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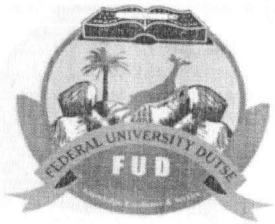

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THE EDITORIAL

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Notes to Contributors

Well researched articles on current issues in inter-disciplinary fields, research findings and book reviews are mostly especially welcome.

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- The manuscript should be between 14 to 18 pages double-line spacing in A4 paper, times new roman 12 point font size
- Submitted articles will be peer-reviewed
- Each article must be an original work of the author and has not been submitted to anywhere else for publication. Also, it should make significant contributions to the specific fields of interest.
- The article should be preceded by an abstract of not more than 200 words and 3-5 keywords.
- The author should ensure that there is a titled containing names (no Initials), address, institutional affiliation, e-mail address and phone number
- All tables, figures and photographs are to specially packed and camera ready
- Author should submit articles as a soft copy through electronic mail (e-mail) MS-Word attachment to thegazelle@gmail.com

CONTENTS

IMPACT OF URBAN HEAT ISLAND ON HUMAN PHYSIOLOGICAL COMFORT IN ILORIN CITY, NIGERIA.

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Abstract

The need for environmental and physiological comfort for effective and productive undertaking by man cannot be overstressed. The study examined the impacts of urban heat island (UHI) on human comfort in Ilorin city, Kwara State. The data used for this study were collected from both primary and secondary sources. The climatic data include minimum temperature, maximum temperature and relative humidity. These were collected from Nigerian Meteorological Agency (NIMET) Office, Ilorin Airport while environmental thermometer was used to record room temperature of selected land use types of Ilorin. Prepared questions and oral interview were also conducted in some selected areas of Ilorin based on land use types. Both descriptive and inferential statistics were used for data analysis, while Heat Index Chat was used to interpret the possible effects of heat on dwellers within the study areas. The data were subsequently subjected to a number of statistical analyses such as: heat index analysis, analysis of variance, trend analysis and reduction pattern analysis. The result of the analysis of variance shows that the variation in the temperature recorded at different urban land use types in Ilorin is statistically significant at 95% confidence level. Industrial and commercial areas recorded the highest air temperature of 49.96^{0}C and 49.27^{0}C respectively compared to other land use types. This shows that the dwellers are at risk of heat related problems such as heat exhaustion,

heat stroke; heat cramps etc. causes of heat island identified are majorly anthropogenic in nature. These include transportation, commercial and industrial activities while others resulted from increase in population, component of building materials and urbanization. The study thus recommended adoption of various proper land management and plants cover (green areas) within the city to reduce the effects of heat island in the city.

Keywords: *Urbanization, Urban Heat Island, Heat Index, Human Comfort, Land use.*

Introduction

Man needs comfort to carry out his daily activities productively. Physiologic comfort according to Ayoade (1993) is defined as condition in which a person's body is in thermal equilibrium with his immediate environment. World Meteorological Organization (1984) also defined physiological comfort as a state in which a person has no wish to decrease or increase insolation or to adjust the ambient thermal environment. With the development of urban areas, changes occur in their landscape, such as changes reflect in building of houses, industries, roads and other infrastructure which replace the open land and vegetation. Thus, surfaces that were once permeable and moist become impermeable and dry these changes caused urban regions to become warmer than their rural surroundings, forming an island of high temperature with landscape (Taha, 2002).

Urban Heat Island is a metropolitan area that is significantly warmer than its surrounding rural areas. Temperature difference is usually greater at night than during the day and larger in winter than summer. This difference is most apparent when winds are weak and diffusion is low. This is because of the nature of surface and the temperature variations. However, the main cause of urban heat island is the modification of the land surface by urban development and waste heat generated by energy usage. Heat island occurs on the surface and in the atmosphere. On a hot sunny summer, urban surface such as roofs and pavement, temperature is about 50^0 F – 90^0F (27^0C – 50^0C) hotter than the air, while shaded or moist surface urban heat

island are typically present both day and night, but tends to be strongest during the day when the sun is shining (Carmona, 2003).

