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Research article

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Spatial Variability of Lower Tropospheric Visibility and Meteorology of Urban centers in Nigeria

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Abstract
The study analyzed the spatial variability of atmospheric visibility and meteorological parameters over selected cities in Nigeria. This study employed the use of secondary data which includes a 36 years (1982-2017) visibility, rainfall, relative humidity, windspeed and temperature data which was gotten from the weather register of the selected meteorological stations. Descriptive statistics, analysis of variance (ANOVA) and student t-test were employed in the analysis of data. Research findings revealed that revealed that the coastal cities witnessed better visibility than the northern part of the study area especially during the dry season. The Analysis of Variance (ANOVA) revealed statistically significant variation in visibility, temperature, rainfall, relative humidity and windspeed at 95% probability level across the selected locations. The student t-test statistics also revealed that a statistically significant difference in visibility, rainfall, windspeed and relative humidity occurs between the wet and dry seasons in most of the selected cities. The study recommends that awareness campaigns and enlightenment programmes be undertaken by various meteorological authorities and other relevant government agencies to improve the awareness of members of the public on the need to adhere strictly to weather alerts and warning systems.

Keywords: Atmospheric Visibility, Variability, Air Pollutants, Meteorological Parameters, Suspended Particulates

Introduction

Troposphere air consists of microscopic particles at varying concentrations, clouds, dry aerosols such as air pollutants, smoke dust as well as hydrometers such as snow and other forms of precipitation which reduces visibility [1]. Many studies revealed that fine particles such as ammonium sulfate, ammonium nitrates, organic matter, elemental carbon, and soil dust dominated the light absorption and scattering and thus effectively reduced the visual range [2]. The optical properties of the fine particles, for example, the mass absorption efficiency, have large spatial and temporal variability and depend on the sources they were emitted from [3]. Furthermore, visibility could be affected by meteorological parameters such as rainfall, temperature, relative humidity and windspeed. Favourable weather conditions contribute significantly to the emission and local circulation of dust aerosols especially in the northern part of Nigeria [4].

Visibility impairment has become a major public concern in most metropolises in Nigeria, especially in North-Eastern Nigeria. Atmospheric visibility reduction could be as a result of weather phenomena such as fog, precipitation, haze, mist and dust that are associated with lithometeor and hydrometeor [5]. Seasonal and diurnal variations in atmospheric visibility and spatial trends have stimulated various academic researches.

Urban areas in Nigeria have witnessed declining atmospheric visibility attributed to meteorological conditions and lower wind speeds as a result of urban area expansion and tall high-density buildings. Dust aerosols constantly transported from the Sahara desert may persist in atmosphere due to favourable weather conditions subsequently leading to poor visibility. Visibility is a proven indicator of ambient air quality. Its deterioration signifies adverse health effects in humans and decreases the efficiency of our transportation systems [6]. In Nigeria, it has been revealed that low visibility has unpropitious effects on traffic safety, human health and the economy in general [4].

More recently, the city of Port Harcourt has continually witnessed a rapid decline in atmospheric visibility occasioned by 'black soot pollution'. However, despite government efforts aimed at reducing anthropogenic activities which cause pollution, prevailing atmospheric conditions has continued to influence a decline in atmospheric visibility most metropolitan cities in Nigeria. Therefore, pertinent questions regarding the spatial and seasonal variability of atmospheric visibility as well as what these mechanisms are, have elicited some levels of awareness from researchers, policy makers and the general public. It is on this premise that this research was undertaken to ascertain the spatial and seasonal variability of atmospheric visibility over selected cities in Nigeria.

Methodology

The study was carried out in Nigeria located in West Africa along the Atlantic Ocean's Gulf of Guinea. Nigeria lies between longitudes 2°49'E – 14°37'E and latitudes 4°16'N – 13°52'N. (Figure 1).

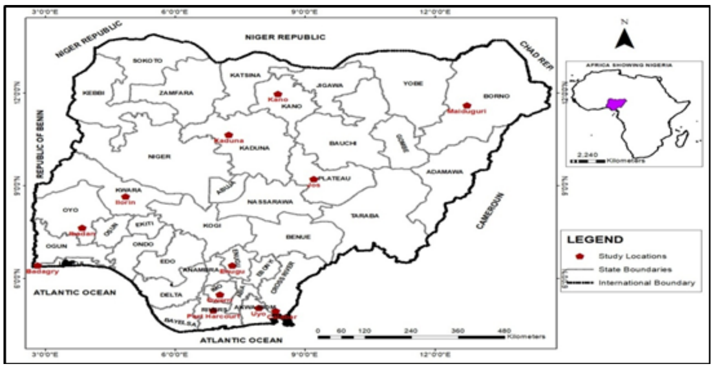

Figure 1: Map of Nigeria depicting the study areas

It is bounded on the North by the Republic of Niger, East by Cameroon and West by Benin Republic while the Southern boundary is Gulf of Guinea which is an arm of the Atlantic Ocean [7]. The southern part of Nigeria experiences heavy abundant rainfall which is usually above 2,000mm (78.7 in) rainfall totals. The coastal regions of the southern part such as the Niger Delta region witnesses rainfall above 4,000mm(157.5 in) of rainfall annually while the rest of the south-eastern Nigeria experiences rainfall values between 2,000 and 3,000mm (118.1 in) of rain per year [8]. Rainfall total in central Nigeria ranges from 1,100 mm (43.3 in) in the lowlands of the river Niger Benue trough to over 2,000 mm (78.7 in) along the Jos Plateau. Rainy season in the Northern part of Nigeria begins in June and ends in September while the rest of the year is hot and dry with high temperature values of 40°C [9]. Nigeria is characterized by three vegetation types: forests, savannahs and montane land [10].

