# Observed characteristics of the urban heat island during the harmattan and monsoon in Akure, Nigeria

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## 1. Introduction

- The UN Predicts that 60% of the world's population (~ 5 billion people) will be living in cities by 2030 and that nearly all the population growth will be in the cities of developing countries.
- This rapid population growth will largely drive the extent and rate of global environmental changes and many of these changes are related to the climate of cities, including the canopy layer urban heat island (UHI); the observed warmth of the urban core compared to its rural surroundings.
- $UHI = T_{Urban} - T_{Rural}$
- Where T is air temperature. However, studies on the urban microclimate and urban climatology of tropical regions are few, and this is particularly so for Sub-Saharan Africa.
- This paper reports results from studies investigating the variation of air temperature across a medium size humid tropical city, Akure (population ~500,000) in south-western Nigeria. The paper focuses on the description of temperature measurements during the harmattan (dry) and monsoon (wet) seasons of 1997.


Fig. 1a – Location map of Nigeria and Akure (7.25 °N, 5.20 °E)

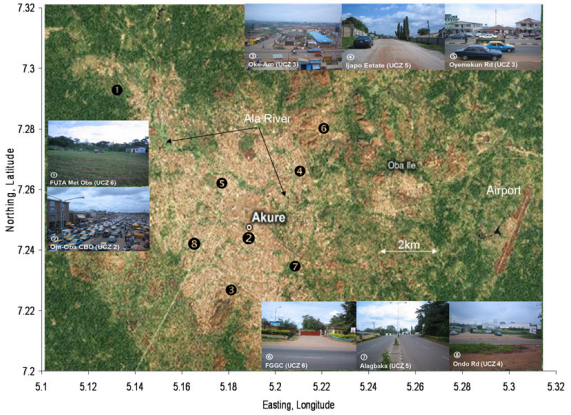


Fig. 1b – Aerial image of Akure, numbered circles represent the measurement sites with corresponding photo and UCZ classification. The Ala River flows from northwest to east. Source: Google Earth

| Number | Site | Latitude (°N) | Longitude (°E) | Elevation (m) | Description | UCZ |
|---|---|---|---|---|---|---|
| 1* | FUTA, Obakekere | 7.2952 | 5.1467 | 363 | University | 6 |
| 2* | Oja-Oba (CBD) | 7.2535 | 5.1952 | 399 | Urban (Core) | 2 |
| 3* | Oke-Ero | 7.2348 | 5.1835 | 343 | Dense residential | 3 |
| 4* | Ijapo Housing Estate | 7.2653 | 5.2155 | 360 | Suburban (planned) | 5 |
| 5** | Oyemekun Rd | 7.2632 | 5.1772 | 486 | Semi-urban | 3 |
| 6* | FGGC, Akure | 7.2793 | 5.2295 | 350 | College | 6 |
| 7 | Govt House, Alagbaka | 7.2385 | 5.2103 | 352 | Govt. Admin. | 5 |
| 8 | Ondo Rd | 7.2465 | 5.1627 | 352 | Light industrial | 4 |

Table 1 – Site details and classification,
* Represent measurement sites used during the monsoon
** Represents measurement site not used during the harmattan

