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Influence of Global Warming On Selected Climatic Variables in Port Harcourt and Its Environs Southern Nigeria

Okeke P.N., George D.M.C and Deki P.G

Department of Environment Management, Federal University of Technology, Owerri, Nigeria.

ABSTRACT: The effects of global warming on selected climatic variables in Port Harcourt and its environs, southern Nigeria were investigated. Data on temperature, rainfall and humidity for thirty-year period (1985-2014) were collected from the Nigerian Meteorological Agency (NIMET) at Port Harcourt and grouped into three decades of 1985-1994, 1995-2004, and 2005-2014. The data were further subjected to statistical analysis using Microsoft excel 2007 version. Results obtained disclosed that the maximum mean temperatures for the three decades were 27.43^{o}C, 28.64^{o}C and 32.11^{o}C for 1985-1994, 1995-2004 and 2005-2014, respectively. The rainfall values for the same periods were 335.81mm, 371.03mm and 382.56mm, respectively. Similarly, the maximum average humidity values were 90.0%, and 90.80% for the three decades, in that order. Although there were increases in the trends of the variables, only temperature showed significant difference. The changes in the average values and variability in the distribution patterns reveal that greenhouse gases (GHGs) – induced global warming impact on the climate indicators.

KEYWORDS: Global warming, GHGs, NIMET, Climate indicators, Port Harcourt.

I.INTRODUCTION

Global warming has become a major environmental issue in recent times; its occurrence has been discussed and debated by various individuals and establishments [1]; [2]; [3]; and [4]. The worldwide concern on this problem however came to the fore from the United Nations through its international conferences in Rio de Janeiro in 1992 [5], Kyoto in 1997 [6] and France in 2015 [7].

Past researchers ([8], [9] and [10]) explained global warming as natural or anthropogenic increase in average world temperature close to the earth surface. The term is interchangeably used with "Green house effect", or climate change [11] and [12]. Climate change, however occurs when there is a continuing change in climate over a period of time [13]. This time frame was given by World Meteorological Organization (WMO) as 30 years [13].

Port Harcourt and its environs are the hub of crude oil exploration and processing activities in Nigeria. Some of the natural gases extracted from the oil wells are flared into the air at a rate of approximately 70million m^3/day [14] or 17.2 billion m^3 per year [15]. This contributes the largest single source of greenhouse gas emission on the planet earth [16]. Greenhouse gases play important role in warming the earth surface. According to [17], human-induced warming has adverse impact on physical system.

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This study therefore investigated the effects of global warming on temperature, rainfall and humidity in the study area. These factors are indicators that increase if the world is warming [18]. In addition, knowledge of changes in these variables are important because of the significant impact they may have on the physical environment and socio-economic wellbeing of the affected communities.

II. MATERIALS AND METHODS

The study area is Port Harcourt and its environs in Rivers State, Nigeria. It is in the Southern part of the country (fig.1) and lies within the geographical coordinates $4^{0}47^{1}21$" North, $6^{0}59^{1}55$" East [19]. Port Harcourt features a tropical monsoon climate with lengthy and heavy rainy season coupled with short dry spell. There are various land use activities in Port Harcourt city which include industrial, commercial, residential etc that use fossil fuel extensively. Within the surrounding areas are oil refineries, oil flow stations and gas flaring activities that generate large volumes of greenhouse gases such as CO_2, CH_4, CFCs, SO_2, etc.

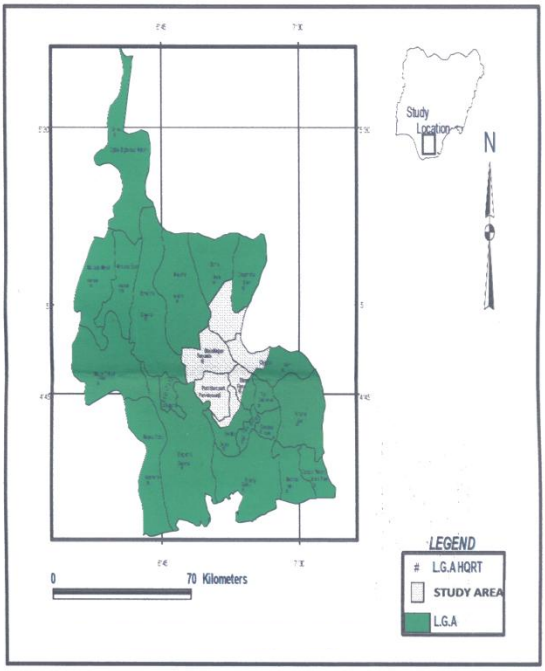

Figure 1: Map of the study area

A. Data Collection and Statistical Procedure

The rainfall, temperature and humidity data for the past 30 years (1995 – 2014) were collected from Nigerian Meteorological Agency (NIMET) in Port Harcourt. Data for each variable were grouped into ten-year intervals (1985-1994, 1995-2004 and 2005-2014). Microsoft excel 2007 version for statistical analysis was used to compute the descriptive statistics, ANOVA and also graphically present the results.

