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Comparative Analysis of Poultry Farmyard and Vegetative Farmyard on Heat Island Production: A Case Study of Orji in Imo State Nigeria

[1]Ewurum N.B.B., [2]I. E. Nwosu

[1, 2] Department of Physics, Imo State University Owerri, Nigeria

Abstract: **The comparative analysis of heat island production in poultry farmyard and vegetative farmyard was carried out at Orji in Owerri Municipality Imo State, located at the globe on longitude 7.04437E and latitude 5.51412N. The purposive sampling technique was used. The study recorded nine (9) temperature readings of both poultry farmyard and vegetative farmyard for a period of three (3) days. Based on comparative analysis, the paired t-test revealed that there was a significant effect at 95% level of confidence. The null hypothesis was rejected and it was concluded that there was a significant effect of animal metabolism on heat island production. Conversely, the chi-square test revealed that at 95% level of confidence, there was no significant relationship between the period of the day and the effect of animal metabolism on heat island production.**

Keywords: **Animal Metabolism, Evaporative Conductivity, Heat Island, Null Hypothesis, Radiative Forcing.**

1. INTRODUCTION

Energy and climate are highly associated with the built environment. Built environment is not only comprised of building collections, but also the physical results of various economic, social and environmental processes [1]. Urban micro-climate change effects can be seen when major cities experience the formation of urban heat islands, due to urban expansion, population growth, and the development of major industrial activities in metropolitan areas [2]. Urbanization promotes the changes of land use and land cover. Urban scale investigation of climate modification requires one to look into human activities.

Human activities are a major influence of urban climate because the concentration effects of their activities may differ considerably from surrounding rural regions. Changes of land cover will relatively change surface properties, like Heat Capacity, Heat Conductivity, Albedo, Roughness Length, Maximum Evaporative Conductivity, Heterogeneity, Leaf Area Index (LAI), and Water Features [3].

Sunrays pass radiant heat energy downwards; this takes place through short wave radiation and heats it up through a process called radiative or radiant heat energy transfer. The radiant heat energy received is sucked up by atmospheric particles on the face of the earth, and then re-radiated to the atmosphere, through another equally important radiative energy transfer process. But in a much less visible sense, all solids suck-up and release radiation like black bodies do [4].

The global interaction exchanged between earth and ocean system have link with the radiant energy, therefore, earth's process like green house effects, heat island effects, global warming etc. depends on it. Heat energy comes back into a whole. If the heat is not dissipated, it alters the surrounding air temperature. This in turn, will cause some parts to be warmer than the other. This phenomenon is defined as heat island. This is naturally guided by some energy retracts into the space (atmosphere). The Radiative Forcing from the earth is always even with the outgoing balancing of the incoming

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radiation, which helps to stabilize the temperature of earth. However, exchange of energy between different sections of the earth surface is not necessarily balanced.

Local temperature is influenced by so many factors including manmade factor like the Anthropogenic Heat. Heat is lost and can be gained by other factors, as a result, energy in conserved. This process does not depend on different types of surfaces, but on the spread of the local climate and different regional meteorology [5&6]. This will result into having a local heat Island (heat hot spot) that can always have a shift experiencing dual seasons [7].

2. METHODOLOGY

The study area is a rural area in Imo State, Orji. Orji is a village in southeast Nigeria. It is located in the Owerri North Local Government Area of Imo State, and at the globe on longitude and latitude 7.04437E and 5.51412N respectively. Geographically, Orji covers an area of roughly 3 square kilometres (1.2sqmi). We established poultry as a study site; the birds' metabolism represents animal metabolism. The poultry housed about one hundred birds.

The data needed to carry out this study is based on temperature. These temperature figures are obtained from specific points in the two designated areas in Orji, a rural poultry farmyard and a rural vegetative farmyard. These data were obtained with a handheld Infrared Thermometer (IRT) wrapped in a thermal glove. The thermal glove prevents temporary inaccurate temperature readings due to thermal shock from moving the instrument quickly from indoor to outdoor temperatures. For each daily observation, a total of nine individual surface temperature measurements were recorded. The mean surface temperature will be derived as the final surface temperature measurement. The surface cover conditions, cloud cover, visibility of contrail, and precise date and time were noted also. The systematic purposeful selection of the places of observation is to enable us have a true representation of factors that influence urban heat island production.

