

## CLIMATE AND HUMAN COMFORT IN ABUJA, NIGERIA

By

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### Abstract

*The influence of climatic factors on the physiological human comfort in Abuja was studied using two sources of data (primary and secondary). Daily, monthly and annual data on climatic variables were collected from the study area as well as data on population for a period of ten years (1994 - 2003). The comfort index was calculated using Thorn's (1959) discomfort index, while Pearson product moment correlation analysis was used to test the relationship between mean values of temperature/relative humidity and population/economic activities. Simple percentage scores were also employed to assess the perception of the people in respect to physiological comfort in the study area. The result obtained show that Abuja's physiological comfort index stood at 24.2°C. The result of the analysis between climatic variables and population shows a strong positive relationship significant at the 1% confidence level. About 70% of the population variation in Abuja was explained by micro climatic factors. 68.4% of the respondents however agreed that the established comfort index does not affect their occupation.*

### Introduction

Human comfort and health are affected more by climate than any other element of the physical environment. The physiological functions of the human body respond to changes in weather (Zemba, 2003). The climatic elements that affect the physiological functions of the human body include radiation (Sunshine), temperature, relative humidity and atmospheric pressure. Several authors (Ayoade, 2004; Zemba, 2003; Wang and Gaffen, 2001; Epstein, 2005) agreed that human comfort and health are influenced most by temperature and humidity variations. Man is constantly exposed to the atmospheric environment whether outdoors or indoors, therefore, his body feelings will be at a certain thermal equilibrium where it derives comfort to inhabit in a region. Physiological comfort is defined as a state of feeling in which a person has no wish to increase or decrease insolation or to adjust the ambient environment. It is a condition in which the person's body is in a thermal equilibrium with his immediate environment and thus the person neither feels cold nor hot but just comfortable.

Climate exercises an influence on man and his activities. Thus, the essentials of life for mankind namely air, water, food, clothing and shelter are all weather dependent or weather related. Certain illnesses are climate induced while several diseases that afflict man show close correlation with climatic condition and season in their incidence. Human physical and mental vigour are generally reduced by high temperature and relative humidity. On the other hand, extremely low temperature or very dry air may impair physical vigour.

Climate does not really cause disease; but basically contributes to the factors that operate together to result to the disease, its severity and spread of the disease. Climate plays certain roles in the determination of human diseases. The first is that climate affects the resistances of the human body to particular diseases and helps in the recovery process from these diseases. Secondly, climate can determine the types and population of disease. Abuja has recorded rapid growth in terms of population and level of economic activities since it

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became the Federal Capital Territory of Nigeria. This growth as noted earlier comes with climatic modifications, which are manifested through the increase in temperature, relative humidity, precipitation, cloud cover and particulate matters. How has Abuja's prevailing climate influence the health, comfort and activities of the city dwellers? This study is geared towards providing empirical answers to this research problem.

### **Study Area**

Abuja the Federal Capital Territory of Nigeria is located on latitude 9° 15'N and longitude 7° 21'E. it is situated in the central part of the country, with an area coverage of about 8,000 sq/km. The Territory is bounded in the north by Kaduna state, west by Nasarawa state, east by Niger and south by Kogi state. The federal capital territory is divided into six areas councils namely, Gwagwalada, Abaji, Kuje and Municipal Area Bwari and kwali. The climate of the area is characterized by two distinct seasons, wet and dry. The wet season spans a period of about 6 to 7 months with 60% of the annual rainfall occurring between the months of July - September (FCDA, 2000). Temperatures are generally low within this period with a range of about 7°C. Relative humidity is however high during this period, especially in the morning when it can reach 95%. The combine effect of low temperature and high relative humidity tend to create a heat trap. When this situation occurs, the general feeling is to be uncomfortably hot. The dry season cover between November to April. In this period, temperatures are generally high as a result of the cloudless sky. Temperature ranges of 17°C have been recorded on some days. Relative Humidity is quite low during the dry season; especially in the afternoons when it drops to about 20%. This low relative Humidity value coupled with high temperature accounts for the desiccating effect of the dry season. The study area is dominated by two major masses, the Tropical Continental and the Tropical Maritime. The Tropical Continental airmass a dry cold and dusty wind that originates over the Sahara desert and blows into the country through the northeast, while the Tropical Maritime is a warm moist wind that originates over the Atlantic ocean and enters the country through the southwest.