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III. RESULTS AND DISCUSSION

Tables 1, 2 and 3 show the results of the statistical analysis of the temperature data for 1985 – 1994, 1995 – 2004, and 2005 – 2014, respectively. Similarly, the rainfall values for the three decades are presented in tables 4, 5 and 6, in that order. The summary of the humidity values are shown in tables 7, 8 and 9 while the ANOVA for the three decades are indicated in tables 10, 11 and 12. Figures 2, 3 and 4 are the graphical presentations of the trends of temperature, rainfall and humidity values, respectively for the study periods.

Table 1: Descriptive statistics of temperature (^{O}C) for 1985 – 1994.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	27.43	27.29	27.29	26.73	26.35	25.32	25.91	25.7	26.03	26.57	27.22	27.19
SD	7.96	9.81	1.31	8.27	3.77	7.03	3.19	4.35	2.96	5.39	2.75	7.44

Where SD is standard deviation

Table 2: Descriptive statistics of temperature (^{O}C) for 1995-2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	27.67	28.47	28.64	28.23	27.71	26.68	26.09	26.04	26.08	25.40	27.42	28.49
SD	8.40	7.50	0.63	6.66	3.52	5.16	2.87	4.55	2.58	7.48	2.55	9.56

Table 3: Descriptive statistics of temperature (^{O}C) for 2005-2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	31.06	32.11	31.29	30.91	30.06	28.72	27.08	24.51	28.09	28.70	26.57	30.42
SD	2.57	2.53	0.03	2.56	1.26	2.39	1.04	1.51	0.93	2.32	0.89	2.43

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Table 4: Descriptive statistics of rainfall (mm) for 1985-1994

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	25.63	70.7	106.94	168.95	276.63	335.81	328.15	192.53	343.37	253.02	82.32	26.21
SD	22.96	39.51	41.29	63.25	63.80	96.87	92.73	107.80	115.43	79.12	47.12	41.02

Table 5: Descriptive Statistics of rainfall (mm) for 1995 – 2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	24.64	47.49	96.92	169.1	261.91	269.7	360.89	293.86	371.03	262.66	104.93	20.79
SD	29.05	40.84	8.33	63.10	22.88	77.28	25.85	100.30	105.67	120.96	59.80	13.49

Table 6: Descriptive Statistics of rainfall (mm) for 2005 – 2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	15.50	45.96	107.30	153.40	242.73	275.83	382.56	364.52	340.97	221.16	83.70	16.68
SD	29.72	38.31	62.52	61.36	16.51	106.55	94.70	93.57	89.58	61.11	34.40	21.60

Table 7: Descriptive statistics of humidity (%) for 1985 – 1994

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	74.3	78.4	81.3	84.3	86.9	89.1	90.0	89.9	89.8	88.6	85.8	78.3
SD	7.42	4.45	2.10	1.57	2.67	1.91	2.24	0.99	2.08	1.07	1.94	3.71

Table 8: Descriptive statistics of humidity (%) for 1995 – 2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	76.0	74.0	80.2	84.0	85.7	88.0	90.3	89.9	90.0	88.1	85.3	80.3
SD	4.24	6.84	1.84	1.00	2.63	0.89	2.29	1.10	2.04	0.83	1.89	2.97

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Table 9: Descriptive Statistics of humidity (%) for 2005 – 2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	75.4	76.1	81.7	83.6	85.8	87.6	90.8	90.6	89.9	88.3	85.6	79.5
SD	6.31	6.33	3.43	1.26	0.79	0.97	1.48	1.26	0.88	1.34	2.71	2.88

Table 10: ANOVA table of temperature for 1985 - 2014

Source of variation	SS	df	MS	F	P-Value	F-Crit
Between group	41.74034	4	10.43508	4.230531	0.001567	2.6786671
Within group	76.46503	31	2.466614			
Total	**118.2054**	**35**				