According to Oke (1995), seasons play an important role too. Heat island of cities located in the mid-latitudes is usually strongest in the summer than the winter, while in tropical regions, the dry season may favour large heat island magnitude. However, urban heat island has the potential to directly influence the health and welfare of urban dwellers; such as human comfort, heat related diseases (Hyperthermia), fever, heat rash (prickly heat), heat cramps, heat edema, heat tetany, heat syncope, for those with low blood pressure, heat exhaustion and heat stroke (sunstroke) among others. Heat island indirectly influences the welfare of the urban dwellers through energy usage to cool their ambient temperature, air pollution, water uses and biological activities among others. There is need to ensure a pleasant and healthy environment for urban dwellers. Thus, this present study attempts the impact of urban heat island (UHI) on man's comfort in Ilorin city and the way out.

The dangerous threat the world faces today according to Ehete *et al* (2012), is fuelled by two powerful human-induced forces of urbanization and climate change. The two forces have unprecedented negative impacts upon quality of live, economic activities and social stability of man. The more urbanized an area is, the more development and the more havoc done to the environment (Tilakasiri *et al.*, 2012). The material commonly used in urban area such as concrete and asphalt, have significantly different thermal bulk properties (including heat capacity and thermal conductivity and surface reductive properties (albedo and emissivity) than the surrounding rural areas. This causes a change in the energy balance of urban area, often leasing to higher temperature than surrounding rural areas.

The energy balance is also affected by the poor vegetation in urban areas, which inhibits cooling by evaporation. Waste heat from automobiles, air conditioning, industry and other sources also contribute to the urban heat island. High levels of pollution in urban areas can also increase the urban heat island as many forms of

pollution change the radiative properties of the atmosphere (Kalney and Cai, 2003). Moreover, urban heat island can potentially increase the magnitude and direction of heat waves within our cities. Studies have shown that mortality rate increase exponentially with maximum temperature (McMichael, 2001).

In the last two decades, Izomoh and Olomu (2005), Noticed a persistent increase in population and sizes of the cities in Nigeria. Oyegun (1985) described Ilorin as one of the latest growing urban centres in Nigeria. The above findings were corroborated by Olanrewaju (2009) that Ilorin Population more than doubled its size within 30years (1976-2005) with the growth rate of between 2.5 and 2.9%. This has resulted in steady rise in air temperature of Ilorin city. The implications of such rise in temperature on human comfort cannot be overemphasized, thus this study attempts examining the effects of Urban Heat Island on human comfort in Ilorin city of Nigeria with the aim of curbing its negative impacts.

This study is inspired from the realization that the urban dwellers experience discomfort arising from excessive heat generated in urban centre. For instance, Olabinri (2005) observed an increase in heat generated in Ilorin city as compared to a nearby rural area of Idofian. Moreover, Olanrewaju (2009) found that city is becoming warmer as a result of rapid urbanization. The repercussion of this on man's physiological comfort could be fatal and therefore suggested that further research efforts be geared towards finding ways of mitigating effects. Earlier works by Atkinson (1975), from the cities in temperate region of the world like Chicago where the temperature is not as high has the tropical region shows clearly that the impact of urban heat island or excessive heat production as a result of urbanization on human comfort is a serious issue. This work therefore strives to investigate the extent of urban heat island effects on human comfort in Ilorin City.

Physiologic Comfort

People vary, sometimes markedly in their feeling of comfort according to their metabolic rate, type of clothing, work load, age diet, emotions, cultural influences, past climate experience and

climatic zone among others. Thus women generally prefer slightly higher level of air temperature than men. Tropical people tend to accept a comfortable higher level of air temperature and humidity than temperature zone peoples. Outdoor workers also tolerate higher level of temperature than sedentary workers while older individuals tend to prefer warmer conditions than younger individuals (Mather, 1973).

Despite the effect of numerous non-meteorological factors on human feeling of comfort, the zone of human comfort has been found to comprise a relatively narrow band of temperature, wind speed and humidity. The four major meteorological controls of physiologic comfort are temperature, humidity, wind and radiation; various bio-meteorological indices have been device to quantify human feeling of comfort in term of measurable climatic elements notably temperature and humidity (Ayoade, 2004). None of these indices can be regarded as wholly satisfactory primarily because they are not comprehensive. To be comprehensive, an index must include both meteorological and non-meteorological controls of physiologic comfort. The non-meteorological factors are obviously not all quantifiable and so attention is usually focused on the quantifiable meteorological controls.The study attempts to examine the impacts of urban heat island (UHI) on human comfort in Ilorin city, Kwara State.