Secondary data was utilized in this study which include a thirty-six years (1982-2017) rainfall, visibility, windspeed, relative humidity and surface air temperature data which was gotten from NIMET stations in the selected cities. Purposive sampling technique was deployed to select the cities in the different ecological regions of Nigeria. The major factor which influenced selection of the cities was the age of the meteorological stations. The selected cities include Badagry, Calabar, Enugu, Ibadan, Ilorin, Jos, Kaduna, Kano, Maiduguri, Owerri, Port Harcourt and Uyo. The computer software known as Statistical Package for Social Sciences (SPSS), version 22 was deployed for the statistical analysis. The Analysis of Variance (ANOVA) was used to analyze the spatial variation of visibility and other meteorological parameters across the selected cities in the study area. To ascertain if a statistically significant difference in visibility and meteorological parameters exists over the wet and dry season, the student t-test was deployed. Spatial variability maps for visibility, rainfall, temperature, relative humidity and windspeed from 1982-2017 were generated using inverse distance weighted (IDW) interpolation technique in ArcGis 10.5.

Results

Spatial Variation of Visibility, Temperature, Relative Humidity, Windspeed and Rainfall

Results of the spatial analysis of visibility for year 1982 are presented in Figure 2. The lowest values in the legend represent areas with low visibility while high values indicate high atmospheric visibility condition. From the analysis, marked variation in visibility exists over the selected cities. The spatial variability of visibility in 1982 showed that the visibility was lower towards the South eastern part around Enugu, Uyo and Calabar which ranged between 6,917.14m and 13,164.0m.

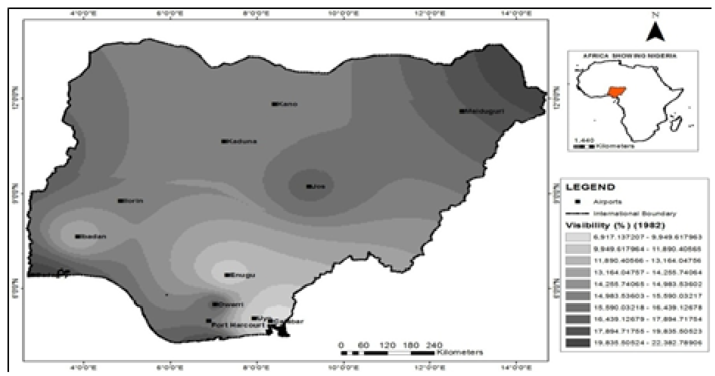

Figure 2: Spatial Analysis of Visibility for 1982

Results of the spatial analysis of visibility for year 2017 are presented in Figure 3. The spatial variability of visibility in 2002 showed that the visibility of Ilorin and Ibadan was within similar range while the visibility of Kaduna, Maiduguri and Owerri also witnessed similar visibility conditions. As shown in the figure below, the least visibility values from the range of 3956.52m to 7991.19m were recorded in Enugu and Calabar.

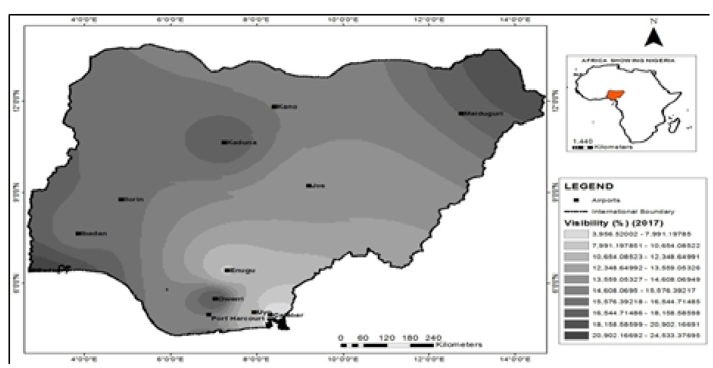

Figure 3: Spatial Analysis of Visibility for 2017

Results of the spatial analysis of temperature for year 1982 are presented in Figure 4. The city of Jos recorded lowest temperature values. The temperature of the city of Kaduna and Kano were higher than the temperature of the city of Jos while the highest temperature value was recorded in the city of Ibadan.

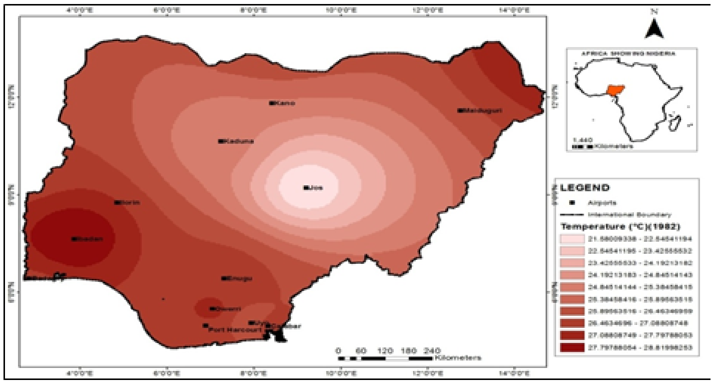

Figure 4: Spatial Analysis of Temperature for 1982

Results of the spatial analysis of temperature for year 2017 are presented in Figure 5. The lowest values in the legend indicate areas with low temperature while high values represent high temperature. The city of Jos recorded lowest temperature values. The temperature of the city of Kano was higher than the temperature of the city of Jos closely followed by Kaduna and Maiduguri. Calabar, Ilorin, Owerri, Port Harcourt and Uyo fell within the same temperature range while the highest temperature value was recorded in the city of Ibadan, Badagry and Enugu.

