THE IMPACT OF URBAN MICRO – CLIMATE CHANGE ON HUMAN COMFORT IN LOKOJA, NIGERIA

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ABSTRACT

Recent change in land use due to urban encroachment has been considered as one of the factors that lead to urban microclimate. Lokoja a growing urban town is faced with challenges of increasing thermal disorder which has generally contributed to certain health problems. This study is to ascertain the thermal discomfort index of Lokoja town and the perception of the residents' to this disorder. Copies of questionnaire and in situ climate data – Temperature, Rainfall, and Relative humidity were used to ascertain the thermal discomfort index and perception of the residents respectively. It was observed that the average annual mean air temperature and average annual relative humidity at maximum of 34.1°C and minimum of 24.06°C and at highest 75.08% and lowest 70.83% respectively revealed that Lokoja is hot with high variable throughout the months of years. With all the months showing various level of discomfort on the thermal discomfort index (Humidex Scale) where the months of March, April and May recorded intense discomfort. About 91% and 89% of the resident perceived that Lokoja weather is harsh and very hot and also very uncomfortable for habitation respectively especially during the months of March, April and May but get relief during the raining and harmattan seasons.. They posited that weather related health problems such as heat stress, heat rashes, headaches and meningitis. Therefore, the impact of built up land use on the declining vegetation is should be addressed to curb the concentration of heat and human growth and activities in the centre of the town. Measures to address Urban Heat Island should also be enforce by the governments and the residents.

Keywords: *Discomfort; temperature; humidity; health; UHI; Lokoja*

INTRODUCTION

Micro-climate studies improve the understanding of urban climatology, environmental change, and human-environment interactions that affect the quality of human life. The impact of urban environments on human health has become a critical issue facing the

global society as the number and percentage of humans living in urban areas continues to grow (Changnon, 1992). Research has shown that the encroachment of urbanization from leads to higher temperatures at night, presenting as a contribution to some of the climate change issues (Arnfield, 2003).Vegetation is one way to counteract the effect of impervious surfaces have on Urban Heat Island (UHI) , and a better understanding of the interaction between air temperature and urban growth is essential in advancing micro-climate studies and those studies related to climatic change and urban ecosystems in a tropical environment (Ifatimehin et al, 2010)

Urbanization has led to distinct changes to the landscape compared to the 'natural' conditions. Consequently, urban development's bring about a change in the physical behaviour of the atmospheric condition, affecting its microclimate, hydrological, Agriculture, thermal properties, which in turn affects the exchange of heat, mass and momentum between the surface and the atmosphere.

Ultimately these changes result in the development of an '*urban microclimate*' that deviates from that of its surroundings (Ifatimehin, 2007; Grimmond and Oke. 1995).

Climatic conditions in the near surface atmosphere, such as air temperature and humidity, are strongly influenced by the energy exchange between land surface elements and the air. The available energy at the land surface elements in terms of radiation and other heat sources at the surface are balanced by heat and vapour fluxes to the air, which are further propagated into the atmosphere through turbulent dispersion and advection (Spronken-Smith & Oke, 1998).

Urbanization in the world's history started when people had the knowledge that lives could be better when they come together as a community in civilized environment. Since the earliest origin, cities have been centers of religion, education, economic activities and political powers.

The presences of cities affect local Micro-climate, as the city changes, so does its Micro-climate (Ifatimehin and Adeyemi, 2008). Ifatimehin et al (2009) posited that the impact of urbanization on Micro-climate allows various researchers to observe that humanity has the ability to alter the local and even global environment within the life time of an individual. Although, small in terms of land area, the urban environment affects a considerable portion of the Earth's population as

forty nine percent of the earth's population lived in urban areas in the year 2005 and indicating that more humans will live in urban areas than rural places in the future (Lee, 2007).

This is a similar situation in Nigerian cities where increasing urbanization has followed the trends so far discussed, Lagos, Abuja, Port Harcourt, Calabar among other and experiencing increasing urbanization in no small measures. These cities are enjoying the many benefits of urban expansion, as well unable to express ways to cope with the many problems associated with urbanization. This is the most common feature of the present situation of cities in Nigeria with high level of socio-economic problems in urban areas.