Study Area

The study area is Ilorin metropolis, which is the capital city of Kwara State, Nigeria. Ilorin metropolis consists of three local government areas namely; Ilorin east, Ilorin west and Ilorin south. Ilorin is located approximately between latitude 8°30' and 8°50' north of the equator and longitude 4°20' and 4°35'east of the Greenwich meridian (Figure 1). Ilorin is the gateway city between the southern and northern Nigeria with an approximate land area of 100kilometres square, (Kwara State Diary, 2012).

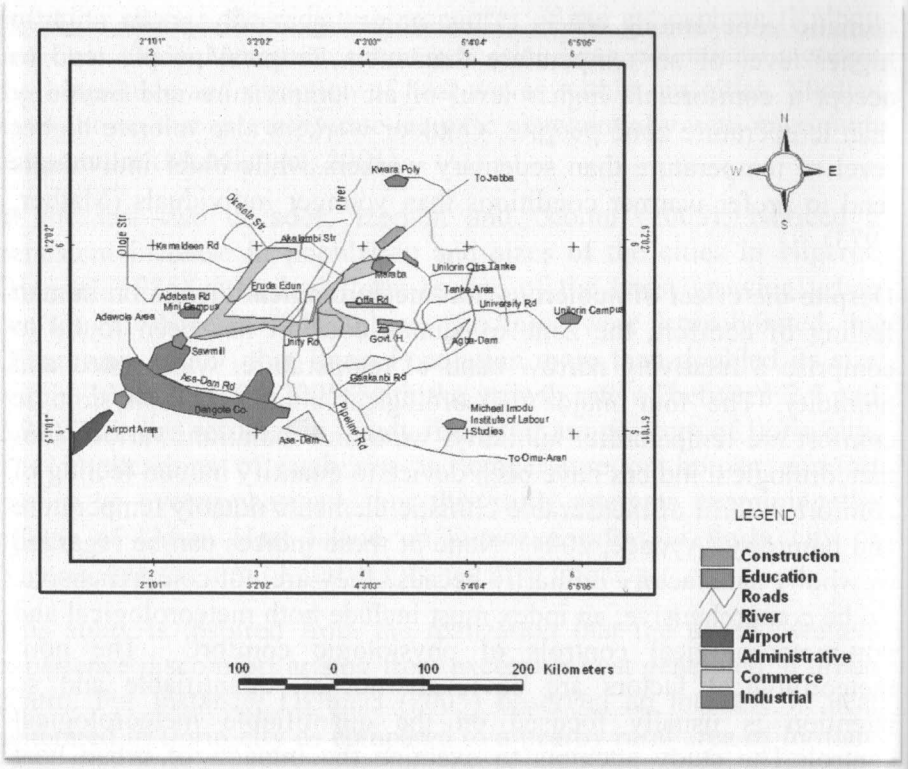

Figure 1: Land use Map of Ilorin
Source: Kwara State Ministry of Land and Housing, Ilorin, 2009.

Like most of West Africa monsoon, the climate of Ilorin is characterized by two seasons. The rainy season and dry season, these are marked by seasonal shift in the wind pattern. The rainy season starts from April and ends in October which is sometimes extended to November. During this season, the dominant wind is the moist maritime south west monsoon which blows inland from across the Atlantic oceans. The dry season begins in November and ends in March, but there is always an occurrence of harmattan period between the months of November and January. The predominant wind during this period is very dry and dusty from Sahara desert. The relative humidity is range between 65%-90% while the mean annual temperature is generally high with a very low range. The mean annual

temperature is about 27^{0}C. (NIMET, 2011). Generally, studies show that the climate of kwara state tends towards aridity (Olaniran, 2002 and Olanrewaju, 2009).

