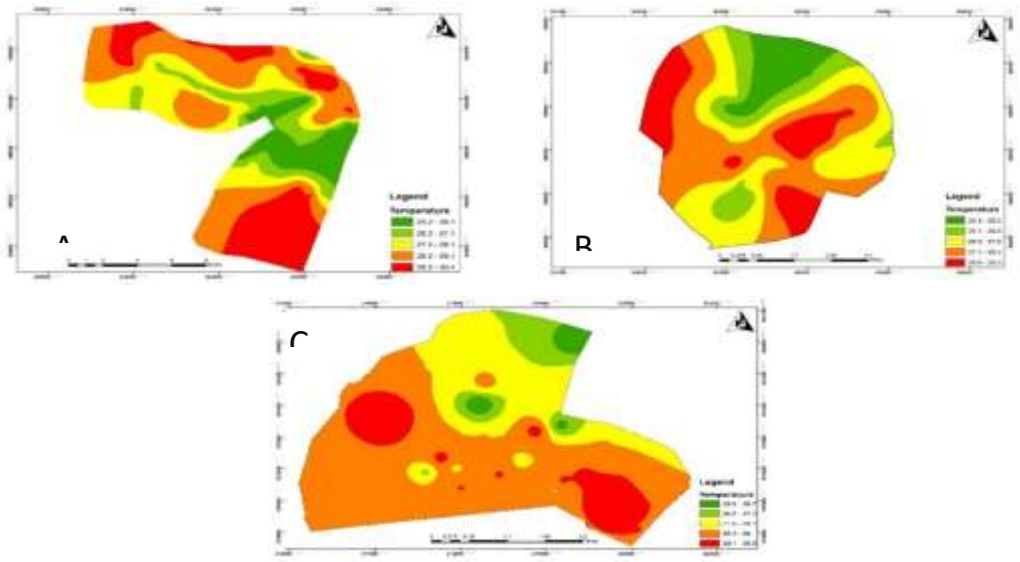

Figure 1: The Thermal Comfort of Residents in FCC(A), Gwagwalad (B) and Kubwa(A)
Source: Author's Analysis, 2022

Mitigating Strategies for Thermal Comfort by Residents in the Study Area

The study finding reveals that 95.8% of residents in Gwagwalada residents claimed to use wind blind/shades as well as air condition to reduce heat discomfort, Kubwa (93.9%) and FCC (89.7%) as shown in Figure 2 and 3. Similarly, the adopted environmental adjustment strategies for occupants to stabilize thermal comfort in buildings is window control behaviour. Blinds are controlled primarily by occupants' visual comfort, rather than air temperature or other environmental conditions. This implies that outdoor and indoor thermal comfort have impact on the productivity and health of the residents. This finding is supported by previous studies (Zhao *et al.*, 2004, Atthajariyakul and Leephakpreeda 2004; Kosonen and Tan 2004; Skoog *et al.*, 2005). The study findings show a minimum temperature record of 27.2°C and maximum at 36.2°C which is above the thermal comfort threshold of 23-26°C and 20-22°C for human occupancy in a given space by ASHRAE (2010) for summer and winter seasons.

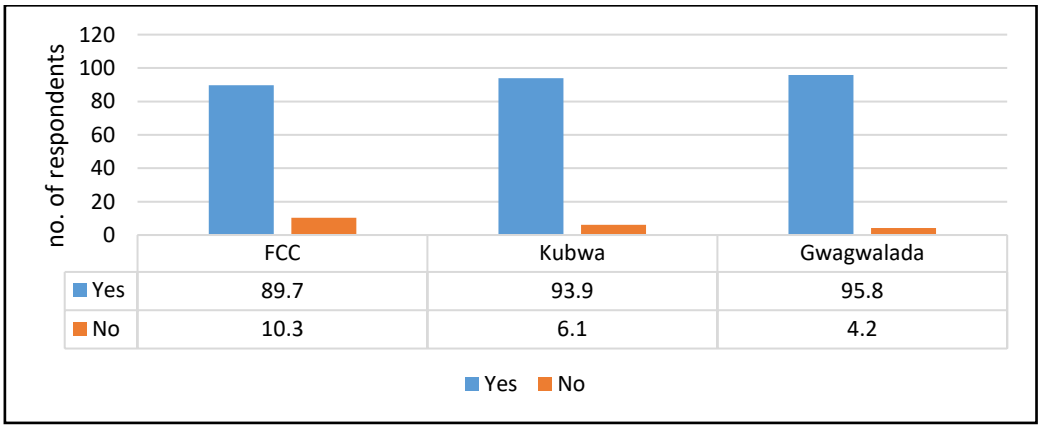

Figure 2: Use of wind blind/ shades

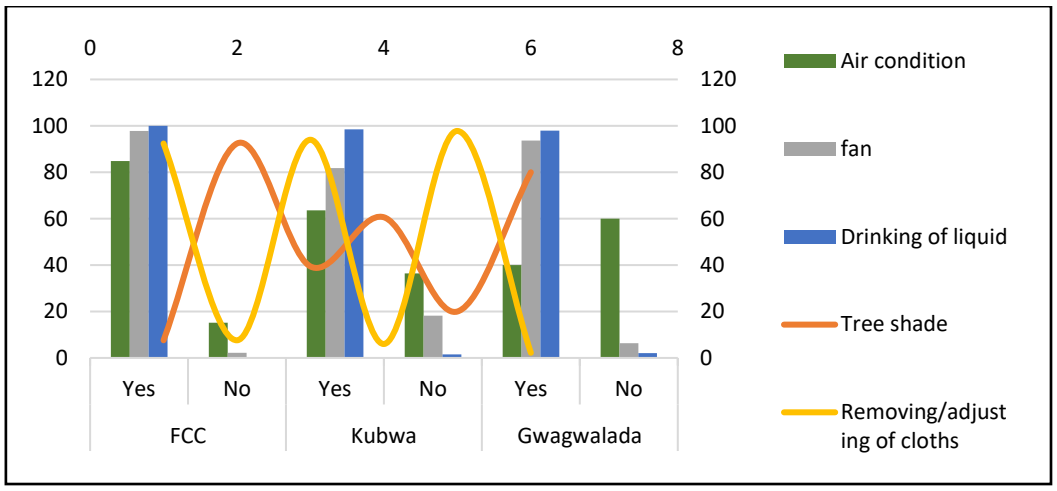

Figure 3: Adopted mitigative measure to regulating thermal comfort

Conclusion

The study was carried out to assess the thermal comfort of residents in FCC, Kubwa and Gwagwalada. The findings reveal that urbanization drives the rise in temperature and ultimately affect the thermal comfort of residents in the area. The study recommends that biophilic design should be adopted by the FCT administration to help mitigate LST and improve the livability of the resident of the FCT.

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