Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.19, 2015

Urban Effect on Micro-Climate of a Tropical Environment

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Abstract
The ultimate aim and purpose of this study was to investigate the urban effects of micro-climate in Sapele town, Delta State. The influence of urbanization on climate was investigated with particular reference to urban centres and rural centres of Sapele region. Figures on temperatures and relative humidity were observed in June, 2013, at between 0900hr and 1500hr GMT daily. Data analysis techniques includes Paried T-Test findings indicate significant difference between urban and rural temperature as well as the relative humidity ($P<0.05$). Urban temperature was positively and significantly correlated with rural temperature ($r=0.358$). And urban relative humidity was negatively but significantly correlated with the rural humidity ($r=-0.224$). These variations show the influence of urbanization on the microclimate of Sapele town. Recommendations are to made to checked these variations. Industries and factories stacks should be located far away from settlements. Weather stations should also be scattered around the region to monitor temperature elevations and other weather parameters.
Keywords: Micro-climate, Urban, Anthropogenic, Sapele Town

INTRODUCTION

As more people migrate from the rural areas to live in cities, urban growth results. This kind of growth is especially common place in developing countries such as Nigeria.

Sapele as assumed the status of an urban center since the 70's, there is a need to study and investigate the influence of micro climate in the area. There is a clear link between micro climatic variables (e.g. wind speed, wind direction, air temperature, humidity, solar radiation and daylight) and a building's energy performance. Furthermore, there is an increasing concern for thermal studies of urban environments in particular, those examining the effect of building configuration, such as urban form, building orientation, surface materials and vegetation on building energy consumption, natural and hybrid ventilation and outdoor comfort. A need has arisen for a robust calculation tool (using the first-cut and calculation method) to enable planners, architects and environmental assessors, to quickly and accurately compare the impact of different urban forms on local climate and urban Heat Island (UHI) mitigation strategies (Yao, and Steemer, 2013).

Human activity has a big influence on the climate of an urban area. An urban micro climate is influenced by urban building configuration and can differ considerably to the local meteorological data that is usually measured for that region (Yao, and Steemer, 2013). While an urban area is an area with a high density of human created structures in comparison with the areas surrounding it, climate is the long term behavior of the atmosphere in a specific area, with characteristics such as temperature, pressure, wind, precipitation, cloud cover and humidity etc. urban microclimate consists of local variations in wind, humidity, solar radiation and temperature as a result of many factors (Somerfield, 2010).

Christopher (2009) defined microclimatology as the study of climate over a small area. He went further to say that it includes botchy changes resulting from construction and natural features. Ajp (2008) also defined microclimate as the weather that is found in a relatively small, very local area. The shape of the urban space creates microclimatic zones according to their properties of shelter from the weather conditions and offer different conditions for urban life (Copenhagen, 2009).

As the country at large continue to urbanize and civilize, the urban microclimate will in turn expand as anthropogenic activities of man (e.g gas flaring, industrialization, bush burning, emission of gases into the atmosphere etc) affects the climate of that area. Urbanization occurs as individual, commercial and governmental efforts to reduce time and expenses in commuting and transportation while improving opportunities for jobs, education, housing and transportation.

As the natural geographical setting and landscape of Sapele and its environs is rapidly being replaced by an agglomeration and clustering of both planned and unplanned building structures, its attendant consequences are enormous. The geometric increase in population, vehicular emissions from exhaust pipes, industrial discharges and increased use of power generating set due to erratic power supply by Power Holding Company of Nigeria (PHCN) all these lead to appreciable disturbance in the natural ecosystem of Sapele town. These anthropogenic activities of man could lead to Urban Heat Island (UHI), gases, which eventually alter the microclimate of Sapele town.