Research Methods

Data used for this study were obtained from both primary and secondary sources. The secondary data includes the maximum and minimum temperature, relative humidity of Ilorin for two decades (1991-2010). The primary data were Room temperature of the various land use types (during heat wave) for two months within Ilorin. Environmental thermometer was used to obtain daily reading from the selected stations across Ilorin city between 15:00 GMT and 18:00 GMT of the day, due to the magnitude of heat wave during this period. The sampling technique employed was the purposive or judgemental sampling and stratified random sampling. Both descriptive and inferential statistics were used to analyse the data. Also, heat index given in degrees Fahrenheit was used as an accurate measure of how hot it really feels when the relative humidity (RH) is added to the actual air temperature (table 1). Room temperature was monitored in five selected locations in the study area for a period of two months

Table 1: Heat Index Chart (Temperature and Relative Humidity)

R H (%)	Temperature (° F)															
	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
90	119	123	128	132	137	141	146	152	157	163	168	174	180	186	193	199
85	115	119	123	127	132	136	141	145	150	155	161	166	172	178	184	190
80	112	115	119	123	127	131	135	140	144	149	154	159	164	169	175	180

75	109	112	115	119	122	126	130	134	138	143	147	152	156	161	166	171	
70	106	109	112	115	118	122	125	129	133	137	141	145	149	154	158	163	
65	103	106	108	111	114	117	121	124	127	131	135	139	143	147	151	155	
60	100	103	105	108	111	114	116	120	123	126	129	133	136	140	144	148	
55	98	100	103	105	107	110	113	115	118	121	124	127	131	134	137	141	
50	96	98	100	102	104	107	109	112	114	117	119	122	125	128	131	135	
45	94	96	98	100	102	104	106	108	110	113	115	118	120	123	126	129	
40	92	94	96	97	99	101	103	105	107	109	111	113	116	118	121	123	
35	91	92	94	95	97	98	100	102	104	106	107	109	112	114	116	118	
30	89	90	92	93	95	96	98	99	101	102	104	106	108	110	112	114	

Note: Exposure to full sunshine can increase HI values by up to 15° F

Source: *Meteorology for Scientists and Engineers, 2nd edition* by Roland B. Stull (2011)

Furthermore, analysis of Variance (ANOVA) was employed to test the variance ratio and also to determine whether or not significant differences exist among the means of several groups. In this research, an hypothesis was tested using one way analysis of variance to determine whether there is a statistically significance difference in the surface air temperature at the different urban land use type in Ilorin. The formula is stated below:

Computation for mean; $C=T^2/np$ ..... (i)

The (corrected) total sum of square

$$Tss=\sum_{i=1}^{n}\sum_{i=1}^{m}(Rij-c) \quad \text{..... (ii)}$$

The sum of square due temperature

$$SS_T=\sum_{i=1}^{n}(T_1^2/n)-C \quad \text{..... (iii)}$$

The sum of square due to error

$SSE= TSS-SS_T$ ..... (iv)

Time series analysis and reduction pattern analysis were also employed under the inferential statistics to determine the trend of climatic variables and to determine the degree of fluctuation of the minimum and maximum temperature respectively

Results and Discussion

Room Temperature at Selected Locations in Ilorin

Table 2: Room Temperature at Selected Locations in Ilorin

ocations	Months	Mean	Median	Std. Dev	Minimum	Maximum	Skewness
ducational	March	30.03	30.03	1.46	26.00	32.05	-0.77
	April	28.20	28.20	1.98	23.00	31.90	-0.82
esidential	March	34.12	34.00	1.31	30.17	35.83	-1.09
	April	32.93	33.42	1.41	29.67	34.67	-0.98
sidential/	March	33.65	34.00	1.65	28.33	36.00	-1.57

Industrial	April	32.37	32.33	1.44	29.00	34.00	-0
Commercial	March	35.01	35.33	1.85	30.33	37.67	-0
	April	34.39	34.67	1.33	30.67	36.33	-1
Industrial	March	35.24	35.67	2.47	29.33	38.67	-0
	April	34.48	34.67	1.15	30.67	36.00	-1

Source: Authors Field Survey (2015)

The study revealed that the highest maximum room temperature for the month of March was 38.67 °C which was recorded in the Industrial area or location. The highest minimum room temperature for the month of March was 30.33 °C which was recorded in the commercial area. The lowest maximum room temperature for the month of March was 32.05 °C which was recorded in the educational area. The lowest minimum room temperature for the month of March was 26.00 °C which was also recorded in the educational area. The reason for this lowest maximum and minimum room temperature obtained in the selected educational area might be due to its location and the vegetation, because there are more trees to absorb the released CO_2 in such an environment(Table 2).

The highest maximum room temperature for the month of April was 36.33 °C which was recorded in the commercial area. The highest minimum room temperature for the month of April was 30.67 °C which was recorded in both the commercial and industrial area. The lowest maximum room temperature for the month of April was 31.90 °C which was recorded in the educational area. The lowest minimum room temperature for the month of April was 23.00 °C which was also recorded in the educational area. The reason for this was stated earlier, that it is based on the location and vegetation of the selected educational area. Table shows the room temperature in the selected locations between the months of March and April in Ilorin.