The study area is typified by gentle undulating topography which is interlaced by riverine depressions. Generally the height varied by 50m from crest of hill to water course. Inselberg occurrence dot the terrain here and there. The vegetal cover is that of park savannah, a community of discontinuous canopy, shrubs and grass layer. The geological composition of the area consists of three major rock types. Metamorphic rock outcrop in the eastern part of Abuja and the Usma river valley in the northwest. Igneous formations constitute the Zuma Bwari-Aso hills and outcrop of Gwagwa plains. Sedimentary rocks are found in stream beds throughout the territory.

### **Data collection**

The study made uses of both secondary and primary data. Secondary data in the form of historical climatic data was obtained from the Nigerian Meteorological Agency (NIMET), Abuja. The data was collected for a period of ten years (1994 - 2003). The climatic data were specifically for maximum and minimum temperature and Relative Humidity, since these two seem, to have greater effect on the physiognomy of man. Secondary data on annual population of Abuja was also obtained from the National Bureau of Statistics (NBS), Abuja. Annual population was used in this study as a measure of the growth in economic activity in the study area. Since, this has been found to be a major pull factor to urban growth in most

cities the world over. This was also done to cover a period of ten year's (1994 - 2003), (Table, I). Primary data was generated through questionnaire administration. The municipal area was divided into ten (10) zones and fifty (50) questionnaires were administered (5 to a zone) using the purposive random sampling technique.

Table 1. Population, Temperatures and Humidity values for Abuja (1994 -2003)

| Year | Population | Maximum Temperature (e) | Minimum Temperature (0c) | Average Humidity (%) |
|------|------------|-------------------------|--------------------------|----------------------|
| 1994 | 404131     | 33.32                   | 21.08                    | 49.92                |
| 1995 | 415568     | 33.53                   | 20.99                    | 50.25                |
| 1996 | 427328     | 33.53                   | 20.80                    | 50.67                |
| 1997 | 439421     | 33.06                   | 21.19                    | 57.75                |
| 1998 | 451857     | 33.84                   | 21.48                    | 50.75                |
| 1999 | 464645     | 32.92                   | 21.67                    | 58.75                |
| 2000 | 477794     | 33.23                   | 21.46                    | 55.54                |
| 2001 | 491316     | 33.28                   | 22.10                    | 56.50                |
| 2002 | 505220     | 33.09                   | 21.98                    | 64.83                |
| 2003 | 519518     | 33.45                   | 22.48                    | 62.80                |

#### Data analysis

The discomfort index (DI) initially proposed by the American Society of Heating and Ventilating Engineers and later modified by Thorn (1959), was used to compute DI for Abuja. The formula is  $Dt = t' - (0.55 - 0.0055u\%) (t' - 14.5^\circ\text{C})$  where DI = Discomfort Index,  $t_o$  = dry bulb air temperature in DC;  $u\%$  = relative humidity. In order to established the relationship between temperature fluctuation and socio-economic activity as demonstrated in population growth, the product moment correlation analysis was used.

Finally, simple descriptive statistics was employed to adequately interpret the people's perception to prevailing climate around Abuja, Nigeria.

#### Results And Discussion

##### *Physiological comfort index analysis*

The results of the discomfort index calculated for Abuja using Thorn (1959) method on mean values presented in Table 1, shows that the DI of Abuja stood at  $24.2^\circ\text{C}$ . Thorn had earlier delimited a maximum index value of  $26.5^\circ\text{C}$  ( $78^\circ\text{F}$ ) and above to suggest the value above which the weather is said to pose some level of discomfort in form of heat. He also delimit a minimum value of  $18.9^\circ\text{C}$  ( $66^\circ\text{F}$ ) as the level below which some form of cold stress result. In a similar study in Jimeta-Yola, Zemba (2003) divided the year into three seasons, February (cold), April (rainy) and September (dry) season condition. He found out that the discomfort index differs on hourly basis as well as seasonal. The discomfort index mean value for the seasons ranges from  $23.1^\circ\text{C}$  to as much as  $40.5^\circ\text{C}$ . The present study adopted an

annual mean in order to come up with a single value denoting the discomfort index for Abuja. In order to confirm the authenticity of this finding, Ayoade (1978) comfort regions for Nigeria was super imposed on the map of Abuja. The result obtained show at the northern part of Abuja falls within Ayoade (1978) comfort zone III, classified as sultry, while the southern part belongs to comfort zone II classified as hot. The implication here is that Abuja is in a region that is hot and humid. This is evident from the mean annual temperature of 27.4°C and a mean relative humidity value of about 55.1%. Since temperatures are generally high in the tropics, the low relative humidity indicates the absence of enough moisture in the air, necessary to cool and nourish the skin. However, the sensation of comfort varies among people, depending on their age, health, sex, stature, skin, colour, clothing, physical activity and housing type.