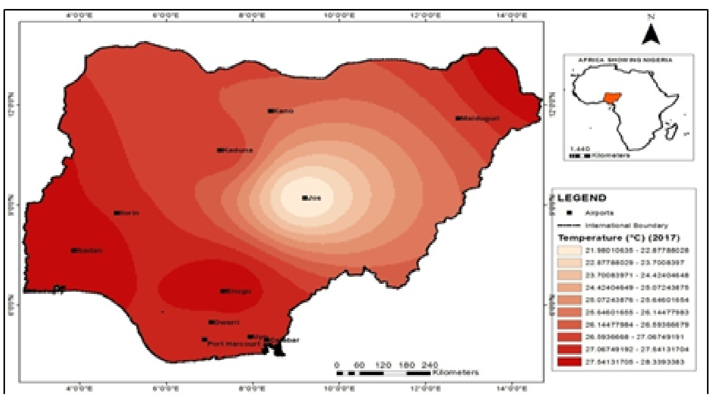

Figure 5: Spatial Analysis of Temperature for 2017

Results of the spatial analysis of rainfall for year 1982 are presented in Figure 6. The lowest values in the legend represent areas with low rainfall while high values indicate high rainfall. From the analysis, marked variation in rainfall exists over the study area. The spatial variability of rainfall in 1982 showed that the rainfall was higher towards the southern cities of Calabar, Owerri, Port Harcourt and Uyo. Rainfall reduced towards the northern part of the study area with the city of Maiduguri witnessing the lowest rainfall values.

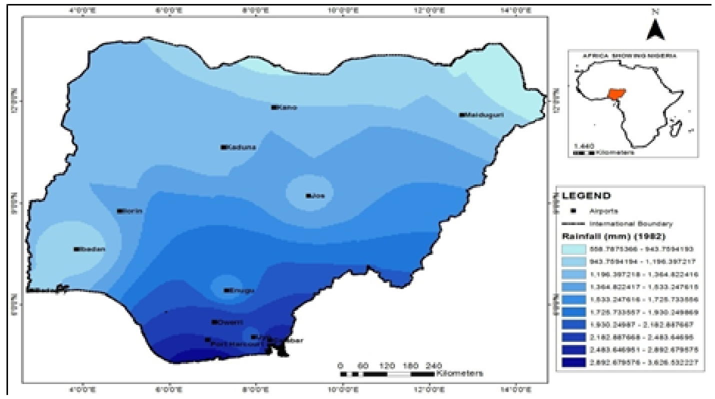

Figure 6: Spatial Analysis of Rainfall for 1982

Results of the spatial analysis of rainfall for year 2017 are presented in Figure 7. The lowest values in the legend represent areas with low rainfall while high values indicate high rainfall. From the analysis, marked variation in rainfall exists over the study area. The spatial variability of rainfall in 2017 revealed that the rainfall was highest in the southern cities while the northern cities however witnessed lower rainfall values. Port Harcourt, Uyo and Calabar witnessed highest rainfall values. Owerri, Enugu, Ibadan and Badagry had slightly lower rainfall values while Kano and Maiduguri had the least rainfall values.

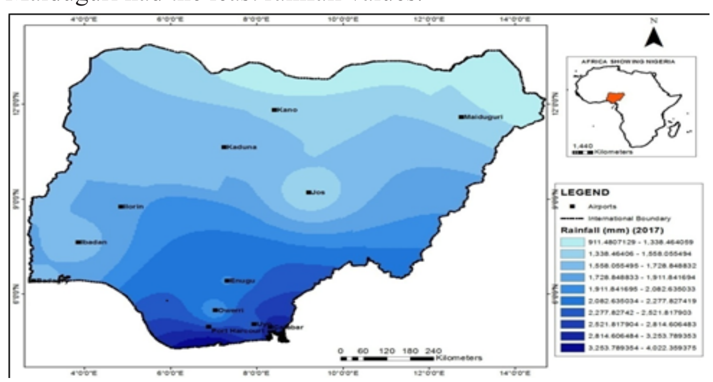

Figure 7: Spatial Analysis of Rainfall for 2017

Results of the spatial analysis of relative humidity for year 1982 are presented in Figure 8. The lowest values in the legend represent areas with low relative humidity while high values indicate high relative humidity condition. From the analysis, marked variation in relative humidity exists over the selected cities. The spatial variability of relative humidity in 1982 showed that the relative humidity was highest towards the southeastern states of Uyo and Calabar which ranged between 84.84% and 91.81%. However, the relative humidity around Port Harcourt, Badagry and Ibadan were slightly lower ranging between 75.42% and 79.26%. Furthermore, the relative humidity around Kano, Kaduna and Maiduguri was the least with values ranging between 53.81% and 57.64%

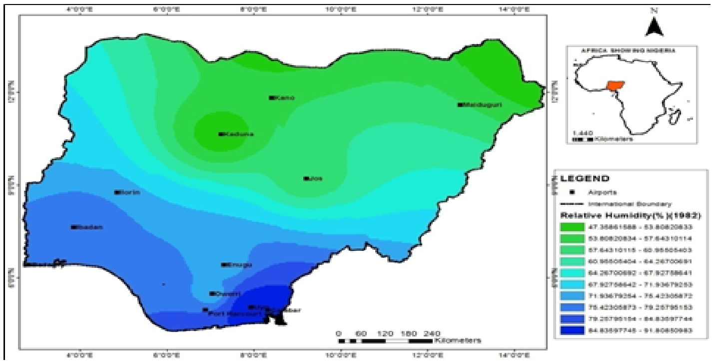

Figure 8: Spatial Analysis of Relative Humidity for 1982

Results of the spatial analysis of relative humidity for year 2017 are presented in Figure 9. The lowest values in the legend represent areas with low relative humidity while high values indicate high relative humidity condition. From the analysis, marked variation in relative humidity exists over the selected cities. The spatial variability of relative humidity in 2017 showed that the relative humidity was highest towards the southeastern state of Calabar and Uyo and lowest in the city of Kaduna.