Mean Monthly Minimum Outdoor Temperature in Ilorin (1991-2010)

The monthly minimum outdoor temperature record for the period of 20 years was obtained from the Nigeria Metrological Agency.

Table 3:Mean monthly minimum temperature in Ilorin (1991-2010)

	Mean	Median	Std. Dev.	Min.	Max.	Skewness
January	20.19	20.35	1.58	18.00	23.20	0.16
February	22.42	22.65	1.36	19.70	24.10	-0.49
March	24.05	24.05	0.62	22.40	25.10	-0.81
April	23.89	24.00	0.77	22.20	25.80	0.09
May	23.14	23.20	0.60	21.50	24.40	-0.83
June	22.20	22.40	0.86	19.2.0	23.20	-2.35
July	21.93	22.10	0.58	20.00	22.50	-2.02
August	21.64	21.80	0.91	18.20	22.70	-2.99
September	21.63	21.80	1.03	17.70	22.60	-3.11
October	21.93	21.95	0.60	20.00	22.90	-1.44
November	21.37	21.65	1.19	18.40	22.70	-0.89
December	19.64	19.95	1.75	15.50	21.60	-0.99

Source: Authors Computation, 2015

The study also revealed that the highest minimum temperature was 25.80 °C which was recorded in the month of April for the 20 years under consideration (table 2). The lowest minimum temperature was 15.50 °C which was recorded in the month of December; this is a period of harmattan where cold is usually experienced in Ilorin. The month of March recorded the highest mean monthly minimum temperature (24.05 °C) which is usually the hottest period in Ilorin. The reason for this high mean monthly minimum temperature obtained in the month of March can be attributed to March been the peak period of little or no rainfall, accompanied with little or no cloud cover to reduce the amount of insolation received in Ilorin. The month of December recorded the lowest mean monthly minimum temperature (19.64 °C) which is usually the period of cold weather in Ilorin.

Mean Monthly Maximum Outdoor Temperature in Ilorin (1991-2010)

The monthly records of maximum temperature were subjected to statistical analysis to determine the monthly mean for the period of 20 years.

Table 4:Mean monthly maximum temperature in Ilorin (1991-2010)

	Mean	Median	Std. Dev.	Min.	Max.	Skewness
January	33.68	33.85	0.96	32.30	36.10	0.48
February	35.83	35.80	0.81	32.30	36.10	0.38
March	35.71	35.90	1.23	33.50	37.20	-0.49
April	33.71	33.95	1.70	29.20	36.00	-1.18
May	31.78	31.50	1.09	29.20	33.50	-0.28
June	30.21	30.10	0.92	27.80	31.90	-0.4
July	28.79	28.80	0.86	27.30	30.10	-0.02
August	28.22	28.00	0.81	27.10	29.60	0.36
September	29.32	29.65	0.81	27.50	30.50	-0.62
October	30.83	30.90	0.97	29.20	32.70	0.11
November	33.40	33.50	1.36	29.60	35.50	-0.98
December	33.93	34.10	0.76	32.50	35.50	0.01

Source: Authors Computation, 2015

From Table 4, the highest maximum temperature was 37.20 °C which was recorded in the month of March for the 20 years under consideration. The lowest maximum temperature was 27.10 °C which was recorded in the month of August; this is a period of when there is a break in rainfall and the atmospheric moisture content is high. The months of February and March recorded the highest mean monthly minimum temperature of 35.83°C and 35.71 °C which is usually the hottest period in Ilorin. The reason for this high mean monthly maximum temperature obtained in these months can also be attributed to months been the peak period of little or no rainfall, accompanied

with little or no cloud cover to reduce the amount of insolation received in Ilorin. The month of August recorded the lowest mean monthly minimum temperature (28.22 °C) in Ilorin.

Mean Monthly Relative Humidity in Ilorin (1991-2010)

The monthly records of relative humidity were subjected to statistical analysis to determine the monthly mean for the period of 20 years.