These powerful trends will sharpen and in turn be sharpened by economic and social development (United Nations, 2008).

There are several impacts of urbanization on the microclimate and since there will be no adequate development in the absence of Urbanization therefore; urbanization has several adverse effects on environment existing in different places across the globe.

The degree and range of which can only be purposeful by some quality measures. Lokoja as a tropical town and with the size of its population and the elevation, make it vulnerable to climate change and the risk is very high.

Very high temperature and air pollution is also raised by the town location, surrounded by rivers and mountains and lot of natural space. High population density and rapid human activities hence, affects rainfall, heat, radiation balance, thermal stress which is commonly felt in Lokoja.

It is on this ground that this research work is conducted, in order to check the impact of urbanization on microclimate of Lokoja and it health implication through assessing the variations in the microclimate characteristics and ascertain the physiological comfort of resident in the metropolis.

STUDY AREA

Lokoja is the capital of Kogi State in Nigeria, located between latitude 7°45' N - 7°50' N of the equator and longitude 6°41' E - 6°45' E of the Greenwich Meridian (Fig 1.1). It lies at an altitude of 45-125 meter above mean sea level. The city is surrounded by Patti ridge hills and ridges.

METHODOLOGY

Data on climatic variables such as temperature, relative humidity and rainfall for a period of 10 years (2001 - 2010) was obtained data from the Nigeria Meteorological Station, Lokoja.

Copies of Questionnaire were administered to ascertain the perceived degree of discomfort among the residents of the town. Descriptive (mean, percentages and charts) and inferential statistics were employed to determine the relationship between the climate variables and how the residents perceived its influence on their physiological comfort.

The Humidex calculator was used to ascertain the degree of discomfort in the town. Interpretation of the index calculated is typically interted using a Humidex Chart (Figure 2).

The Humidex formula is as follows:

$$H = T + (0.5555 * (e - 10)) \quad \ldots\ldots 1$$

Where: H = humidex; T = temperature (^{o}C); E = relative humidity

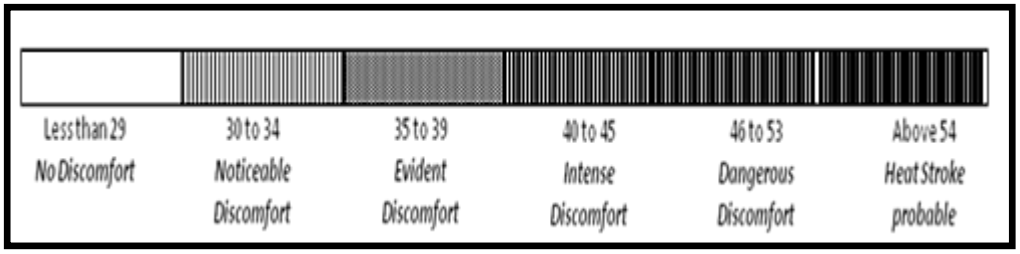


Figure 2: The Humidex Chart (Adapted from The Canda Meteorologist (1965)

RESULTS AND DISCUSSION

In studying the Microclimate, it therefore involves measuring the change in local weather conditions over a period of time in a small area, which has been carried out and the results are been presented in this chapter.

Average Monthly Pattern of Temperature in Lokoja

Figure 1.3 shows the average monthly temperature of Lokoja

from January – December within the period of ten (10) years has not gone bellow 26.34^{0}C. Highest temperature is 30.03^{0}C (April) while January has the lowest temperature of 26.34^{0}C and there was a very close range in average temperature in June and October (27.74^{0}C and 27.88^{0}C)

Average Annual Temperature Pattern in Lokoja

From figure 1.4 below shows that the highest amount of temperature that was recorded between years 2001-2010 was 28.55^{0}C in 2010 while the lowest was 27.8^{0}C in 2007.

It was observed that throughout this study years, there was a consistent annual temperature which is 28.15^{0}C and 28.26^{0}C in 2002 and 2003 respectively. From the figures below, it was observed there was undulating and gradual fluctuations in the average annual temperature of Lokoja from the record.