Table 11: ANOVA table of rainfall for 1985 - 2014

Source of variation	SS	df	MS	F	P-Value	F-Crit
Between group	132.1975	4	33.64938	0.001843	0.9999928	2.6786671
Within group	556000.1	31	17935.49			
Total	**556132.3**	**35**				

Table 12: ANOVA table of humidity for 1985 - 2014

Source of variation	SS	df	MS	F	P-Value	F-Crit
Between group	1.02921	4	0.257304	0.0081292	0.999861	2.678667
Within group	981.2096	31	31.6519246			
Total	**982.23881**	**35**				

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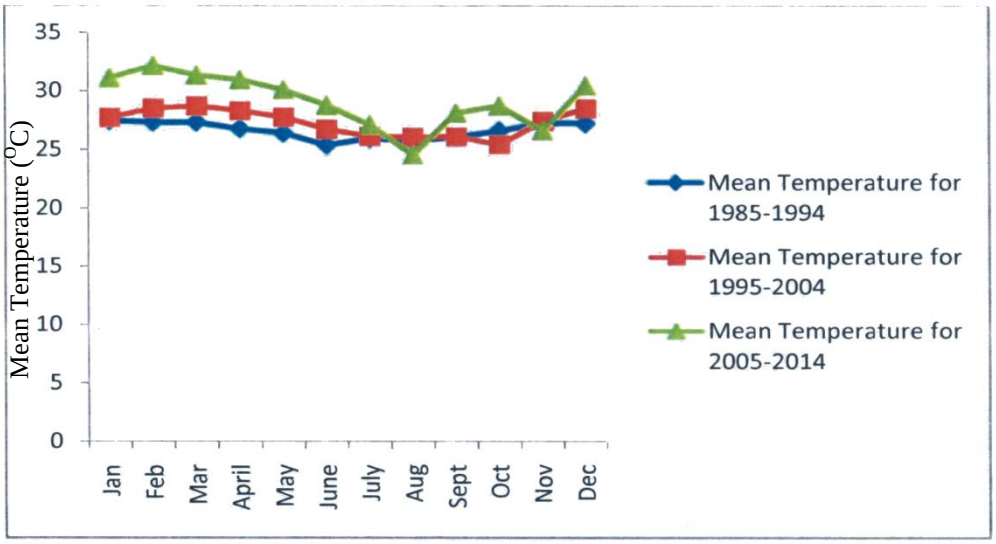

Figure 2: Graph Showing Mean Temperature Values for 1985-1994, 1995-2004, and 2005-2014

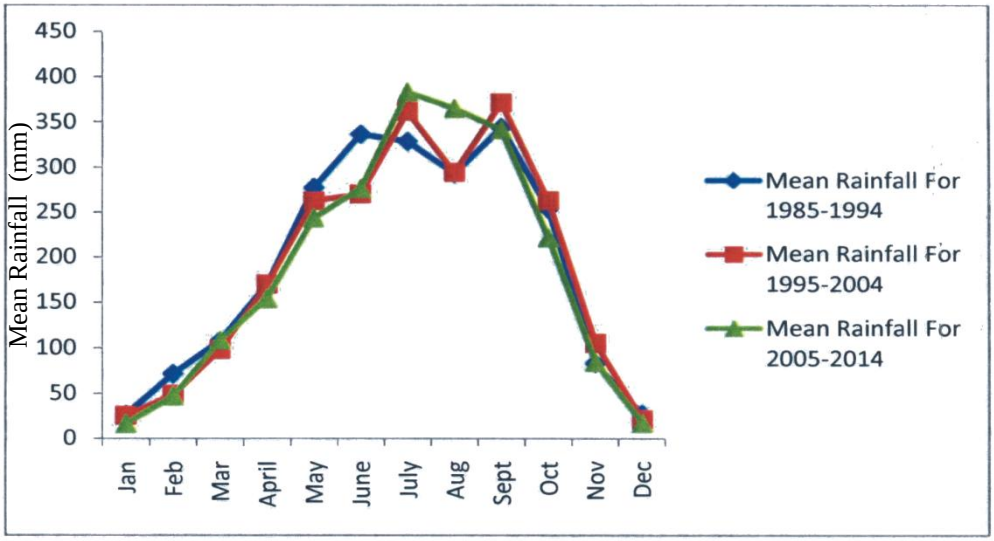

Figure 3: Graph Showing Mean Rainfall Values for 1985-1994, 1995-2004, and 2005-2014