Table 5:Mean Monthly Relative Humidity in Ilorin (1991-2010)

	Mean	Median	Std. Dev.	Min.	Max.	Skewness
January	52.15	52.5	12.07	35	80	0.6
February	53.85	54.5	13.20	29	77	-0.109
March	64.205	64.5	6.58455	47	74	-0.852
April	72.1	73	4.2414	59	79	-1.641
May	78.65	79	2.41214	74	82	-0.292
June	81.92	83	2.56322	73.4	85	-2.039
July	84.75	85	2.35919	80	90	-0.149
August	85.5	86	2.62578	81	90	-0.087
September	84.95	85	2.30503	79	88	-0.735
October	82.1	82.5	2.61373	75	85	-1.104
November	67.9474	67	7.52384	53	79	-0.533
December	58.6	56	8.5557	43	75	0.241

Source: Author's Computation, 2015

From Table 5, the highest relative humidity was (90%), recorded in the months of July and August for the 20 years under consideration. The lowest relative humidity was (29%), recorded in the month of February; this is a period of little or no rainfall in Ilorin. The month of

August recorded the highest mean monthly relative humidity (85.50%). The month of January recorded the lowest mean monthly relative humidity (52.15%).

Mean Annual Minimum Outdoor Temperature in Ilorin (1991-2010)

The annual minimum outdoor temperature record for the period of 20 years was obtained from the Nigeria Metrological Agency. This annual records was subjected to statistical analysis to determine the annual mean for the period of 20 years. The results of the statistical analysis are presented in Table 5.

Table 6:Annual Summary of the statistical analysis for Min. Temperature (°c) 1991-2010

Years	Mean	Median	Std. Dev.	Minimum	Maximum	Skewness
1991	22.54	22.25	1.24	19.90	24.60	-0.35
1992	21.63	21.95	2.58	15.50	25.10	-1.18
1993	21.65	22.05	1.76	18.80	24.50	-0.23
1994	21.92	22.40	2.02	16.80	24.40	-1.51
1995	22.17	22.40	1.62	18.20	24.50	-1.16
1996	22.46	22.10	1.28	19.70	24.30	-0.48
1997	22.25	22.20	0.87	20.30	23.70	-0.68
1998	22.73	22.70	1.67	20.00	25.80	0.12
1999	21.21	22.05	1.95	17.70	23.90	-0.74
2000	21.61	21.45	1.35	19.20	24.00	-0.11
2001	21.60	21.50	1.39	18.40	23.70	-0.78
2002	21.81	21.85	1.85	18.00	24.60	-0.73
2003	21.93	21.70	1.59	19.20	24.00	-0.05
2004	22.08	21.85	1.04	20.10	23.80	0.15
2005	22.13	21.90	1.65	19.00	24.50	-0.17
2006	21.67	21.80	2.22	16.50	24.10	-1.39
2007	21.83	22.05	1.50	18.30	23.80	-1.18
2008	22.38	22.50	1.42	18.90	24.20	-1.21
2009	22.01	22.00	1.42	19.20	24.30	-0.51
2010	22.42	22.15	1.64	18.70	24.80	-0.81

Source: Authors Computation, 2015

Table 6, show that the highest annual minimum temperature recorded is 25.10^{0}C and the lowest is 15.50^{0}C over the 20 years period. The year 1998 recorded the highest mean annual minimum temperature of 22.73^{0}C over the 20 years period of study while year 1999 recorded the lowest mean annual minimum temperature of 21.21^{0}C. Range of values for standard deviation is 0.87-2.58^{0}C, the values of standard deviation suggested that there are variability in the year to year minimum temperature received in Ilorin during the period of study, that is the minimum temperature fluctuated yearly below or above the long term average mean of the 20 years under consideration.

Heat Index Analysis

Heat index analysis was carried out using heat index calculator by adding relative humidity to the actual air temperature recorded in the various land use type in Ilorin (educational, residential, residential/industrial, commercial and industrial). The result of the heat index will enable us to determine the heat disorders and related medical consequences in various land use type in Ilorin city. The results of the heat index calculated are presented below:

Table 4.8: Heat Index in the Surveyed Locations or Zones in Ilorin

	Zones	March	April
1	Educational (University of Ilorin)	33.79	31.36
2	Residential (Gaa-Akanbi)	44.38	44.16
3	Residential/Industrial (Asa Dam)	42.97	42.34
4	Commercial (New Market)	47.20	49.27
5	Industrial (Dangote Industry)	49.96	49.60