Method of Data Collection:

Data on temperature were obtained at three different periods of the day (Morning, Afternoon and Evening). Temperature readings for the morning period were obtained at 0800hr-1000hr (9:00am - ll:00am local time), 1200hr-1400hr (l:00pm-3:00pm local time) and 1600hr-1800hr (5:00pm-7:00pm local time). The hourly intervals were taken because micro climate varies at one hour intervals. The data for this study were collected for a cumulative period of 3 days.

Method of Data Analysis:

Data were analyzed using the statistical paired t-test which made inferences on the effect of animal metabolism on Urban Heat Island production. Also the Chi-Square statistical test was employed to make inferences on the relationship between Urban Heat Island production and the different periods of the day. Tables and charts were also used to represent the various readings.

3. RESULTS

The results obtained in the experiments involving Poultry farm recorded for three days are shown in table 1 while the resulting figure is shown on fig. 1.

Table 1: The temperature readings of the poultry farm for three days at various time intervals

	Temperature ^{o}C		
Time (hr)	Day 1	Day 2	Day 3
9:00 am	25.1	25.4	25.0
10:00 am	25.7	25.2	25.4
11:00 am	25.6	26.0	26.4
12:00noon	30.6	30.5	31.0
1:00pm	31.9	32.9	31.7
2:00pm	31.7	31.1	32.0
3:00 pm	28.7	28.9	27.9
4:00 pm	27.4	28.4	27.9
5:00 pm	27.2	29.8	27.4

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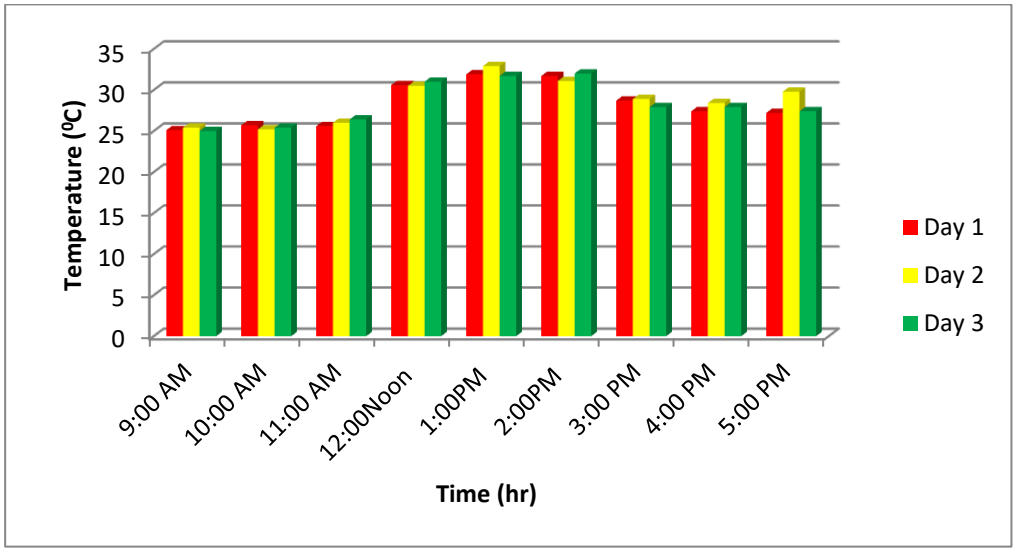

Fig 1: A Bar chart of the temperature readings of a Poultry farm for three days at various time intervals

The results obtained in the experiments involving Vegetative farm recorded for three days are shown in table 2 while the resulting figure is shown on fig. 2.