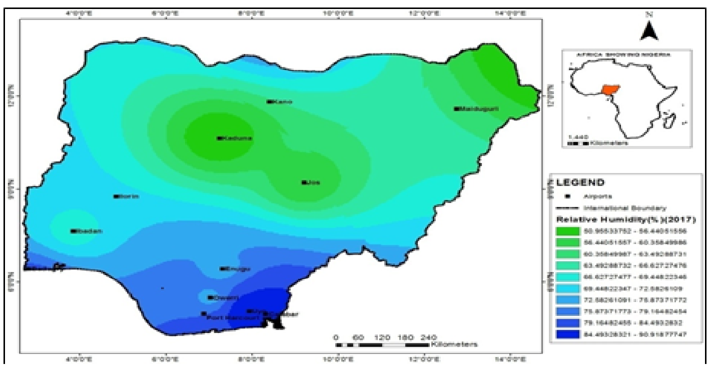

Figure 9: Spatial Analysis of Relative Humidity for 2017

Results of the spatial analysis of windspeed for year 1982 are presented in Figure 10. The lowest values in the legend represent areas with low windspeed while high values indicate high windspeed. From the analysis, marked variation in windspeed exists over the selected cities. The spatial variability of windspeed in 1982 showed that the windspeed was highest at Jos while the lowest windspeed was witnessed in Ibadan.

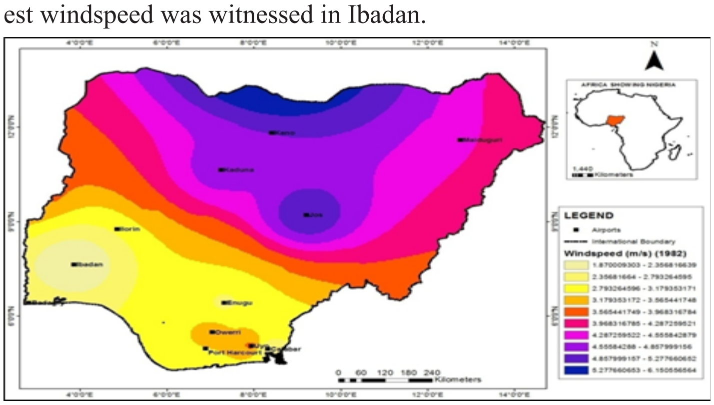

Figure 10: Spatial Analysis of Windspeed for 1982

Results of the spatial analysis of windspeed for year 2017 are presented in Figure 11. The lowest values in the legend represent areas with low windspeed while high values indicate high windspeed. From the analysis, marked variation in windspeed exists over the selected cities. The spatial variability of windspeed in 2017 showed that the windspeed was highest at Jos. The windspeed decreased southwards with Ibadan, Badagry and Enugu recording the least windspeed. Furthermore, the spatial windspeed around Owerri and Uyo was similar while generally, the windspeed in the Southern part of the study area was the least.

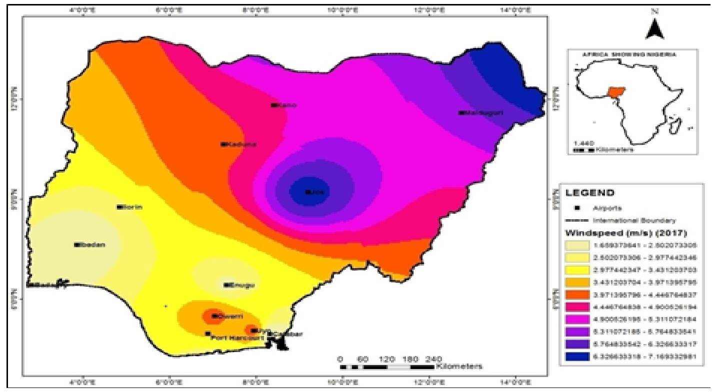

Figure 11: Spatial Analysis of Windspeed for 2017

Table 1 presents the analysis of variance for visibility, temperature, rainfall, relative humidity and windspeed across cities where it is revealed that F calculated for visibility across all the stations was 88.515 and the p value was 0.000. Since the p value was less than 0.05 significant levels, the null hypothesis (Ho1) is rejected and the alternate hypothesis is upheld. Thus, the study revealed a statistically significant variation in visibility across the selected cities.

In the analysis of temperature, the F calculated for temperature across all the stations was 245.644 and the p value was 0.000. Since the p value was less than 0.05 significant levels, the null hypothesis (Ho) is rejected. Thus, the study revealed a statistically significant variation in temperature across the selected cities.

In the analysis of rainfall, F calculated for rainfall across the selected stations was 112.376 and the p value was 0.000. Similarly, since the p value was less than 0.05 significant levels, the null hypothesis (Ho) is rejected. Thus, the study revealed a statistically significant variation in rainfall across the selected cities.

In the analysis of relative humidity, F calculated for relative humidity across the selected stations was 426.468 and the p value was 0.000. In the same vein, since the p value was less than 0.05 significant levels, the null hypothesis (Ho) is rejected. Thus, the study revealed a statistically significant variation in relative humidity across the selected cities.