Mean Annual Minimum and Maximum Temperature

Figure 1.5 below shows that in 2002 we have the lowest mean minimum temperature with 23.75^{0}C and highest data for the mean minimum temperature was 25.41^{0}C in 2001. While maximum has it lowest in 2004 with 33.16 and highest record in 2010 with 36.33^{0}C and it was observe that there was a uniform record within 2006 and 2007 for average maximum temperature.

Average Monthly Pattern of Humidity in Lokoja

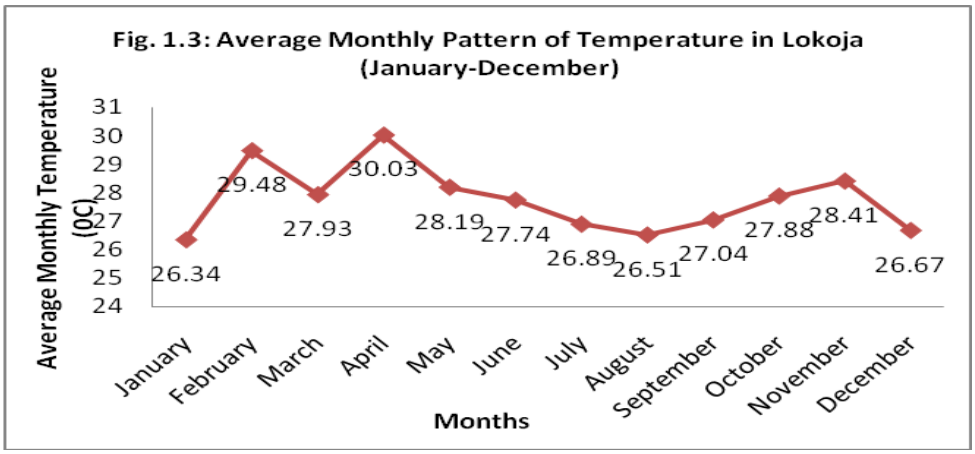
From the figure 1.6 below, it show that the highest monthly humidity was 68% in August and the lowest from the record was 48.5% November. Figure 4.8 also shows that there was a very close range in July and September (67.4 and 67.9).

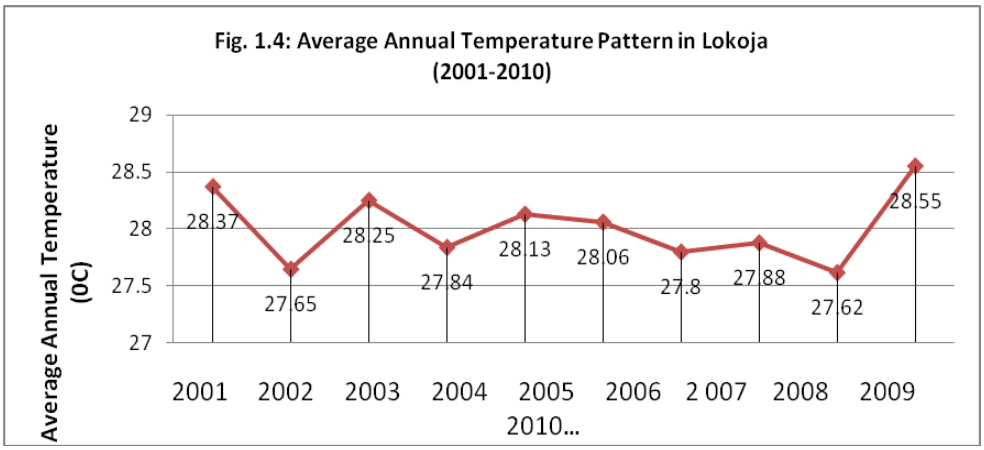
Average Annual Pattern of Humidity in Lokoja