Table 2: The temperature readings of the vegetative farm for three days at various time intervals

	Temperature ^{o}C		
Time (hr)	Day 1	Day 2	Day 3
9:00 am	24.9	24.6	24.8
10:00 am	24.7	25.0	25.4
11:00 am	25.5	26.0	25.3
12:00noon	30.0	30.6	30.3
1:00pm	32.4	31.3	31.6
2:00pm	30.6	31.6	31.4
3:00 pm	28.4	27.5	28.4
4:00 pm	27.9	27.5	27.1
5:00 pm	29.3	27.0	26.9

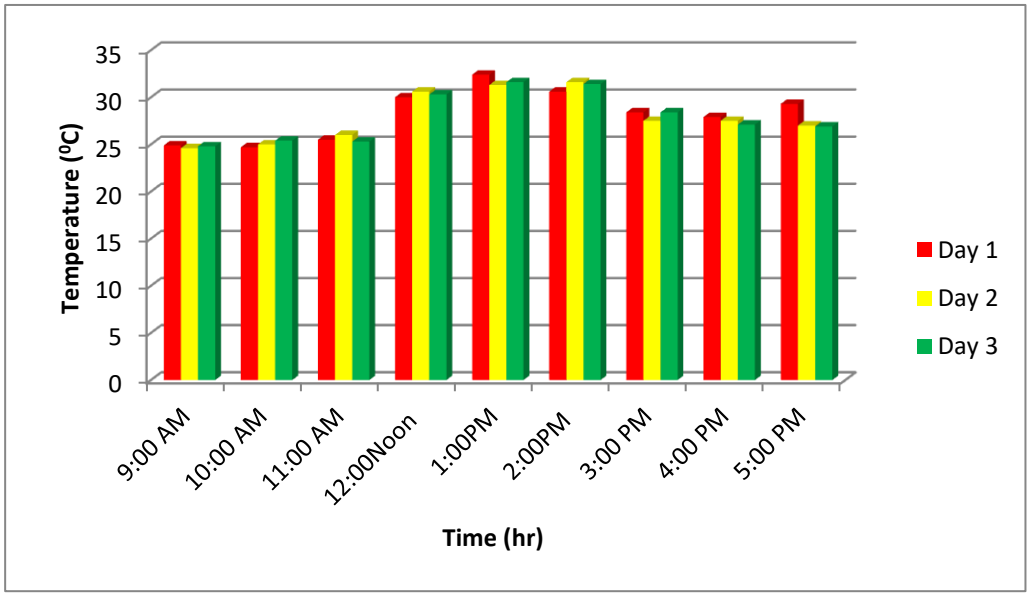

Fig 2: A Bar chart of the temperature readings of a Vegetative farm for three days at various time intervals

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The paired t-test was employed to ascertain the effect of animal metabolism on urban heat island production at Orji, Imo State. The data used in this Statistical analysis came from table 3 while the accompanying chat is as highlighted in fig. 3.

Table 3: Mean temperature readings (°C) of the Poultry farm and Vegetative farm at Orji, Imo State

	Temperature °C		
Time (hr)	**Poultry Farm (X)**	**Vegetative Farm (Y)**	**X – Y = d**
9:00am	25.2	25.0	0.2
10:00am	25.4	25.0	0.4
11:00am	26.1	25.6	0.5
12noon	30.7	30.1	0.6
1:00pm	32.3	31.8	0.5
2:00pm	31.6	31.0	0.6
3:00pm	28.5	28.1	0.4
4:00pm	27.9	27.6	0.3
5:00pm	28.1	27.7	0.4
			Σd = 3.36

