CJPS COOU Journal of Physical Sciences 5 (1), 2022 COOU

USING THE MANN- WHITNEY U TEST NON-PARAMETRIC TOOL TO INVESTIGATE TEMPERATURE VARIATIONS IN BENIN METROPOLITAN CITY

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ABSTRACT
This study investigates variability in the micro climate of Benin Metropolis within the period of six years 1980-1985 and 2000 -2005 using temperature as the principal parameter. Secondary data obtained from the Nigerian Meteorological Agency Benin Airport and Nigerian Institute For Oil Palm Research (NIFOR) Benin, were subjected to Mann-Whitney U rank statistics to test for the significant variation. The result obtained showed that there were significant differences in the mean of temperature between 1980 — 1985 and 200-2005 (U = 32.000, SE = 4.233. p value = 0.002). It is recommended that,the public should be enlightened and educated by the regulatory authority regarding the danger of global warming by providing collaboration among all institutions and organization.

Keywords: Mann- Whitney U test, Non-parametric, Benin Metropolis.

INTRODUCTION

Weather, the day to day state of atmospheric conditions, consists of short term variation of energy and mass exchange within the atmosphere. The exchange results from processes that equalize differences in the distribution of net radiant energy from the sun and acting over an extended period of time. This exchange processes accumulate to become climate (Critchfield, 2015). Climate is the aggregate or synthesis weather of a given location for a period of time about (30 - 35 years). The climate of a particular region depends upon a number of factors; which include altitude, proximity of oceans, lakes and mountains (Areola et al, 2012)

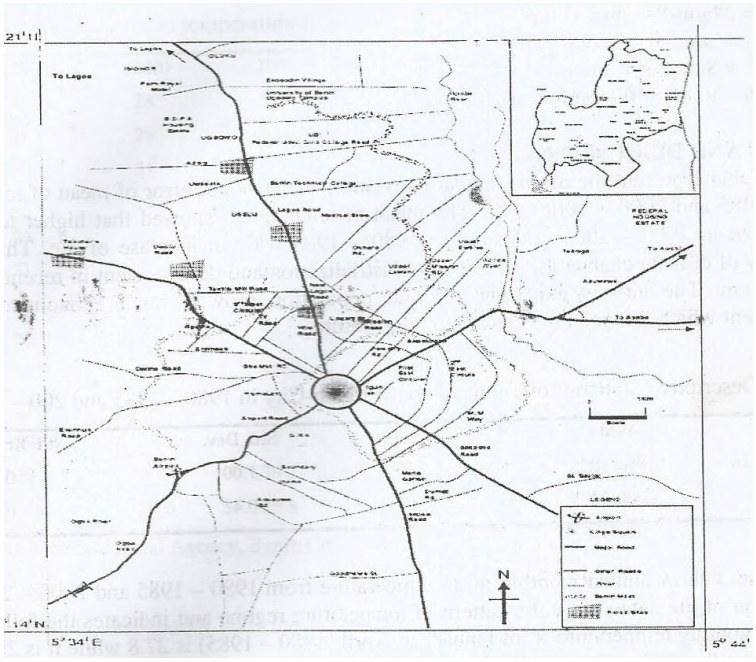
Temperature is an active factor in the physical environment of all living things. Its influence on human welfare range from immediate effects of weather events to complex responses associated with climate changes. Changes on a small scale are relatively easy to initiate and control, yet their cumulative effects locally and their possible extension to areas of larger scale are difficult to assess. Human beings have been modifying their micro climate environment ever since they first sought the shade of a tree, burnt a fire or fashioned a shelter (Barau, 2014). Temperature is one of the most important of atmospheric properties, but though our bodies are sensitive to it. Temperatures are quite unreliable because sometimes we feel so hot or cold depending on whether our body is conserving heat to maintain the internal temperature at about 37°c and which of these is happening and at any moment depends on exposures to sunlight, terrestrial radiation, wind, humidity and the time, size and temperature of the ambient air, (Gates, et al (2016).