The Urban Heat Island, Urban Humidity Island and Urban Rain Island phenomena are inevitable and ubiquitous, wherever there is a city these effects are produced, solar radiation and thermal mass are inextricably symbiotic; irrespective of the amount of urban mass it will exert disruptive pressures on microclimatic and

Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
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ultimately local and regional weather systems giving way to aluminum roofing sheets with resulting changes in radiation characteristics of the surfaces. Similarly, the height of the rate of escape at night of the sun's energy absorbed the day by building materials (Oguntoyinbo, 1981)

The removal of vegetation from Sapele town has markedly altered the surface properties of the area and hence has modified the energy and water balance of the area (Omogbai, 1985). This is as a result of increase in the numbers of building structures and warm air conditioners that adds warmth to the surroundings, which pollutes and radiates heats to the surrounding landscape and also turning of landscape into townscape also altered the natural environment. The alteration according to Efe (2002a and 2006) resulted in increased temperature of the urban canopy. In recent times there has been a call for periodic re-examination of the urban climate of tropical cities with that of other cities in the world (Lowry, 1998, Efe, 2006 and Adelekan 2005). Based on these calls and with these numerous problems and the neglects associated with Sapele town, the needs arises to carry out this study in order to find out how urbanization has affected the microclimate of the area.

In other to achieve this, the following specific objectives are to be pursued as follows;

1. To study the temperature and humidity in the urban and rural area of Sapele and its surrounding areas.
2. To study the physiological comforts in these different areas.
3. To proffer solutions on how to reduce adverse effect of urbanization on both human activities and climate.

HYPOTHESIS

The following hypotheses were tested in the study

- There is no significant difference between the temperature of Sapele urban and that of the rural areas of Sapele Urban
- There is no significant difference between the relative humidity of Sapele urban and that of the rural area.

STUDY AREA

This study is based on Sapele (Urban and Rural). It is located at the co-ordinates of latitudes 50201 and 50501N and Longitude 50151and 50411E. It has a total landmass of about 291.37km2 (see Fig 1.)

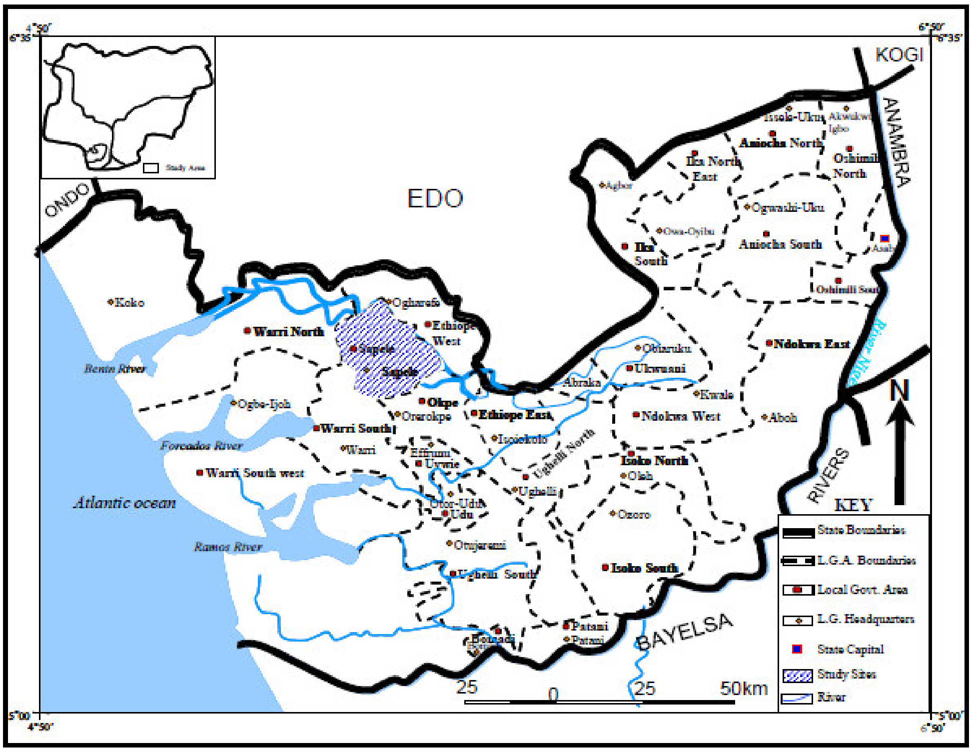

Fig. 1: Map of Delta State Showing Sapele L.G.A with Nigeria Insert

It has a population figure of 142,652 (1991 census). The growth rate of the population was projected at 3.1% annually. This gave rise to (179,188) in 1999 and (184,766) in the year 2000.