Source: Authors Computation (2015)

Table 4.8, show the result of the heat index calculated for the months of March and April in the various land use types (educational, residential, residential/industrial, commercial and industrial) within the study area. In the month of March, the industrial area recorded the highest heat index (49.96°C) and the educational area recorded the lowest (33.79°C). From these results in Table 4.8, it can be infer that the people in the industrial, commercial, residential/industrial and

residential area are in danger of health disorder such as heat cramps, heat exhaustion and probably heat stroke if the activities in such zones are continued in the month of March. At this temperature, people in this area will be extremely uncomfortable. The best thing to do in such areas is to drink a lot of water, discontinue outdoor activities and also indoor activities if there is no air condition. However, the people in educational area that recorded heat index of 33.39°C should exercise extreme caution because at that temperature, heat cramps and heat exhaustion are possible in the area.

Also in the month of April, the industrial area recorded the highest heat index (49.60°C) and the educational area recorded the lowest (31.36°C). From these results, it can be infer that the people in the industrial, commercial, residential/industrial and residential selected are in danger of health disorder such as heat cramps, heat exhaustion and probably heat stroke if the activities in such zones are continued just like in the month of March. It is better for the people to also discontinue indoor and outdoor activities at this temperature in the month of April. However, the people in educational area that recorded heat index of 31.36°C in the month of April can only experience fatigue at such temperature, but it could results to heat cramps if activity is continued for a prolonged period.

Table 4.9: Summary of the Anova for the Surface Temperature of Different Urban Land Use Area in Ilorin

Groups	*Count*	*Sum*	*Average*	*Variance*
Educational	31	931.10	30.04	2.12
Residential	31	1057.57	34.12	1.71
Residential/Industrial	31	1043	33.64	2.73
Commercial	31	1085.33	35.01	3.42
Industrial	31	1092.33	35.24	6.10

Source: Authors Computation, (2015)

In Table 4.10, if the *F* ratio is larger than the *F* critical value, *F crit*, there is a statistically significant difference. If it is smaller than the *F crit* value, the score differences are best explained by chance. In the below analysis therefore, the *F* ratio (42.53) is larger than the F crit (2.43), then there is a statistically significant difference in the amount

of air temperature in the urban land use type in Ilorin in the month of March. The summary of the Anova in Table 4.9 also corroborated this finding with Industrial and commercial areas recording the highest surface temperature of 35.24°C and 35.01°C respectively, while the educational area recorded the lowest average surface temperature of 30.04°C.

Table 4.10: Results of Anova for the Surface Temperature of Different Urban Land Use Area in Ilorin

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	546.8795	4	136.7199	42.53482	8.27E-24	2.431965
Within Groups	482.1457	150	3.214305			
Total	1029.025	154				

Source: Authors Computation (2015)

Temperature and Relative Humidity Trends in Ilorin

The trend in minimum temperature, maximum temperature and relative humidity received in Ilorin within the 20 years of record was obtained by plotting each variable against year. This analysis enables us to see the linear trend in the climatic variables used (minimum temperature, maximum temperature and relative humidity) and the equation derived from the trend line can be used to make forecast into the future. The resulting trends and trend line equation from the analysis were presented in Figures 4.8-4.10.

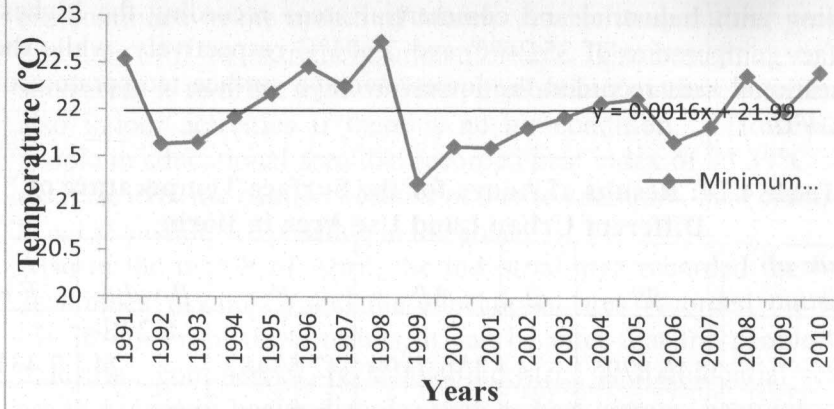

Fig. 4.8: Minimum Temperature Trend in Ilorin (1991-2010)

The graph obtained from the plot of minimum temperature against time in figure 4.8 has a positive trend line; it shows that minimum temperature is on the increase. The trend line equation shows that the minimum temperature is increasing at the rate of 0.01^0C every year during the 20 years period of study even with yearly fluctuation. However, this rate of increase in minimum temperature based on the 20 years trend is not significant.