The temperature at a given place and given time depends on the balance between the incoming and outgoing heat. Hence a consideration of heat balance provides a good physical basis for understanding the geographical pattern of temperature. Temperature is divided into two groups

i.e minimum and maximum temperature (Middleton, et al 2016). The aim of this study is to determine the annual variation in temperature within Benin Metropolis for a six year period of 1980 - 1985 and 2000 - 2005

THE STUDY AREA

Benin City is located at Latitude 06° 19' E to 6° 21^{J}E and longitude 5° 34^{L}E to 5° 44'E with an average elevation of 77.8m above sea-level. It is a pre-colonial city, the capital of defunct Bendel state and the present day Edo state. Benin City is underlain by sedimentary formation of the Miocene-Pleistocene-age often referred to as the Benin formation (Odemerho, 2018). The city is located in the humid tropical rainforest belt of Nigeria with a population of 1,496million according to the 2015 national population census with a projected population census with of 4.3 million by 2030 at 2.9% growth rate. Benin City belongs to AF category of Koppen's Climatic classification, (Ojo,et al. (2013)



RESEARCH METHODOLOGY

The data used in this study consist mainly of secondary data which have been fully documented by the Nigerian Meteorological Agency, Benin City, Airport and Nigerian Institute for Oil Palm Research Benin, Edo State. The data collected comprised of temperature (c) of year 1980 -1985 and 2000 - 2005. The data were grouped into months and years and analyzed for the following: The mean, Standard deviation, Variance and ranges for temperature, the trend of the parameters and differences or similarities within the parameters of climate during period of study were determined.

Mann-Whitney U test is a non-parametric analysis which involve variable that do not fit well into classification of dichotomous and continuous variable. Mann-Whitney U test is one of the

most powerful non-parametric tests for comparing two populations. It is used to test the null hypothesis that two populations have identical distribution functions against the alternative hypothesis. Mann -Whitney U test does not require the assumption that the differences between the two samples are normally distributed.

The Mann-Whitney U test is a non-parametric test for a between-subjects design using two levels of an independent variable and scores that are measured at least at the ordinal level. It is often used in place of the t test for independent groups when there is an extreme violation of the normality assumption or when the data are scaled at a level that is not appropriate for the t test. Mann-Whitney test are assumption - free test because they make fewer assumptions about the type of data on which they can be used.
The mean (ws) and the standard error (SEws) can easily be calculated.
The mean of Mann-Whitney test can be calculated using the equation below:

$\overline{WS} = \frac{n_1(n_1+n_2+1)}{2}$----------{1}
The standard error of Mann-Whitney test can be calculated using the equation below;

$$SW_{\overline{ws}} = \frac{n_1 n_2(n_1 + n_2 + 1)}{2} - - - - - - - - - - - - -\{2\}$$

Finally the Mann-Whitney test U can be calculated using the equation below
$\bar{U} = \frac{n_1 n_2+n_1(n_1+1)-R_i}{2}$ ----------{3)
where U = Mann-Whitney U test
n_1 = Sample size one
n_2 = Sample size two
R_i= Rank of the sample size

RESULT AND DISCUSSION
Table 1 presents the mean, standard deviation and standard **error** of mean of temperature from 1980 - 1985 and 2000 - 2005 in °c. The mean of temperature showed that higher temperature was experienced in 2000 - 2005 compared to 1980 - 1985 with an increase of 3°c. This could be the possibility of climate change as a result of industrialization and development in recent years in Benin Metropolitan. The city is experiencing high population growth, rapid economic and industrial development which brings in the change in temperature.