Sapele is located within the Niger Delta region of Nigeria, which has the Agbada, Akata and Benin formation in terms of geology. The rock is made up of the sedimentary type, which falls within the recent

Holocene era. Buckle, 1978 stated that, a large part of the sedimentary rock formation is very recent age, having been laid down in the next 12,000 years.

It has a flat terrain with a western part of the area being swampy and towards the Northeast is the undulating plain. Although the area is not hilly, the land slopes towards the Benin and Ethiope rivers in the Eastern part.

Generally, the soils of the area are acidic and non-saline in the freshwater swamps but in the mangrove swamps they are saline and usually near neutrality or slightly acidic (Udo, 1984).

The area is drained by three major rivers namely, Ethiope, Jameison and Benin. These rivers empty their water into the Atlantic Ocean.

The climate is warm and wet throughout the year. It is characterized by sub-equatorial type of climate marked by two dominant seasons, which are wet and dry. The wet season begins from March to October while the dry season spans from November to February. The area experiences almost uniform temperature but with a variation of 10 C throughout the year and with a mean of 27^{0}C. The average monthly rainfall is about 2,277mm.

The vegetation consists of the rain and freshwater swamp forest. Species of trees include Iroko (Chlorapheraexlessa), Mahogany (Khayaivorensis), Walnut (Lovatrichilloides), Sapele Hardwood. The freshwater swamp forest is made up of mangrove trees (Rhizoperaracemosa), epiphytic plants and Raphia palms (Eleasisguineesis).

However, as a result of anthropogenic activities, cultivated rubber trees and other secondary re-growth forest have replaced the natural vegetation, while few of the natural vegetation are found only along the banks of river Ethiope, Jameison, Benin and in the heart of the swamps. Other secondary re-growth vegetation is found in the hinterlands. Elsewhere, most of the original forest has been cleared for settlement, for firewood and farming.

MATERIALS AND METHODS

The data needed to carry out this study are data on temperature, relative humidity and physiologic comfort (effective temperature).

These temperature figures are obtained from specific points in the two designated areas in Sapele urban and rural. The relative humidity (R.H) figures are calculated from the temperature reading using the hygrometer (wet and dry bulb thermometer).

The Physiologic Comfort (PC) figures are calculated using the formula;

$ET = 0.4 (T_d + T_w)$

where;

ET= Effective temperature

Td= Temperature of the dry bulb

Tw= Temperature of the wet bulb

The sampling technique involves the purposive in which two areas are selected in Sapele and its environs using parameters such as population density, and land use pattern. The areas are;

1. Sapele urban: This is populated and heavily commercialized.
2. Sapele rural: Sparsely populated and agricultural areas.

The systematic purposeful selection of the places of observation is to enable the researcher have a true representation of factors that influence temperature in Sapele and its environs.

The instrument employed in data collection is the placement of a hygrometer (wet and dry bulb thermometer) at Ugbeyiyi and Warri/Sapele road around Okpe round about. The observations were made in June 2013 with the assistance of field workers. Figures on temperature and relative humidity were observed at 0900hr (10:00am local time) and 1500hr (4:00pm local time). The choice of 0900hr (10:00am) and 1500hr (4:00pm) GMT represents the six hour interval in observing weather. The six (6) hourly intervals are taken because micro climate varies at one hour interval, hence the hours of 0900hr (10:00am) and 1500hr (4:00pm) were selected for this study.

The data for this study was collected for a period of one month (June, 2013) using the dry and wet bulb thermometer. Temperature and relative humidity and physiological comfort figures were calculated.

The statistical technique employed in this study is the paired T-Test which was used in the variation and comparism of the readings in the different stations in the study area; and also used to find the differences between the urban and rural area.