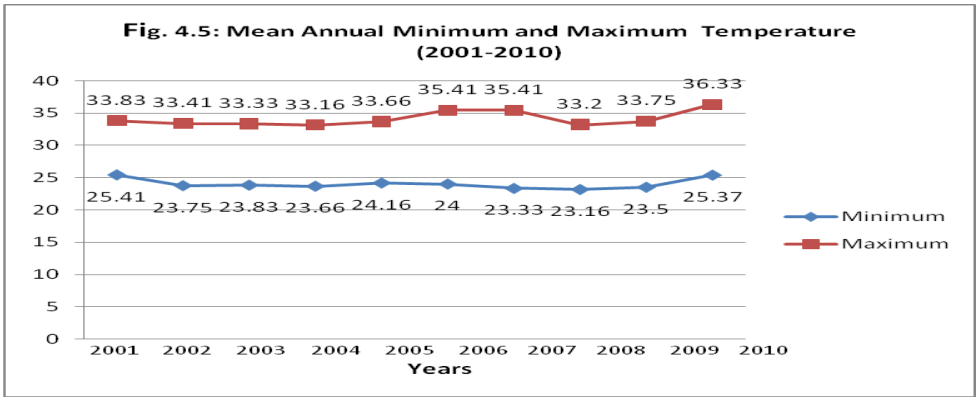
Figure 1.7 shows that between the ten years of study, the lowest humidity that was recorded was 70.83% and the highest was 75.08 in 2008 and 2009. It was also observed that there was some uniformity with little fluctuation and that within these ten years no record was less than 70.83.

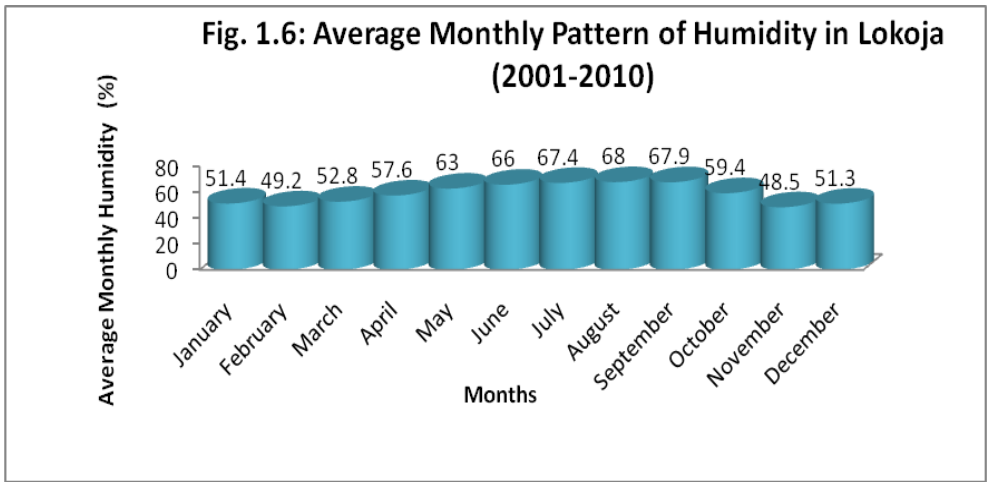
Discomfort Level in Lokoja (2001 - 2010)

As shown in Table 1, the least recorded humidex value between 2001-2005 was in January (31), in which discomfort can be described as just being noticeable.









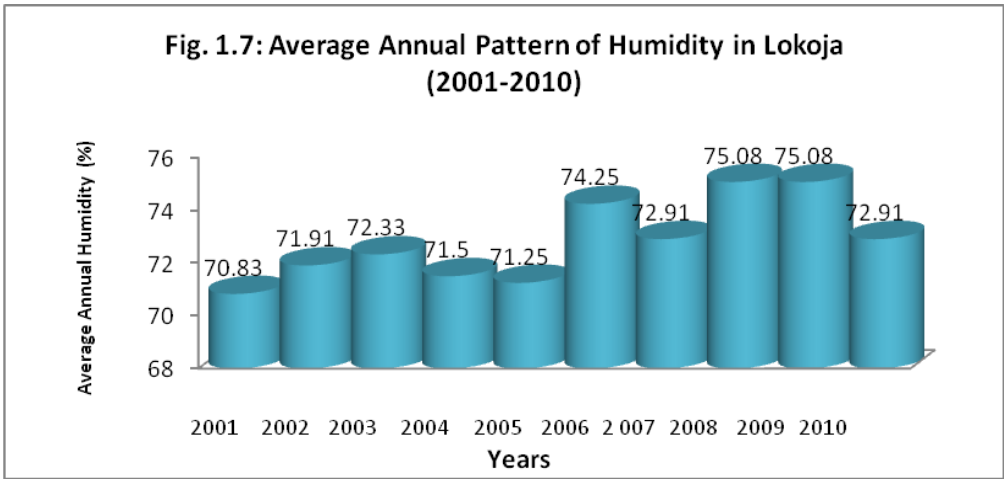


Table 1: Level of Discomfort in Lokoja.