#### **Relationship between climate and economic activities**

The study adopted average temperature in Abuja as the major climatic element for analysis, while population figures spanning the same period (Ten years) was used as an indicator of economic growth in the area. Product moment correlation analysis was used to test the null hypothesis of no significant relationship between the climate and economic growth in Abuja. The result of the analysis is presented in Table 2.

Table 2. Relationship between climate and economic activity

| Variables                  | r     | R <sup>2</sup> | Df | T -value | Sig. level |
|----------------------------|-------|----------------|----|----------|------------|
| Population and temperature | 0.836 | 0.699          | 8  | 0.632    | 0.05       |

The result shows that a strong positive relationship exists between population (Economic activity) and average temperature (Climate) in Abuja, with a correlation coefficient (r) value of 0.836. This means that as the population of Abuja increases the average temperature will also increase. The coefficient of determination (r<sup>2</sup>) shows that about 70% of temperature variation in Abuja can be attributed to the population increase. This relationship is significant at the 95% confidence level.

Perception of physiological comfort in Abuja  
 Table 3. Socio-climatic perception of respondents in Abuja

| S/No | Variable                              | Percentage |
|------|---------------------------------------|------------|
| 1.   | Occupation                            |            |
|      | Civil servant                         | 44.7       |
|      | Self employed                         | 42.1       |
|      | Student                               | 13.2       |
| 2.   | Weather condition perception          |            |
|      | Cold                                  | 1.3        |
|      | Hot                                   | 39.5       |
|      | Moderate                              | 59.2       |
| 3.   | Temperature during the rainy season   |            |
|      | Cold                                  | 47.4       |
|      | Hot                                   | 10.5       |
|      | Moderate                              | 40.8       |
|      | Indifferent                           | 1.3        |
| 4.   | Temperature during the dry season     |            |
|      | Cold                                  | 2.6        |
|      | Hot                                   | 90.8       |
|      | Moderate                              | 6.6        |
| 5.   | Disease occurrence during rain season |            |
|      | Cold, cough and catarrh               | 10.5       |
|      | Malaria                               | 30.3       |
|      | Pneumonia                             | 14.5       |
|      | Indifferent                           | 11.8       |
| 6.   | Disease occurrence during dry season  |            |
|      | Malaria                               | 28.9       |
|      | Meningitis                            | 34.2       |
|      | Typhoid                               | 3.9        |

Source: Field work (2006)

Results from Table 3 shows that the responses to questionnaire interview were quite diverse as 44.7% were civil servants, 42.1 % are self-employed while 13.2% are students from secondary and tertiary institutions. When asked their general impression of the weather condition in Abuja, a very small percentage (1.3%) consider it cold. A greater percentage considered the weather as being moderate, while 39.5% are of the opinion that Abuja is generally hot. 47.4% of the respondents agreed that rainy seasons in Abuja are cold as a result of low temperature produced by the cloudy nature of the sky at this period. About 41 % said the weather is rather moderate, while 10.5% are of the view that the weather is still hot during the rainy season. On the issue of temperature during the dry season, about 91% of the respondents agreed that temperatures are generally high. On observed variation in the diurnal weather, 52.6% agreed that there are variations, while 42.8% claim they noticed no variation. 38.2% of respondents agreed that this variation is most pronounced in the mornings and it is perceived by 48.7% of respondents as at gradation from cold to hot in the

late hours of the morning. Change factors identified include location (17.1%), removal of vegetal cover (10.5%) and urbanization and economic activities (26.3%). A greater percentage (68.4%) however, agreed that the observed variation does not affect their occupation.

### **Conclusion**

The relationship between climate and human comfort in Abuja, Nigeria has been examined. A single number (temperature value) representing the annual discomfort index for Abuja has been calculated. The implication of this finding is that, though Abuja is already in a region that is hot and humid, any increased in the population of the city will be followed by an attendant increased in its temperature. These will consequently heighten the tendency for the weather to be uncomfortable, especially during the dry season and harmattan periods. The research therefore concludes that in order to check the adverse effect of this relationship of population/economic activities on temperature increase; especially as it affects the physiological comfort of the inhabitants of Abuja. The current policy of creating, maintaining and sustaining green zones should be vigorously pursued in the Federal Capital Territory. These green zones apart from acting as carbon sink also double tip as under ground water recharge zones. Finally; structures should be oriented in such a way as not to obstruct the free flow of air necessary to disperse artificially generated urban heat.

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