DISCUSSION OF RESULTS

The following data were generated during the study

a) Temperature figures observed from the two different areas of study. Temperature figures are presented in Table 1.
b) Relative humidity figures observed from the two different areas of study. Relative humidity figures are presented in table 2.

c) Physiological comfort figures from two different areas of study. Physiologic values calculated are presented in table 3.

Table 1: Temperature figures observed from the two different Parts of Sapele region at 0900hr and 1500hr

	Sapele P.O (Urban) 10AM		4PM			Ugbyiyi (Rural) 10AM		4PM		
DATE	DRY (OC)	WET (OC)	DRY (OC)	WET (OC)	DIURNAL MEAN TEMP	DRY (OC)	WET (OC)	DRY (OC)	WET (OC)	DIURNAL MEAN TEMP
1-JUN-2013	28.5	26	30.5	28.5	29.5	28	`28	27	27	27.5
2-JUN-2013	29	28	29	28	29	28	25.5	27.5	27.5	27.6
3-JUN-2013	28.5	26	27.5	25.5	28.5	25	24.5	28	28	26.5
4-JUN-2013	29	27	29	27	29	26	25	26	26	26
5-JUN-2013	27.5	25.5	28	26	27.8	27	26	26	26	26.5
6-JUN-2013	27.5	25.5	27.5	25.5	27.5	26	24	26	26	26
7-JUN-2013	28	26	28	26	28	26	24	27.5	27.5	26.7
8-JUN-2013	27.5	25.5	27.5	25	27.7	27.5	25.5	27	27	26
9-JUN-2013	28	26.5	28	26	27.5	27	25.5	28	28	27.8
10-JUN-2013	27.5	25	28	25	28	25	26	27	27	27
11-JUN-2013	27	25	29	26.5	27.5	28	27	28	28	26.5
12-JUN-2013	28	25.5	28	24.5	28	26	24	26	26	27
13-JUN-2013	27	25	29	26.5	28	26	25	28	28	27
14-JUN-2013	26	24	32	25.5	28	26	26.5	26	26	26
15-JUN-2013	27	25.5	31	27	29	26.5	24	26.5	26.5	26.5
16-JUN-2013	27	26	28.5	28	29	25	26	28	28	26.5
17-JUN-2013	27	25.5	28	28.5	27.9	27	25.5	27	27	27
18-JUN-2013	29	28	27	27	27.5	26	24	27.5	27.5	26.6
19-JUN-2013	28	27	28	26	28	26	24.5	26	26	26
20-JUN-2013	28	23	30	26	29	25	24	26.5	26.5	25.7
21-JUN-2013	28	25.5	27.5	26	27.6	26	25	28	28	27
22-JUN-2013	27	25	29	25	28	26	25.5	26	26	26
23-JUN-2013	27.5	25.5	28.5	25	28.5	26	24	26	26	26
24-JUN-2013	26	24	28	26.5	27	24.5	25.5	26.5	26.5	25.5
25-JUN-2013	26	24.5	29	26	27.5	26	25.5	27.5	27.5	26.7
26-JUN-2013	27	25	27	24.5	27	24.5	23.5	26.5	26.5	25.5
27-JUN-2013	26.5	24.5	29	26.5	27.9	26	25.5	26	26	26
28-JUN-2013	26	24	28	26	27	26	25	26	26	26
29-JUN-2013	27	25	28	25.5	27.5	27	26	27	27	27
30-JUN-2013	27.5	25.5	31.5	29.5	29.5	29	28	27	27	28

Source: Field Work, 2013

Note Below: *The diurnal mean temperature figure is derived from the average mean of the min and max thermometer (10am and 4pm)*

From table 1 above, it is clear that the temperature of the urban areas of Sapele rose to 29.5^{oc} on the 1st day of the month of June, 2013 while the temperature decreased to 27.5^{oc} on the 6th of June, 2013 and increased again to 30th of June, 2013 indicating that the temperature of the urban areas is influenced by human and anthropogenic activities. The reverse is the case in the rural areas as shown in the graph and table above. Temperature increased sharply to 27.8^{oc} on the 9th of June, 2013 and decreased to 25.5^{oc} on the 24th and 26th of June, 2013 and rose again to 28^{oc} on the 30th of June, 2013 indicating that the temperature varies and decreases downward as we descend the rural areas.