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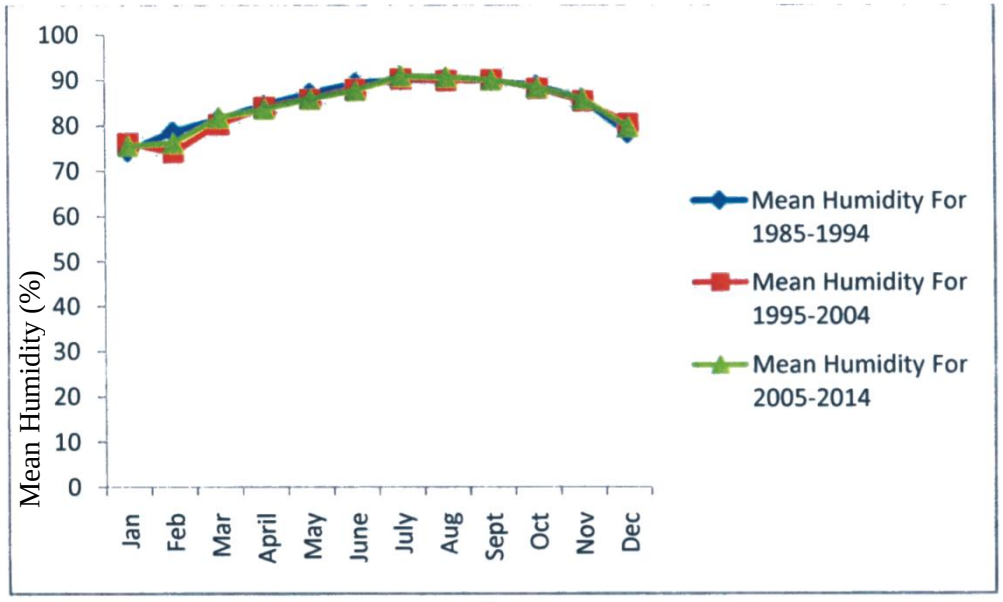

Figure 4: Graph Showing Mean Humidity Values for 1985-1994, 1995-2004, and 2005-2014

From table 1, the maximum mean temperature of 27.29^{0}C was recorded in March and it decreased to the lowest value of 25.32^{O}C in June. In the second decade, the mean maximum value increased to 28. 64^{0}C and was experienced in February. This decreased to 25.40^{0}C in October. Table 3 shows that the mean maximum temperature further increased to 32.11^{0}C in February and also decreased to 24.51^{0}C in August.

The rainfall data in table 4 indicate that the highest value was 342.37mm and was experienced in September while the lowest was 25.63mm and was recorded in January. Similarly, from 1995 to 2004 the highest mean rainfall value of 371.03mm was in September which decreased to 20.79mm in December. Between 2005 and 2014, the mean rainfall value increased to 382.56mm in July while the lowest value of 15.50mm was obtained in January.

Table 7 indicates that the first decade of the study period had the highest average humidity value (90.0%) in July and the lowest (74.3%) in January. From 1995 to 2004 the highest average value increased marginally to 90.30% and was experience in July. The lowest value during this period was 74.00% in February. Within the last decade of 2005 to 2014, the highest average humidity value increased further to 90.80% in July while the lowest mean value of 75.40% was in January. The ANOVA analysis in tables 10 -12 indicate that only temperature showed significant difference in its values in the three decades since F (4.23053) is greater than F-critical (2.6786671).

From the results there were changes in the values of the climate indicators, and also variability in their distribution patterns which according to [20], characterize climate change. The temperature, rainfall and humidity records presented in figures 2, 3 and 4, respectively show increases in trend and variations in periods of occurrence from 1985 to 2014. This agrees with the most notable prediction of the Atmospheric Scientists in their complex computer model (General Circulation Model or GCMS) that increased GHGs would lead to an increased variability of such climate factors as average global temperature, precipitation, etc [11]. The findings also support the report in [22] that global warming had increased on average, rain and snowfall worldwide. Similarly, [21] linked emission of GHGs as the major culprit in these changes.

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IV. CONCLUSION

The temperature, rainfall and humidity data analysis in this study indicate that the climatic factors varied within the 1985 to 2014 period. There were increases in the mean values of the variables although only temperature showed significant difference. Changes in their distribution patterns were also observed. The findings further goes to corroborate the scientific agreement that climate change is occurring and anthropogenic activities are forcing it. Gas flaring which is the underlying cause of this climatic effect in the study area should be controlled to avoid more serious climate extreme such as flooding that is occasionally experienced in Port Harcourt city.

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