Level of Humidex	2001-2005	2006-2010
	Months	Months
Noticeable discomfort	January	December, January
Evident discomfort	February, June-December	February, May-November
Intense discomfort	March, April and May	March and April

In February, humidex value rose to 36 and discomfort became evident. In March, April and May, a further increase in humidex value occurred (i.e. 40-41). This made discomfort to be intense.

Table 1: Calculated Value of Humidex in Lokoja

Months	Humidex Value	
	2001-2005	2006-2010
January	31	34
February	36	39
March	41	41
April	40	41
May	40	37
June	39	38
July	37	37
August	36	37
September	38	37
October	39	39
November	38	38
December	35	34

However, between June – December, humidex value dropped slightly within the range of 35-39; which made discomfort to change from being intense to being evident.

It was observed that between 2006 – 2010, the least humidex value was recorded in December and January (i.e. 34), when discomfort was noticeable. A rise also occurred in February to 39 and discomfort became evident.

A further increase was noticed in March and April to 41, making discomfort to be intense. This was followed by a slight drop to a range of 35-39 from May-November.

People's Perception on the Intense heat regime in Lokoja town

In collaborating the humidex value of thermal discomfort in Lokoja, the perception of residents were seek, about 35% believed that the thermal condition of the urban environment of Lokoja is harsh, 29% indicated that it is very hot, 27% affirmed it is hot, while 9% opined that they can really placed categorized the thermal level of the town because they used to the it amd felt indifferent.

Residents' Perception on thermal discomfort in Lokoja town

However, 71% perceived that the thermal condition of the Lokoja's environment is very uncomfortable because all year round it is very hot with the exception of the harmattan season and when rain is at its peak. This justify the humidex level of the town (Table 1) and is corroborated by the work of Emmanuel (2007) and Basara et al., (2010) and Bertoldi et al. (2010).