Table 2: Relative humidity figures observed from the two different part of Sapele Region.

DATE	Sapele P.O (Urban) RH (%)			Ugbyiyi (Rural) RH (%)		
	10AM	4PM	Mean RH	10AM	4PM	Mean RH
1-JUN-2013	87	85	86	100	100	100
2-JUN-2013	96	96	96	81	83	82
3-JUN-2013	82	88	85	81	74	78
4-JUN-2013	85	85	85	96	96	96
5-JUN-2013	85	85	85	96	96	96
6-JUN-2013	85	85	85	84	88	86
7-JUN-2013	85	85	85	88	82	85
8-JUN-2013	85	81	83	97	97	97
9-JUN-2013	93	93	93	85	83	84
10-JUN-2013	81	74	78	96	96	96
11-JUN-2013	88	82	85	95	96	96
12-JUN-2013	83	81	82	96	93	95
13-JUN-2013	83	85	85	84	85	84
14-JUN-2013	83	74	79	95	95	95
15-JUN-2013	93	83	88	100	100	100
16-JUN-2013	96	93	95	95	96	96
17-JUN-2013	92	88	90	96	96	96
18-JUN-2013	96	96	96	97	97	97
19-JUN-2013	96	88	92	84	88	86
20-JUN-2013	67	65	66	97	97	97
21-JUN-2013	81	83	82	84	85	84
22-JUN-2013	88	82	85	96	96	96
23-JUN-2013	85	87	86	97	97	97
24-JUN-2013	83	74	79	97	95	96
25-JUN-2013	93	83	88	97	97	97
26-JUN-2013	83	81	82	95	95	95
27-JUN-2013	88	82	85	97	97	97
28-JUN-2013	85	85	85	96	96	96
29-JUN-2013	83	81	82	96	96	96
30-JUN-2013	88	85	87	96	96	96

Source: Field Work, 2013

Table 2 above reveals that, relative humidity is higher in rural areas than in urban areas. This is true to say as the highest relative humidity figure observed in the rural areas was 100% as observed on the 1st and 15th of June, 2013 whereas, the urban figure was 96% as observed on the 2nd and 18th of June, 2013. This indicates that there are more of moist air in the rural areas than the urban areas.

Table 3: Effective Temperature Figures in June 2013

DATE	Sapele P.O (URBAN) RH (%)			UGBYIYI (RURAL) RH (%)		
	10am	4pm	Mean RH	10am	4pm	Mean RH
1-JUN-2013	26.6	28.4	27.5	27.2	26.4	26.8
2-JUN-2013	27.6	27.6	27.6	26.2	25.8	26
3-JUN-2013	26.6	26	26.3	24.6	26	25.3
4-JUN-2013	27.2	27.2	27.2	25.2	25.2	25.2
5-JUN-2013	26	26.4	26.2	26	25	25.6
6-JUN-2013	26	26	26	24.8	25.8	24.9
7-JUN-2013	26.4	26.4	26.4	24.8	25.4	25.3
8-JUN-2013	26	25.8	25.9	25.4	26.4	25.4
9-JUN-2013	26.6	26.6	26.6	26	26	26.2
10-JUN-2013	25.8	25.8	25.8	26	26.8	26
11-JUN-2013	25.6	27	26.3	24.4	25	25.6
12-JUN-2013	26.2	26.2	26.2	26.8	26.4	25.9
13-JUN-2013	25.6	27.2	26.4	24.8	26.8	25.6
14-JUN-2013	24.8	28.8	26.8	25.2	25.2	25.2
15-JUN-2013	25.8	28.6	27.2	26	26	26
16-JUN-2013	26	27	26.5	24.4	26.8	25.6
17-JUN-2013	25.8	26.4	26.1	26	26	26
18-JUN-2013	27.6	26	26.8	25.4	26.6	26
19-JUN-2013	26.8	26.4	26.6	24.8	25	24.9
20-JUN-2013	25.2	26.8	26	25.2	25.8	25.2
21-JUN-2013	26.2	25.8	26	26	26.4	25.8
22-JUN-2013	25.6	27	26.3	25.2	25.2	25.2
23-JUN-2013	26	26.6	26.3	25.4	25.4	25.4
24-JUN-2013	24.8	25.8	25.3	24.2	25.6	24.9
25-JUN-2013	25	27	26	25.4	26.6	26
26-JUN-2013	25.6	25.4	25.5	24.2	25.6	24.8
27-JUN-2013	25.2	27	26.1	25.4	25.4	25.4
28-JUN-2013	24.8	26.4	258.6	25.2	25.2	25.2
29-JUN-2013	25.6	26.2	25.9	26	26	26
30-JUN-2013	26	29.2	27.6	27.6	26	26.8