In the analysis of windspeed, F calculated for windspeed across the selected stations was 164.080 and the p value was 0.000. Since the p value was less than 0.05 significant levels, the null hypothesis (Ho) is rejected. Thus, the study revealed a statistically significant variation in windspeed across the selected cities.

Table 1: Analysis of Variance (ANOVA) for Visibility, Temperature, Rainfall, Relative Humidity and Windspeed across Cities

		Sum of Squares	df	Mean Square	Sig.	Sig.
Temperature	Between Groups		10	135.059	245.644	.000
	Within Groups	231.472	421	.550		
	Total	1582.061	431			
Rainfall	Between Groups	325920893.000	10	32592089.300	112.376	.000
	Within Groups	122101611.007	421	290027.580		
	Total	448022504.007	431			
Relative Humidity	Between Groups	74348.061	10	7434.806	426.468	.000
	Within Groups	7339.472	421	17.433		
	Total	81687.533	431			
Visibility	Between Groups	7318823033.541	10	731882303.354	88.515	.000
	Within Groups	3481015395.859	421	8268445.121		
	Total	10799838429.400	431			
Windspeed	Between Groups	739.582	10	73.958	164.080	.000
	Within Groups	189.764	421	.451		
	Total	929.346	431			

Seasonal Characteristics of Visibility, Temperature, Relative Humidity, Windspeed and Rainfall

Result of the spatial analysis of temperature for the wet season is presented in Figure 12. The lowest values in the legend represent areas with low temperature while high values indicate high atmospheric temperature. From the analysis, marked variation in temperature exists over the selected cities. The spatial variability of temperature in the wet season revealed that temperature was highest in Maiduguri. Kaduna and Kano witnessed similar temperature value. In the same vein, the temperature of Ibadan and Ilorin were similar in the wet season while Jos witnessed the least temperature during the wet season.

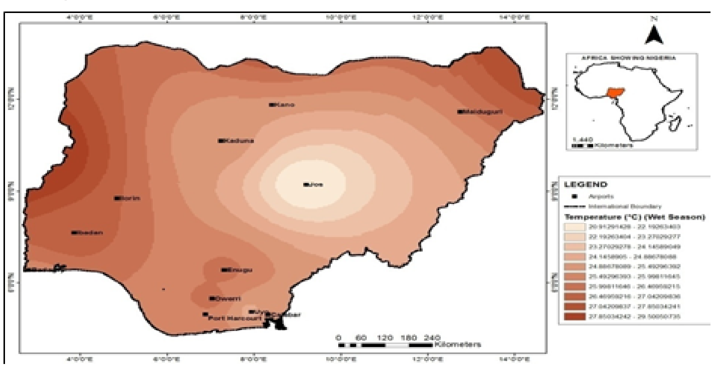

Figure 12: Variability of Temperature in the Wet Season

Results of the spatial analysis of temperature for the dry season are presented in Figure 13. The lowest values in the legend represent areas with low temperature while high values indicate high atmospheric temperature. From the analysis, marked variation in temperature exists over the selected cities. The variability of temperature in the dry season revealed that temperature was highest in Ibadan. Kaduna and Kano witnessed similar temperature value. In the same vein, the temperature of Ilorin, Enugu, Port Harcourt, Uyo and Calabar were similar while Jos witnessed the least temperature during the dry season.

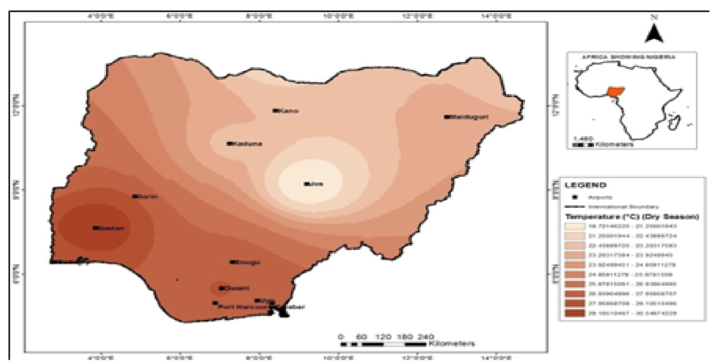

Figure 13: Variability of Temperature in the Dry Season

Results of the spatial analysis of rainfall for the wet season are presented in Figure 14. The lowest values in the legend represent areas with low rainfall while high values indicate high rainfall. From the analysis, marked variation in rainfall exists over the selected cities. The variability of rainfall in the wet season revealed that temperature rainfall increased towards the southern part of the study area and was highest in Calabar . Generally, rainfall decreased towards the northern part of Nigeria in the wet season. However, the least rainfall was recorded in the city of Ibadan, Badagry and Enugu during the wet season.

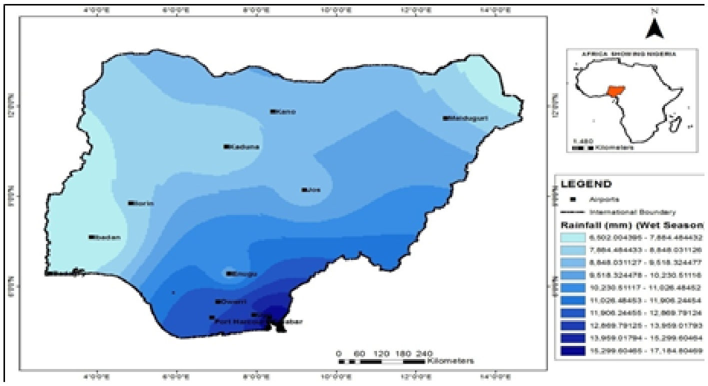

Figure 14: Variability of Rainfall in the Wet Season

Results of the spatial analysis of rainfall for the dry season are presented in Figure 15. The lowest values in the legend represent areas with low rainfall while high values indicate high rainfall. From the analysis, marked variation in rainfall exists over the selected cities. The variability of rainfall in the wet season revealed that temperature rainfall increased towards the southern part of the study area and was highest in Calabar and Owerri. The northern part of the study witnessed lesser rainfall values with Kano, Kaduna and Jos witnessing the least rainfall during the wet season.