## 2. Experimental Details

- The data presented here were collected during two separate measurement campaigns, one from 14th January – 4th February, 1997 during the harmattan (dry season) and the other from 15th October – 7th November, 1997 during the monsoon (wet season), see Adekunle (1997) and Okpara (1997) respectively.
- The characteristics of UHI in Akure has been assessed using a network of seven thermographs and six mercury-in-glass hygrometers during the dry and wet seasons respectively installed at screen level.
- Hourly data were extracted from the thermograph charts during the harmattan, but data were only collected manually at 0600,0900,1200,1500 and 1800 local time during the monsoon.
- Recently, widespread discrepancies in the classification of so-called urban and rural measurement sites defining UHI magnitude have been reported (Stewart, 2007) and highlight the need for universally applicable landscape classification scheme for defining and measuring UHI magnitude.
- For clarity about the detailed character of the reference sites used in this study, each site is classified according to the Urban Climate Zone (UCZ) scheme, Oke (2006) . See Fig. 1 and Table 1 for the location, photographs and classification of the sites respectively. Using this scheme the estimate of the magnitude of the urban heat island becomes $UHI = T_{UCZ2} - T_{UCZ6}$ for this study.
- However because UCZ2 and UCZ6 were not always the warmest and coolest sites respectively, depending on weather and city metabolism, the UHI reported here has been estimated as the difference between the mean temperatures of the 3 warmer inner city UCZ's (2, 3 & 4) and the 2 cooler outer city UCZ's ( 6).

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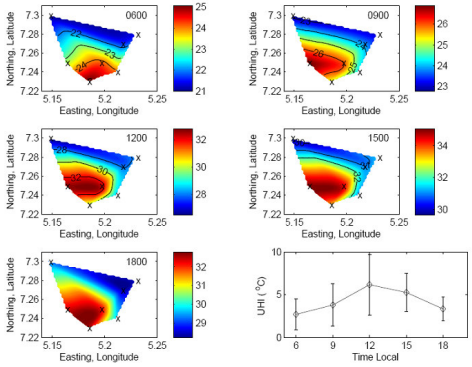


Fig. 2a – Spatial and temporal variation of Akure urban heat island during the harmattan. Bottom right: Mean UHI intensity

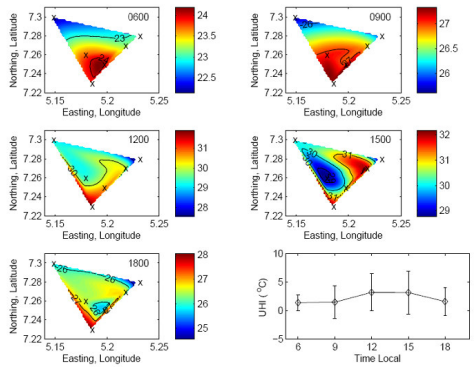


Fig. 2b – Spatial and temporal variation of Akure urban heat island during the monsoon. Bottom right: Mean UHI intensity

## 3. Mean UHI structure

- Fig. 2 show that the Akure UHI contour patterns differ from the simple idealized concentric structure around the city centre.
- Warm regions extend over the city core the south and cooler regions are located in the more vegetated northeast and northwest directions.
- Also of interest is the influence of Ala River that tends to split the temperature distribution into two distinct heat and cool islands during the cooler parts of the day in the dry season. This pattern is less evident during the wet season.
- Fig. 2b shows that a cool island exist between 1500 – 1800 during the wet season over the urban core, extending from the northwest southwards. This highlight the cooling effects of the vigorous evapotranspiration of the city trees during the monsoon and the potential of trees as a cost effective UHI and climate change impact mitigation tool in Akure.

## 4. Mean UHI magnitude

- The UHI has been found to occur throughout the day and night with the highest intensity occurring during the day, with mean values reaching 6.2°C and 3.2°C in the dry and wet seasons respectively. See Fig. 2 bottom right.

## 5. Conclusions & Future plans

- A network of air temperature measurements over Akure have been analysed and results reveal some spatial and temporal characteristics of the UHI in Akure.
- The UHI has been found to occur throughout the day and night with the highest intensity occurring during the day around noon, with mean values reaching 6.2°C and 3.2°C in the dry and wet seasons respectively.
- Its structure was also observed to be greatly influenced by weather, city metabolism, anthropogenic activities, local geographic features and vegetation (Influence of Ala river during the harmattan and vegetation during the wet season respectively).
- A more detailed re-assessment of the UHI in Akure using a denser network of measurements to investigate the relationships between the city geometry, sky view factor, land use and trees is being planned.

## References

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