Source: field work, 2013

Table 3 above reveals that, the highest effective temperatures was 27.6^{oc} on the 2nd and 30th of June, 2013 (urban) and 26.8^{oc} on the 1st and 30th of June, 2013 (rural) and the lowest ET figure was 25.3^{0}C on the 24th June, 2013 (urban) and 24.8^{0}C on the 26th June, 2013 (rural). This indicates (using the Effective Temperature Index; below 18^{0}C extreme cold, 81^{0}C-25^{0}C no physiologic comfort, 25^{0}C above physiologic comfort is attained). The inhabitants in Sapele landscape attained physiologic comfort in near all the days of the month in both urban and rural areas using the ET index (which states that one can attain physiologic comfort if the Effective Temperature is 25^{0}C and above but below 25^{0}C no comfort is attained), except for the days of 6th, 9th and 26th of June, 2013 in the rural areas which recorded 24.9^{0}C, 24.9^{0}C, 24.9^{0}C and 24.8^{0}C respectively, meaning that they (in rural areas) did not attain physiologic comfort and were not comfortable during these days. This is true because effective temperature is higher in urban areas than in rural areas and it varies from urban to rural areas.

Generally speaking, from the various analysis above, we can deduce that temperature and effective temperature is usually higher in urban areas than rural areas while relative humidity is lower in urban areas than rural areas. This is a clear indication that variation exist in the temperature, relative humidity and physiologic comfort of urban and rural areas.

4.2 Testing of Hypothesis

Hypothesis One

Ho: There is significant difference between the temperature of Sapele Urban and that of the rural areas of Sapele region.

Hi: There is a significant difference between the temperature of Sapele urban and that of the rural areas of Sapele region.

Table 4: Paried samples Statistics

	Mean	N	Std. Deviation	Std. Error mean
Pair 1 Urban	85.3333	30	5.93838	1.08420
Rural	93.0667	30	6.03400	1.10165

Source: Author's research, 2013

From table 4, the mean relative humidity for the urban area of Sapele shows 85.3% while that of the rural areas of Sapele shows 93.0%. This implies that relative humidity for the rural area is higher than that of the urban area. However the standard deviation result shows 5.93 for the urban areas and 6.03 for the rural area. It therefore indicates that variation in relative humidity in the rural area is higher than that of the urban area.

Table 5: Paired Samples

Correlation

	N	Correlation	Sig.
Pair 1 Urban & rural	30	-.224	.234

Source: Author's research, 2013

From table 5 it can be observed that the correlations between the relative humidity for the urban and rural areas in negatively weak with correlation value of r=-.224

Table 6: Paired Samples Test

	Paired differences							
				95% Confidence Interval of the difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2 tailed)
Pair 1 Urban – Rural	-7.73333	9.36587	1.70997	-11.23061	4.23606	4.523	29	.000

Source: Author's research, 2013

From table 6 the model is significant at P<0.05. This implies that the Ho hypothesis is rejected, which means "there is no significant difference between the relative humidity of the urban areas and that of the rural areas of Sapele at 0.05 level of significance. And we accept the H1 hypothesis which is "there is a significant difference between the relative humidity of the urban areas and that of the rural area of Sapele at 0.05 level of significance.