Table 1. Descriptive Statistics of Temperature of Benin-City in 1980-1985 and 200 - 2005

	Years	N	Mean	Std. Dey.	Std. Error. Mean
Temperature	1980-1985	6	26.95	1.00	0.410
	2000-2005	6	29.68	0.42	0.174

Table 2 and 3 show annual monthly mean temperature from 1980 - 1985 and 2000 - 2005 in °c: The examination of the data shows the pattern of temperature regime and indicates the following: Firstly, the mean monthly temperature from January to April (1980 - 1985) is 27.8 while it is 29.3°c in (2000-2005). Secondly, during the rainy period, mostly from June -

September, temperature is steady. Mean monthly temperature during these period of rainy season are 25.7° and 30.1°c in 1980 - 1985 and 2000 - 2005 respectively. This period is usually followed by the hot and dry season which last from March to mid-May. It is a period when inter tropical discontinuity runs through the region, which brings rainfall to the region.

Table 2: Annual monthly mean temperature from 1980-1985 in Degree centigrade (°c)

Months	1980	1981	1982	1983	1984	1985	Mean
January	27	26	26	27	27	27	26.9
February	28	27	28	28	27	27	27.5
March	29	28	29	29	27	28	28.3
April	28	28	29	28	29	28	28.5
May	27	27	28	27	28	27	27.3
June	26	27	27	26	26	26	26.3
July	25	26	26	25	25	25	25.3
August	26	25	26	26	26	25	25.6
September	26	25	25	26	26	26	25.6
October	27	27	27	27	27	27	27.0
November	28	28	28	28	28	28	28.0
December	26	\27	27	27	27	28	27.0
Mean	26.9	26.8	27.3	27.0	26.9	26.8	

Source: Nigerian Institute for Oil Palm Research (NIFOR) Benin

Table 3: Annual Monthly mean temperature from 2000 - 2005 in Degrees Centigrade (°c)

Months	2000	2001	2002	2003	2004	2005	Mean
January	29	28	28	29	29	28	28.5
February	28	29	30	31	29	30	29.5
March	30	31	31	30	30	29	29.5
April	28	28	29	30	31	20	29.3
May	29	30	31	29	30	31	30.0
June	31	31	31	30	29	29	30.2
July	30	31	29	30	31	31	30.3
August	29	.29	30	30	30	29	29.5
September	30	30	31	31	30	31	30,5
October	31	30	30	30	31	31	30.5
November	29	29	29	28	29	*29*	28.8
December	29	30	29	29	31	28	29.3
Mean	29.4	29.6	29.8	29.7	30.1	29.6	

Source: Nigerian Meteorological Agency, Benin City Airport.

Benin- City has its hottest month with mean monthly temperature reading of 28.5° in April 1980 -1985 and 30.5°c in the months of September and October for 2000 - 2005 respectively (Fig 2). The temperature is always high for most days of the month.