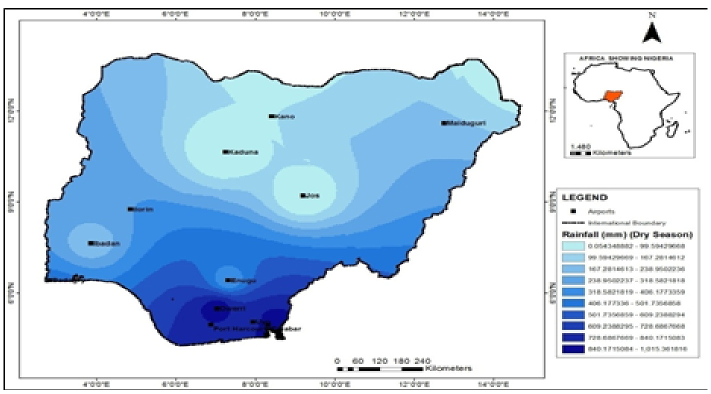

Figure 15: Variability of Rainfall in the Dry Season

Results of the spatial analysis of relative humidity for the wet season are presented in Figure 16. The lowest values in the legend represent areas with low relative humidity while high values indicate high relative humidity. From the analysis, marked variation in relative humidity exists over the selected cities in the wet season. The variability of relative humidity in the wet season revealed that relative humidity increased towards the southern part of the study area and was highest in Calabar. The northern part of the study witnessed lesser relative humidity values with Maiduguri witnessing the least relative humidity during the wet season.

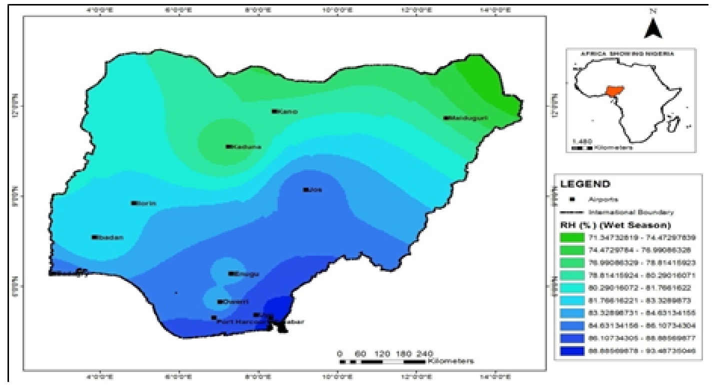

Figure 16: Variability of Relative Humidity in the Wet Season

Results of the spatial analysis of relative humidity for the dry season are presented in Figure 17. The lowest values in the legend represent areas with low relative humidity while high values indicate high relative humidity. From the analysis, marked variation in relative humidity exists over the selected cities in the dry season. The variability of relative humidity in the dry season revealed that relative humidity increased towards the southern part of the study area and was highest in Calabar. The northern part of the study witnessed lesser relative humidity values with Kaduna and Jos witnessing the least relative humidity during the wet season.

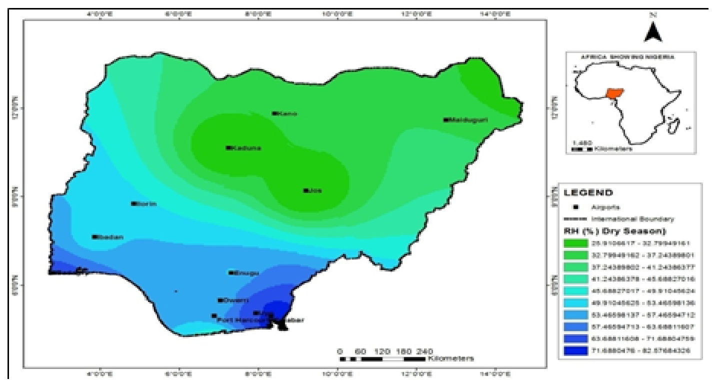

Figure 17: Variability of Relative Humidity in the Dry Season

Results of the spatial analysis of visibility for the wet season are presented in Figure 18. The lowest values in the legend represent areas with low visibility while high values indicate high visibility. From the analysis, marked variation in visibility exists over the selected cities in the wet season. The variability of visibility in the wet season revealed that visibility decreased towards the southern part of the study area and was lowest in the city of Calabar. Visibility was highest in the city of Kaduna, Badagry and Maiduguri

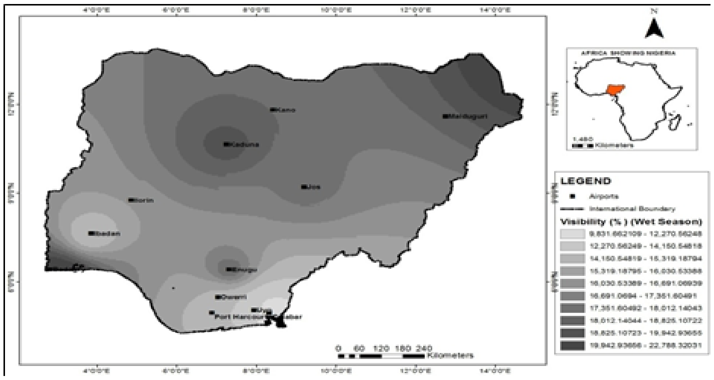

Figure 18: Variability of Visibility in the Wet Season

Results of the spatial analysis of visibility for the dry season are presented in Figure 19. The lowest values in the legend represent areas with low visibility while high values indicate high visibility. From the analysis, marked variation in visibility exists over the selected cities in the dry season. Generally, the variability of visibility in the dry season revealed that visibility decreased southwards while increasing northwards. Visibility was lowest in Uyo, Enugu and Ibadan while the highest values were recorded in the city of Badagry.