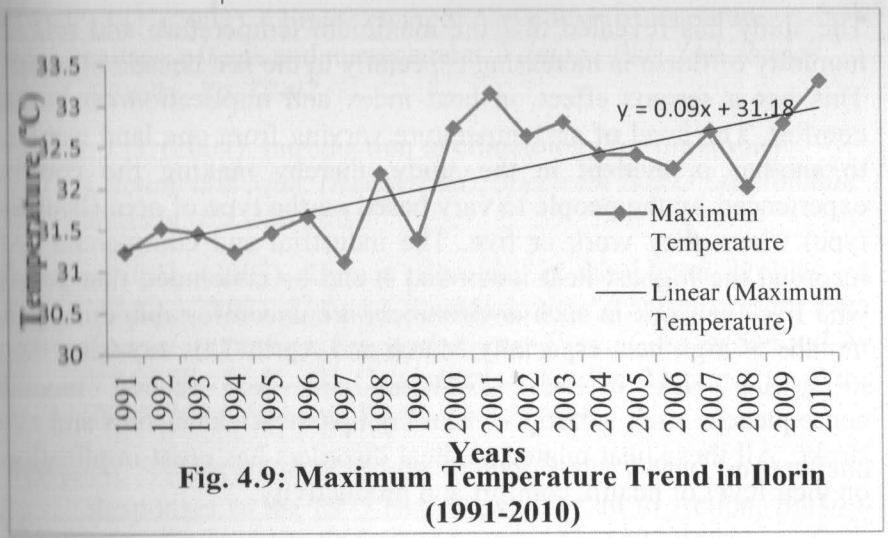

Fig. 4.9: Maximum Temperature Trend in Ilorin (1991-2010)

The graph obtained from the plot of maximum temperature against time in figure 4.9 has a positive trend line with yearly variability; it shows that maximum temperature is also on the increase. The trend line equation shows that the maximum temperature is increasing at the rate of 0.09^0C every year during the 20 years period of study. The trend-line shows that the maximum temperature is increasing sharply over the 20 years under consideration which is an indication that the city of Ilorin is becoming warmer every day and this has an implication on human comfort.

Conclusion and Recommendations

Human comfort is an important factor that determines the level of human's activities and productivity. Human comfort cannot be overemphasized in the face of an increasing urban temperature where most population of the world lives now. The urban temperature is increasing based on the increased anthropogenic activities of man. Also, the rate of urbanization that leads to the natural habitat been replaced by artificial surfaces is contributing to an increase in urban heat island. Hence, this has a disturbing influence on human comfort and health as well as their level of productivity.

The study has revealed that the maximum temperature and relative humidity of Ilorin is increasing especially in the last decade of record. This has a serious effect on heat index and implication on human comfort. The level of air temperature varying from one land use type to another is evident in the study, thereby making the comfort experienced by the people to vary based on the type of area (land use type) where they work or live. The industrial and commercial area recorded the highest heat index and it can be concluded that people who lives or work in such environment are uncomfortable during the months of high heat especially March and April. This exposing them to greater risk of heat disorders and heat related medical consequences such as fatigue, heat cramps, heat exhaustion and heat stroke. All these heat related medical disorders has great implications on their level of health, comfort and productivity.

Further, this high temperature is dangerous to health and comfort, and prolonged exposure put the residents of Ilorin to risk of stroke incidence, heart diseases and pulmonary disorder. The urban heat island will also have economic effect on the people as well as the government of the city, these effects are: an uncomfortable person will be less productive, an individual with heat related health issue will also pay medical bills and the government will spend millions of naira for urban forestation which can also pave way for corruption.

In order to mitigate the effect of urban heat island on health, there is need to educate or sensitize the people on issues concerning to climate change and its impact on human health, effect of anthropogenic activities. Finally the people in the study area should be exposed to the broadcast of weather or climatic report so as to enable them observe the variation and to adjust and adapt to it.

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