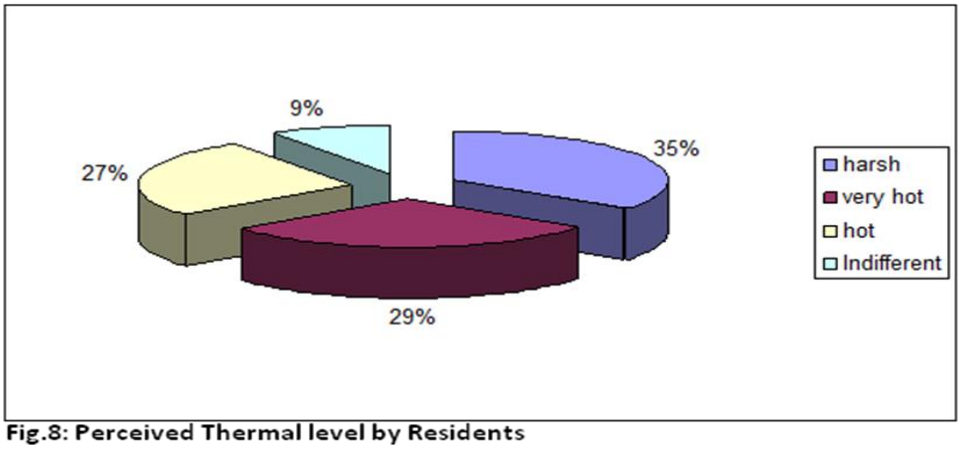


Fig.8: Perceived Thermal level by Residents

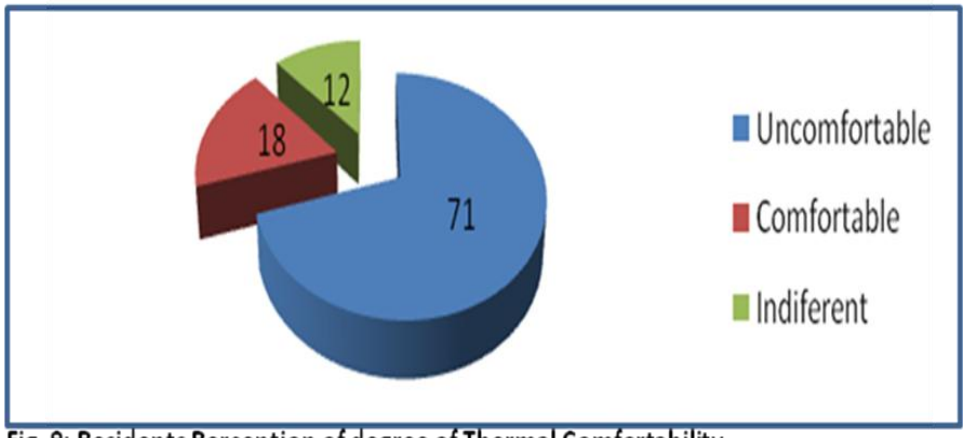


Fig. 9: Residents Perception of degree of Thermal Comfortability

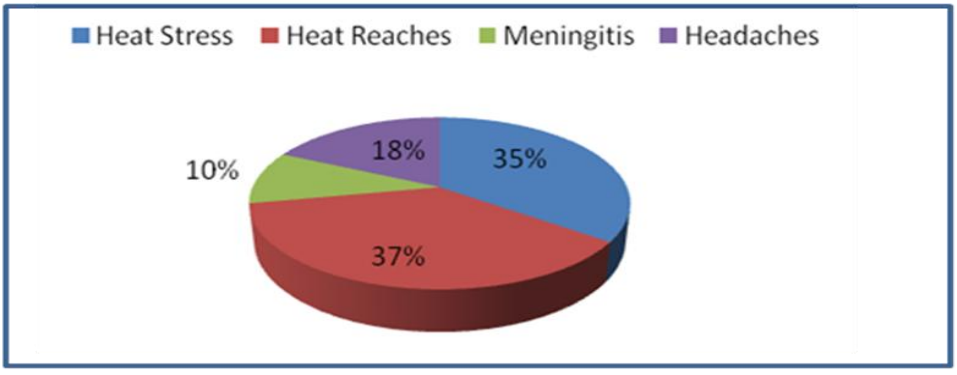


Fig. 10: Residents' Perceived Health Problems from Thermal Discomfort

This physiological discomfort among residents is perceived to have some resultant effects on their health and makes them vulnerable to weather related health problems.

Figure 10 shows 37% react to it by having heat rashes, 35% heat stress (Fatigue and exhaustion), 18% headaches and 10% meningitis.

CONCLUSION

This study has reveal that rainfall, humidity and temperature in Lokoja are variable and dependent on urbanization such as land use, physical expansion and human activities.

The study has also shown that the residents of Lokoja find the weather uncomfortable, especially the high temperature and harsh weather, which usually cause some climate/ heat ailments that usually inflict the people. The water body (River Niger and Benue) also contribute to the harsh weather, but there may be a need for another research for obtain a scientific result/variables.

It has equally been observed in this study that the rate of conversion and transformation of land use types such as the increasing built up at the expense of vegetation is one of the contributing factor to the increase in the urban heat island temperature as identified by Ifatimehin (2007) using land Surface Temperatures (LSTs). These increase had resulted in the increased of thermal condition of the town and thereby aggravating discomfort and health problems such as the increased malaria incidence in the town as breeding and blood feeding of mosquitoes are temperature dependent (Ifatimehin, 2011).

It has also been shown that urbanization increase steadily in terms of built up area and surface cover and these alter the climatic element in the city while rainfall and humidity fluctuate and temperature increases. The areas that are congested with residential buildings and vehicular smoke have high temperature of 33.6^{o}C maximum and there is a visible difference between the city center and the suburbs, therefore urban growth as lead to low rainfall and increase in temperature.

Lokoja dwellers have a good perception about the weather condition of the city, the harsh weather result in heat related disease, headache and heat-reaches.