Hypothesis Two

Ho: There is no significant difference between the Relative Humidity of Sapele urban and that of Sapele rural.

Hi: There is a significant difference between the Relative Humidity of Sapele urban and that of Sapele rural.

Table 7: Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error mean
Pair 1 temp_urban	20.0800	30	.70388	.12851
temp-rural	26.5367	30	.65888	.12029

Source: Author's research, 2013

From table 7, the mean temperature for the urban area of Sapele shows 28.08^{0}C while that of the rural areas of Sapele shows 26.53^{0}C. This implies that temperature for the rural area is lower than that of the urban area. However the standard deviation result shows .70 for the urban areas and .65 for the rural area. It therefore means that variation in temperature in the rural area is lower than that of the urban area. This is not unconnected to the various human activities in the different areas of study.

Table 8: Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 temp_urban&temp_rural	30	.358	0.52

Source: Author's research, 2013

From table 8 it can be observed that the correlations between the temperature for the urban and rural areas is positively weak with correlation value of r=.358.

Table 9: Paired Samples Test

	Paired differences							
				95% Confidence Interval of the difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2 tailed)
Pair 1 temp_urban_1 temp_rural	1.54333	.77312	.14115	1.25465	1.83202	10.934	29	.000

Source: Author's research, 2013

From table 9 the model is significant at $p<0.05$. This implies that the Ho hypothesis is rejected, while is "there is no significant difference between the temperature of the urban areas and that of the rural areas of Sapele at 0.05 level of significance. And we accept the Hi hypothesis this implies that "there is a significant difference between the temperature of the urban areas and that of the rural areas of Sapele at 0.05 level of significance.

The study was primarily concerned with the influence of urbanization on the microclimate of Sapele region. It was aimed at studying the temperature and humidity in Sapele Urban and its surrounding rural areas and to investigate the physiological comfort of these areas. From the findings, the study established the following; there is a significant difference between the temperature of Sapele urban and that of Sapele rural. There is also a significant difference between the relative humidity of Sapele urban and that of Sapele rural. Paired T-test analysis was employed to statistically test the data on temperature and humidity required. The variation in daily temperature and humidity between Sapele Urban and Sapele Rural is not unconnected with the various human activities in Sapele and its environs ranging from the excessive heat and gases emitted into the atmosphere by continuous burning of bushes, emission of carbon dioxide (CO_2) from automobile vehicles and other industrial activities that clustered Sapele region. Planned and unplanned settlements with increasing population within the town could also be implicated.

Conclusion and Recommendations

The influence of urbanization on the microclimate of Sapele region is confirmed by this study. The Paired T-test indicates that there are significant variations in the daily temperature and humidity between Sapele urban and that of Sapele rural. Consequently, variations in the physiological comfort in the true areas of study, hence the low in agricultural yield in Sapele region. The increase temperature and low humidity within Sapele region could lead to Urban heat Island which is being experienced in the region.

In view of the climatic parameters acquired and subsequent analysis, the microclimate of Sapele has been influenced by urbanization, hence, the need for an urgent check. As a result of the findings of the study, the following recommendations are made;

- ❖ Industries and factories such as Bakeries, oil mills, etc. should be sited away from human habitats. Because of the enormous problems and health hazards associations with these phenomena, government environmental laws enforcement agencies especially FEPA should be involved in the design and location of these factories and industries should be at least two kilometres away from towns and villages.
- ❖ FEPA should enforce all existing environmental laws on indiscriminate burning of bushes and should encourage and enlighten the public on the advance effect of urban warming.
- ❖ The urban and regional unit of Ministry of land and survey should embark on the demolition of illegal structures. This will improve the aesthetic value of Sapele region.
- ❖ Government should embark on the construction of housing estates and recreational centers away from the city centers. This will encourage massive urban drift to the suburbs.
- ❖ Weather centers should be scattered around the region to monitor temperature, humidity and other weather parameters. This will enable meteorologist to forecast temperature elevations and predict consequent effects on the microclimate of the region.

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