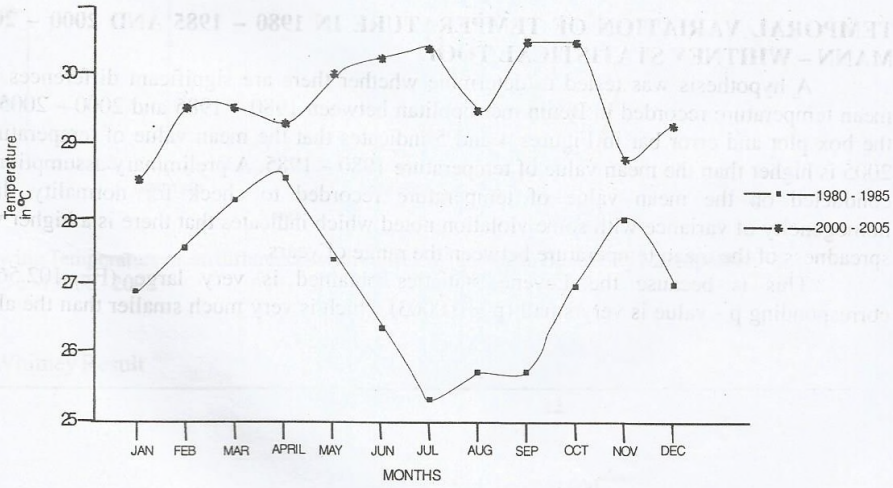
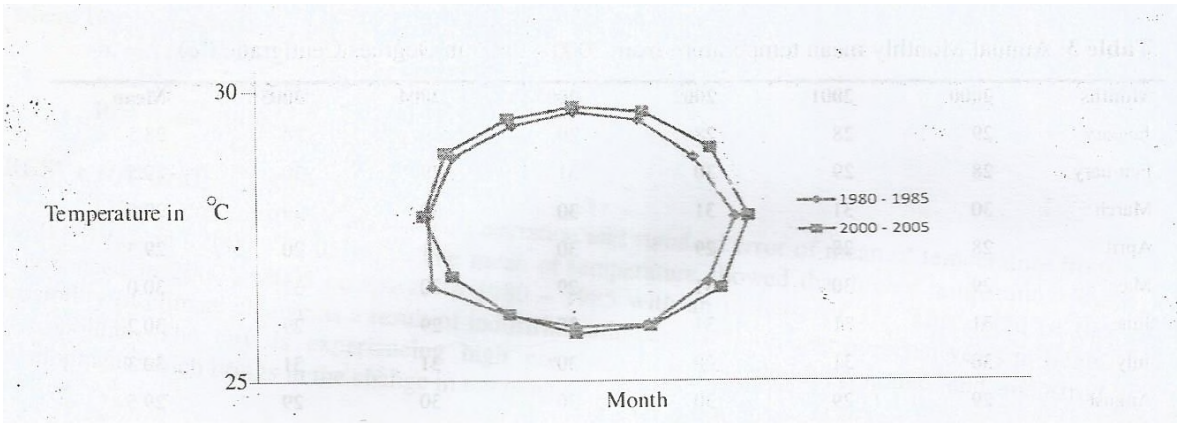


Figure 2 line graph showing temperature variation within Benin City Metropolitan between 1980 – 1985 and 2000 - 2005



Another important characteristic feature of temperature within Benin Metropolitan is that, inter-tropical convergence zone (ITCZ) moves southward and the mean monthly temperature decrease to a minimum of between 28.0°c in November to 27.0°c in December and 26.9°c in January 1980-1985 and 28.8°c in November to 29.3°c in December and 28.5°c in January 2000 - 2005 (Tables 2 and 3. This decrease and increase in temperature for the year under study show a kind of uniformity of temperature distribution.

Temperature is a more or less stable parameter as it did not fluctuate widely between 1980 - 1985 and 2000 - 2005 in the study area. The annual mean daily maximum temperature is highest in April and May of about 29°c while it is lowest in January with 26°c.

The coefficient of variation for the study period falls under normal variability because it did not exceed 30%. The standard deviation indicates that there is an appreciable amount of stability in the year of study and the range.between the year with the highest average amount of temperature and lowest amount of temperature did not exceed 2.8°c.

TEMPORAL VARIATION OF TEMPERATURE IN 1980 **- 1985 AND** 2000 - 2005 **USING** MANN **- WHITNEY STATISTICAL TOOL**

A hypothesis was tested to determine whether there are significant differences between the mean temperature recorded in Benin metropolitan between 1980 - 1985 and 2000 - 2005. A cheek at the box plot and error bar in Figures 4 and 5 indicates that the mean value of temperature in 2000 -2005 is higher than the mean value of temperature 1980 - 1985. A preliminary assumption testing was 'conducted on the mean, value of temperature recorded to check for normality, linearity and homogeneity of variance with some violation noted which indicates that there is a higher variability of spreadness of the mean temperature between the range of years.

This is because the Levene statistics obtained is very large (F= 102.566) and the corresponding p - value is very small (p = 0.0003) which is very much smaller than the alpha value