The climate of the aggregated urban environment has developed

from a long tradition with observations describing the phenomenon, towards an increased knowledge of some of the important underlying physical processes urban microclimate studies have developed process descriptions and sophisticated numerical models but with limited connection to empirical data.

Therefore, heat related health problems have been seen to be one of the major impacts of urban heat island (UHI) which has affect on resident of Lokoja.

It is on this ground that the government agencies, should give room to promote ways of mitigating the effect urban heat island (UHI).

Base on the findings of this research, below are the recommendations:

i. To increase vegetation cover and greeneries space in form of urban forest and garden and flower around buildings in order to reduce temperature.
ii. Improvement in building style and proper city planning is recommended especially in the high density area, standard build space should be created.
iii. Albedo which is surface reflectivity should be increase, e.g shinny roof in order to reduce radiation absorption
iv. Government agency should embark on seminar and literacy campaign to warn people of the danger of urban heat island in Lokoja
v. Environmental impact assessment should be mandated before any development can take place.
vi. Monitoring systems through reliable data like Remote Sensing should be adopted as activities which will enable planners and decision makers arrest errors before they occur, as well as manage changes in dynamic environments so that over population can be avoided.

REFERENCES

Arnfield A.J (2003) Two decades of urban climate research: a review of turbulence, exchanges of energy and water, and the urban heat island. *Int J Climatol*, 23: 1–26

Basara, J.B., Basara, H.G., Illston, B.G. and Crawford, K.C. (2010). The Impact of the Urban Heat Island during and Intense Heat wave on Oklahoma City. *Advances in Meteorology*. Doi:10.1155/2010/230365

Bertoldi, G., Notarnicola, C., Leitinger, G., Endrizzi, S., Zebisch, M., Della Chiesa, S. and Tappeiner, U. (2010). Topographical and ecohydrological controls on land surface temperature in an alpine catchment. *Ecohydrology,* 3(2):189 - 204

Changnon, S.A. (1992). Inadverteent weather modification in urban areas: lessons for global climate change. *Bulletin of the American Meteorological Society,* 73(5):619-627

Eliasson I, Upmanis H (2000) Nocturnal airflow from urban parks – implications for city ventilation. *Theor Appl Climatol,* 66: 95–107

Emmanuel, R. (2007). Human Comfort, urban climate change and energy use: Assesssing adaptation options for the rapidly growing tropical mega – cities. *The 24th Conference of Passive and Low Energy Architecture, (PLEA2007),* 22-24 November, Singapore

Grimmond, C.S.B and Oke, T.R. 1995: Comparison of heat fluxes from summertime observations in the suburbs of four North American cities. *Journal of Applied Meteorology* 34, 873-889.

Ifatimehin, O.O. (2007). An Assessment of urban Heat Island of Lokoja Town and Surroundings using Landsat ETM Data. *FUTY Journal of the Environment,* 2(1):100-108

Ifatimehin, O.O. and Adeyemi, J.O. (2008). A Satellite Remote Sensing based Land surface Temperature retireival from Landsat TM Data. *Ethiopian Journal of Environmental Studies and Management,* 1(3):63-70

Ifatimehin, O.O., Ujoh, F. and Magaji, J.Y. (2009). An evaluation of the effect of Land use/cover change on the surface temperature of Lokoja town, Nigeria. *African Journal of Environmental Science and Technology,* 3(3):86 – 90

Ifatimehin, O.O., Ishaya, S. and Ujoh, F. (2010). An analysis of temperature variations using remote sensing approach in Lokoja Area, Nigeria. *Production Agricultural Technology Journal,* 6(2):63-70.

Ifatimehin, O.O. (2011). Urban *Malaria Risk Mapping Using Geoinformatic Technology*. Germany: Lambert Academic Publishing.

Lee, K.N. (2007). An urbanizing world. In L. Starke (Ed), *2007 State of the World: Our urban future* (3-21). Washington DC: Worldwatch Institute.

Spronken-Smith, R.A. & Oke, T.R. 1999. Scale modelling of nocturnal cooling in urban parks. *Boundary-Layer Meteorology,* 93: 287-312.

United Nations (2008*). Disaster Reduction Strategy.* United Nations, Geneva