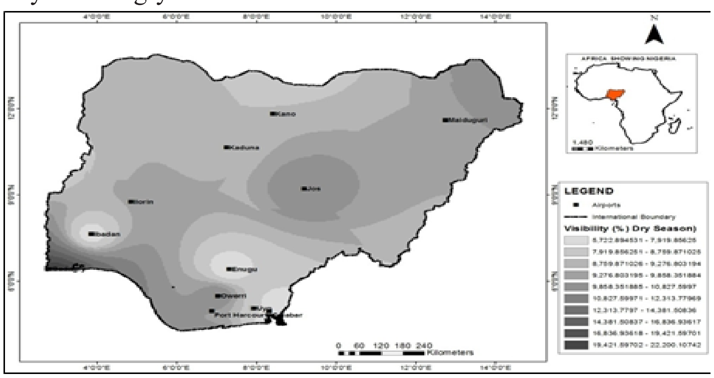

Figure 19: Variability of Visibility in the Dry Season

Results of the spatial analysis of windspeed for the wet season are presented in Figure 20. The lowest values in the legend represent areas with low windspeed while high values indicate high windspeed. From the analysis, marked variation in windspeed exists over the selected cities in the wet season. The variability of windspeed in the wet season revealed that windspeed was lowest in the city of Ibadan and was highest in the city of Jos.

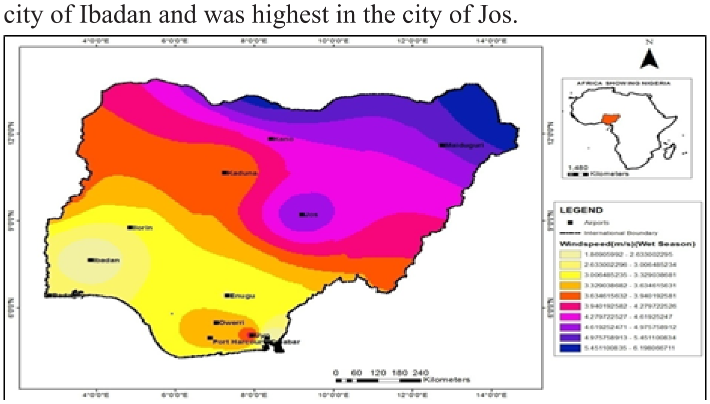

Figure 20: Variability of Windspeed in the Wet Season

Results of the spatial analysis of windspeed for the dry season are presented in Figure 21. The lowest values in the legend represent areas with low windspeed while high values indicate high windspeed. From the analysis, marked variation in windspeed exists over the selected cities in the dry season. Generally, the variability of windspeed in the dry season revealed that windspeed was lowest in Badagry and Ibadan and highest in the city of Jos.