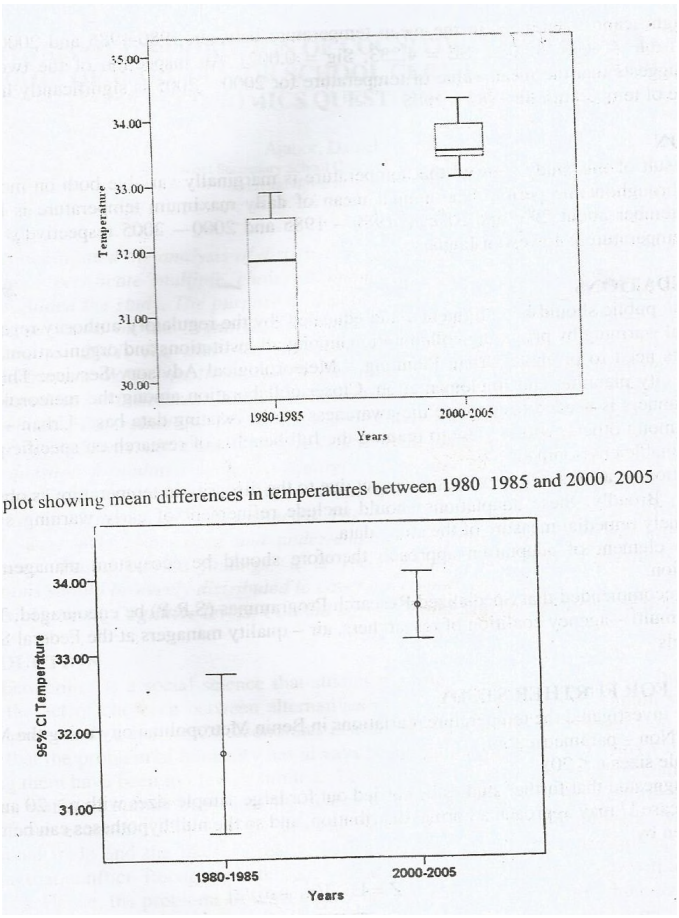


Fig. 5 Error bar showing Temperature mean differences with confident interval in Benin City Metropolitan Between l980 1985 and 2000-2005

Table 4: Mann-Whitney Result

Total	**N12**
Mann - Whitney u	32.000.
WilcoxonW	52.00
Test statistics	32.000
Standarderror	4.233
Standardized test Statistics	2.118
Asymptotic Sig (2 sided test)	0.004
Exact sig (2 sided test)	0.002

There were significant differences in the mean temperature between 1980-1985 and 2000- 2005 as presented in Table 4 (U = 32.000, SE = 4.233, Sig = 0.002). An inspection of the two mean of temperatures suggests that the mean value of temperature for 2000 - 2005 is significantly higher than the mean value of temperature in 1980 - 1985

CONCLUSION

The result of this study showed that temperature is marginally variable both on monthly and annual basis throughout the period. The annual mean of daily maximum temperature is highest in April and September about 29°c and 31°c in 1980 - 1985 and 2000 - 2005 respectively while the annual mean temperature is lowest in January.

RECOMMENDATIONS

That the public should be enlightened and educated by the regulatory authority regarding the danger of global warming by providing collaboration among all institutions and organizations

1. There is need to promote Urban Planning - Meteorological Advisory Service: This will be useful in city planning and implementation. Closer collaboration among the meteorologist and Urban planners is needed to increase the awareness on the existing data base, Urban - Weather Models among others, with a view to reaping the full benefits of research on specific problems and sustainable environment.
2. Adaptation measures will be very significant due to the disparity in temperature as observed in the study. Broadly, these adaptations should include refinement of early warning system to enable timely remedial measure of the study data.

A central element of adaptation approach therefore should be ecosystem management and conservation.

3. It is also recommended that Specialized Research Programmes (S.R.P) be encouraged. This will involve a multi - agency coalition of researchers, air - quality managers at the Federal State and Local levels

SUGGESTION FOR FURTHER STUDY

This study investigated the temperature Variations in Benin Metropolitan city using the Mann -Whitney U Test Non - parametric tool.
(For small sample sizes n < 20).
It is therefore suggested that further studies be carried out for large sample sizes with n > 20 and above, in which case U may approach a normal distribution, and so the null hypotheses can be tested by a Z - test given by

$$Z = \frac{U - [(\frac{n_1 + n_2}{2})]}{Standard\ deviation}$$

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