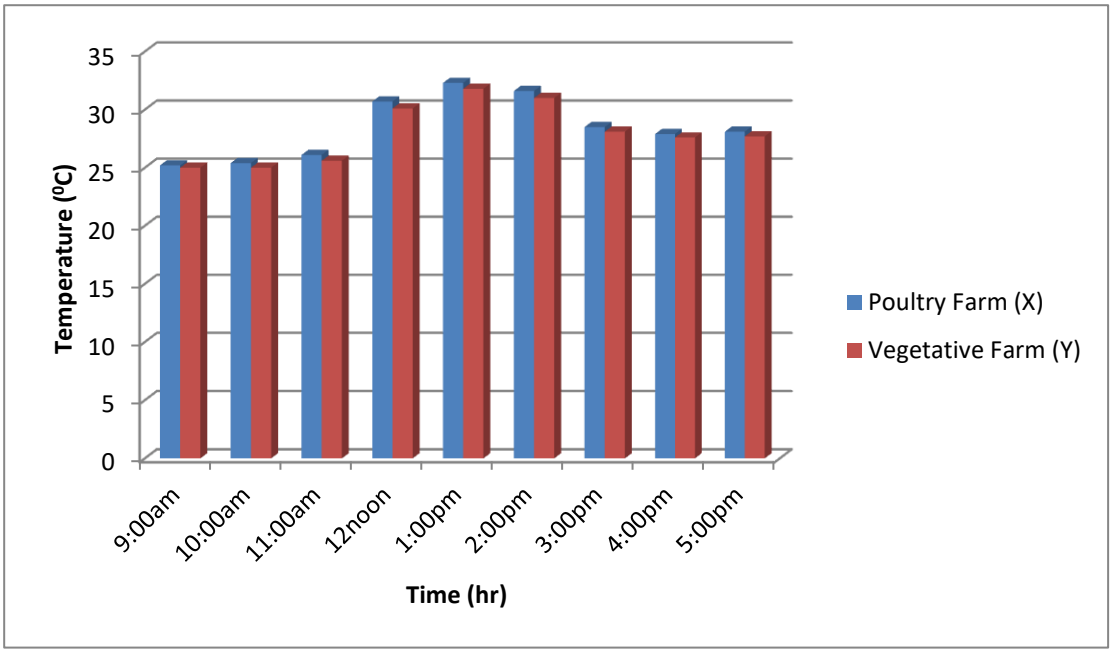

Fig 3: Bar chart of the mean temperature readings (°C) of the poultry farm and vegetative farm at Orji, Imo State.

The figure above shows that Heat Island production was higher in the Poultry farm than in the Vegetative farm in all period of time. It also revealed that Heat Island production was at the peak in the afternoon (12:00pm local time) and was lowest at 9:00am local time.

Statement of Hypothesis:

H_0: There is no effect of animal metabolism on urban heat islands production.

H_1: There is an effect of animal metabolism on urban heat islands production.

Computations:

$$\sum(X - Y) = \sum d = 3.36; \quad n = 9$$

$$\sum(X - Y)^2 = \sum d^2 = 1.83; \quad \bar{d} = \frac{3.36}{9} = 0.373$$

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$$SD = \sqrt{\frac{\sum d^2 - \sum nd^2}{n}} = \sqrt{\frac{1.83 - 16.47}{9}} = -1.627$$

∴ SD(d) = - 1.627

$$SE(d) = \sqrt{\frac{(SD(d))^2}{n}} = \sqrt{\frac{-1.627^2}{9}} = 0.5423$$

$$\text{Test criterion (t)} = \frac{|\bar{d} - 0|}{SE(d)} = \frac{|0.373|}{0.5423} = 0.688$$

Degree ofr freedom (df) = n - 1 = 8, for 8 df ,

$t_{0.05}$ = -1.627

The calculated "t" is greater than $t_{0.05}$, this means that there is a statistical significant effect at 5% level of significance. The null hypothesis is rejected and it is concluded that there is an effect of animal metabolism on urban heat islands production.

To verify whether there is statistically significant relationship between the periods of the day and the effect of animal metabolism on urban heat island production, we use the chi-square test to investigate this using table 4 and the accompanying chat in fig. 4.

Table 4: Mean temperature readings (^{0}C) of the poultry farm and vegetative farm in Orji Imo State according to the period of the day.