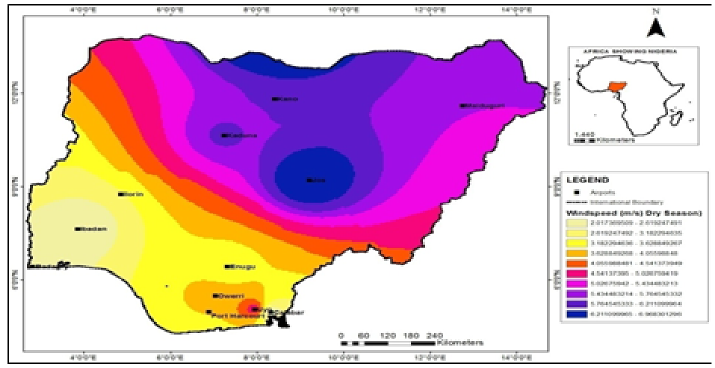

Figure 21: Variability of Windspeed in the Dry Season

Table 2 reveals the student t-test value values of visibility, temperature, rainfall, relative humidity and windspeed between wet and dry seasons. In the city of Badagry, the t-test value of 0.336 which was greater than the p-value of 0.05 implies that the null hypothesis is accepted. Therefore, there exists no statistically significant difference in visibility between the wet and dry seasons. On the other hand, the t-test values of 0.000 for rainfall, temperature, relative humidity and windspeed implies a statistically significant difference in rainfall, temperature, relative humidity and windspeed between the wet and dry season in Badagry. In the city of Calabar, Jos, Kaduna and Uyo, the t-test values of 0.000 for visibility, rainfall, temperature, relative humidity and windspeed implies a statistically significant difference in visibility rainfall, temperature, relative humidity and windspeed between the wet and dry season in Calabar. The city of Enugu recorded t-test values of 0.047 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. Since these values were less than 0.05. The null hypothesis is rejected and the alternate hypothesis is upheld. This implies a statistically significant difference in visibility, rainfall, temperature, relative humidity and windspeed between the wet and dry season in Enugu. The city of Ibadan recorded t-test values of 0.04 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. Since these values were less than 0.05. The null hypothesis is rejected and the alternate hypothesis is upheld. This implies a statistically significant difference in visibility, rainfall, temperature, relative humidity and windspeed between the wet and dry season in Ibadan. The city of Ilorin recorded t-test values of 0.215 for temperature while the t-test values for visibility, rainfall, windspeed and relative humidity was 0.000. This implies that the difference in temperature between the wet and dry season in Ilorin was not statistically significant. However, there exists a statistically significant difference in visibility, rainfall, relative humidity and windspeed between the wet and dry season in Ilorin. The city of Kano recorded t-test values of 0.01 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. Since these values were less than 0.05. The null hypothesis is rejected and the alternate hypothesis is upheld. This implies a statistically significant difference in visibility, rainfall, temperature, relative humidity and windspeed between the wet and dry season in Kano. The city of Maiduguri recorded t-test values of 0.05 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. This implies a statistically significant difference in visibility, rainfall, temperature, relative humidity and windspeed between the wet and dry season in Maiduguri. The city of Owerri recorded t-test values of 0.354 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. This implies that the difference in windspeed between the wet and dry season in Owerri was not statistically significant since the p-value of 0.354 was greater than the critical value of 0.05. However, there exists a statistically significant difference in visibility, rainfall, relative humidity and temperature between the wet and dry season in Ilorin as the p-value of 0.000 was less than the critical value of 0.05. The city of Port Harcourt recorded t-test values of 0.475 for windspeed while the t-test values for visibility, rainfall, temperature and relative humidity was 0.000. This implies that the difference in windspeed between the wet and dry season in Ilorin was not statistically significant since the p-value of 0.475 was greater than the critical value of 0.05. However, there exists a statistically significant difference in visibility, rainfall, relative humidity and temperature between the wet and dry season in Port Harcourt as the p-value of 0.000 was less than the critical value of 0.05.

Table 2: Student t-test values of Visibility, Temperature, Rainfall, Relative Humidity and Windspeed between Wet and Dry Seasons

S/No	Cities	Visibility	Rainfall	Temperature	Relative Humidity	Windspeed
1	Badagry	0.336	0.000*	0.000*	0.000*	0.000*
2	Calabar	0.000*	0.000*	0.000*	0.000*	0.000*
3	Enugu	0.000*	0.000*	0.000*	0.000*	0.047*
4	Ibadan	0.000*	0.000*	0.000*	0.000*	0.004*
5	Ilorin	0.000	0.000*	0.215	0.000*	0.000*
6	Jos	0.000*	0.000*	0.000*	0.000*	0.000*
7	Kaduna	0.000*	0.000*	0.000*	0.000*	0.000*
8	Kano	0.000*	0.000*	0.000*	0.000*	0.001*
9	Maiduguri	0.000*	0.000*	0.000*	0.000*	0.005*
10	Owerri	0.000*	0.000*	0.000*	0.000*	0.354
11	Port Harcourt	0.000*	0.000*	0.000*	0.000*	0.475
12	Uyo	0.000*	0.000*	0.000*	0.000*	0.000*

*Significant at 0.05% probability level

Discussion of findings

Research findings from the analysis reveal spatial variability of visibility, rainfall, temperature, relative humidity and windspeed. Analysis of variance revealed that F calculated for visibility, temperature, rainfall, relative humidity and windspeed across all the stations was 88.515, 245.644, 112.376, 426.468 and 164.080 respectively. The p value of 0.000 for visibility, rainfall, temperature, relative humidity and windspeed implies that a statistically significant spatial variation exist across the selected cities. The finding of this research is in tandem to the research findings of [11]. Who in their study revealed statistically significant spatial variation of visibility across locations.

The study also revealed that the rainfall and relative humidity were higher in southern part of the study area. It was also revealed that the coastal cities witnessed better visibility than the northern part of the study area especially during the dry season. The southern cities of Badagry, Enugu, Ibadan, Ilorin and Port Harcourt experienced higher wind speed values during the wet season while the northern cities of Kaduna, Kano and Maiduguri recorded higher wind speed values during the dry season The findings of this research agrees with the findings of [12]. Who in their study revealed that rainfall and relative humidity were higher in the coastal areas even as the coastal areas witnessed better visibility.

The study also established no statistically significant difference in windspeed between seasons in the city of Owerri and Port Harcourt. Similarly, the study revealed no statistically significant difference in visibility and temperature between seasons in the city of Badagry and Ilorin respectively. However, the research findings indicated that the study revealed a statistically significant difference in visibility, rainfall, temperature, windspeed and relative humidity between the wet and dry seasons for the cities of Uyo, Maiduguri, Kano, Kaduna, Jos, Ibadan, Enugu and Calabar. The finding of this study is in consonance to the findings of [13]. Who in their study of the effects of harmattan dust (aerosols) on visibility over the city of Bauchi, revealed significant statistical difference in visibility and other meteorological parameters between the wet and dry seasons.

Conclusion

The study was able to establish spatial variability of visibility, rainfall, temperature, relative humidity and windspeed across the selected study locations from1982-2017. The rainfall pattern across the selected cities revealed statistically significant variation across the selected cities. Moreso, the study established that there is marked variation in temperature across the selected cities. In the same vein, the study also revealed statistically significant variation in visibility, relative humidity and windspeed across the selected cities. The study is therefore in affirmation to the spatial variation of visibility, rainfall, temperature, relative humidity and windspeed. Furthermore, the study has provided evidence of seasonal variation in visibility, temperature rainfall, relative humidity and windspeed in the study area.

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