Period	Poultry Farm	Vegetative Farm	Total
Morning	25.6	25.2	50.8
Afternoon	31.5	31.0	62.5
Evening	28.2	27.8	56.0
Total	85.3	84.0	169.3

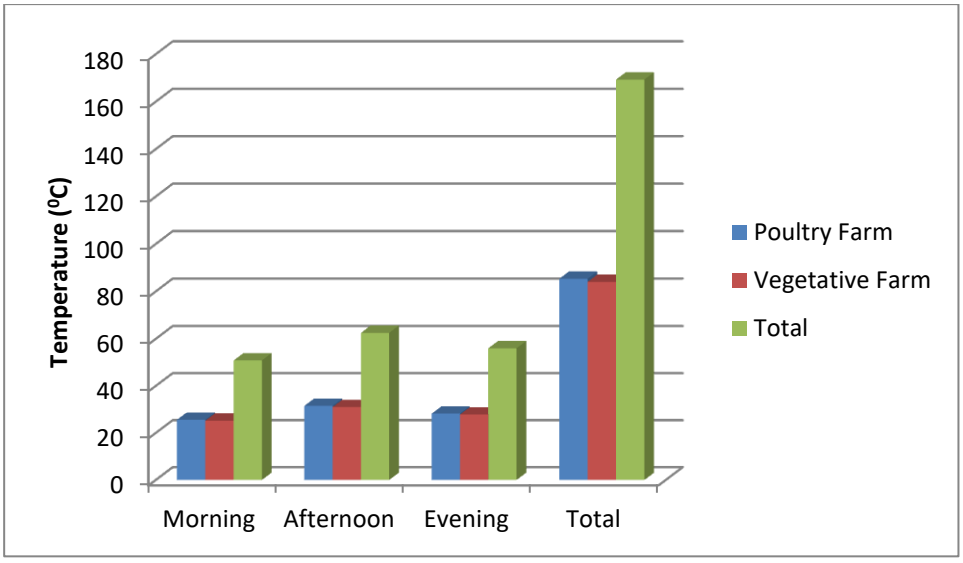

Fig 4: Mean temperature readings (^{0}C) chat of the poultry farm and vegetative farm according to the period of the day.

Statement of hypothesis:

H_0: There is no statistically significant relationship between the period of the day and the effect of animal metabolism on Urban Heat Island Production.

H_1: There is a statistically significant relationship between the period of the day and the effect of animal metabolism on urban heat island production.

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Computation:

$$E_{11}=\frac{50.8\ X\ 85.3}{169.3}=25.59 \qquad E_{12}=\frac{50.8\ X84}{169.3}=25.21$$

$$E_{21}=\frac{62.5\ X\ 85.3}{169.3}=31.44 \qquad E_{22}=\frac{62.5\ X\ 84}{169.3}=31.07$$

$$E_{31}=\frac{56\ X85.3}{169.3}=28.12 \qquad E_{32}=\frac{56\ X\ 84}{169.3}=27.72$$

Table 5: Chi – Square table

O	E	(0 - E)	$(0 - E)^2$	$\frac{(0 - E)^2}{E}$
25.6	25.59	0.01	0.0011	0.00004298
31.5	31.44	0.06	0.0036	0.0001145
28.2	28.12	0.08	0.0064	0.0002276
25.2	25.21	-0.01	0.0001	0.0000396
31.0	31.07	-0.07	0.0049	0.00015771
27.8	27.72	0.08	0.0064	0.00023088
				0.00077764

Degree of freedom df = (r-l)(c-l); df = 2

Level of significance = a = 0.05

From the table $x^2_{0.052} = 5.99$

Calculated f = 0.00077 is less than $x^2_{0052} = 5.99$. Hence the null hypothesis is not rejected and it is concluded that there is no statistically significant relationship between the period of the day and the effect of animal metabolism on urban heat island production.

4. CONCLUSION

The results obtained and analyzed showed that animal metabolism have significant effect on Heat Island Production. It was also observed that there is no statistical significant relation between the period of the day and the effect of animal metabolism on Heat Island Production. We as well conclude that Heat Island Production was more from poultry farm than in the vegetative farm, in all period of time, based on statistical evidence

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