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The Effects of Dry Season Induced Air Pollutants Concentrations in Eleme, Rivers State, Nigeria.

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Abstract: *Air quality assessment was carried out to evaluate dry season status of air pollution concentrations in the study area. The results obtained around Eleme area indicated that the mean concentrationof SO_2 exceeded permissible limits in the dry season; the mean concentration ofNO_2 also exceeded the Federal Ministry of Environment(FMEnv) and National Ambient Air Quality Standards (NAAQS) limits.The mean value of H_2S was 1.87±1.01ppm, similarly, the mean value of VOCswas 6.82±3.51. The mean concentration of CO exceeded stipulated limits. The mean value of ammonia was 5.98±3.53ppm; also the mean value of methane was 7.5±6.91ppm in the dry season. Furthermore, the dry seasonmean concentration of TSP and $PM_{2.5}$ far exceeded both FMEnv and NAAQS limits. Also, the dry season mean concentrations of PM_{10} exceeded NAAQS limit. The research revealed the prevalent air pollutants and the sampling points with high pollution concentrations that may affect the publicin the study area.*

Keywords:*Air pollutants concentrations, Induced, Dry season, Effects,Air pollution.*

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I. Introduction

The high concentration levels of air pollutants have been shown to have wide-ranging negative effects on human health and the environment. The adverse impact of air pollution in Nigeria is alarming (Okecha, 2000; Efe, 2005; Emmanuel *et al.,* 2009; Gobo *et al.,* 2012 and Antai, *et al.,* 2016). Deterioration of soil, material and buildings decay, living organism and vegetation damages including degradation of environment are the evidence of the presence of these air pollutants.

This research studied the concentrations of air pollutants of Eleme Local Government Area. This research work will benefit the authorities concerned in many ways such as formulation of new policies, reduction of public health risks and protection of the environment, that will help to reflect the actions taken to help mitigate and abate the effects of climate change, promotion of good environment for economic activities, reduction of community agitations, ensuring of good climatic conditions for crops and other bio-entities to thrive and ensuring of sustainable development.

Based on the direct derivation from the alarming air pollution, this research entails the present dry season air quality status of Eleme Local Government Area.

Aim of the Study

The research aim is to evaluate the concentration levels of air pollutants as it is influenced by dry season factors.

II. Materials And Methods

Selection of Sapling Sites

A total number of seven (7) sampling points were selected in Eleme Local Government Area using WHO's (2005) guideline for site selection studies for population density, topography, industrial clusters, and heavy traffic. The sampling points are shown in Fig.1.

All the sampling points selected were geo-referenced using GPS model 76Cx Garmin Global Positioning System. The air pollutants were measured *in-situ* with the use of Air Quality meters.

Field observations were carried out visually and recorded in the field notebook. Camera was used to take photographs to show evidence of important features and activities that may be the primary sources of the air pollutants.

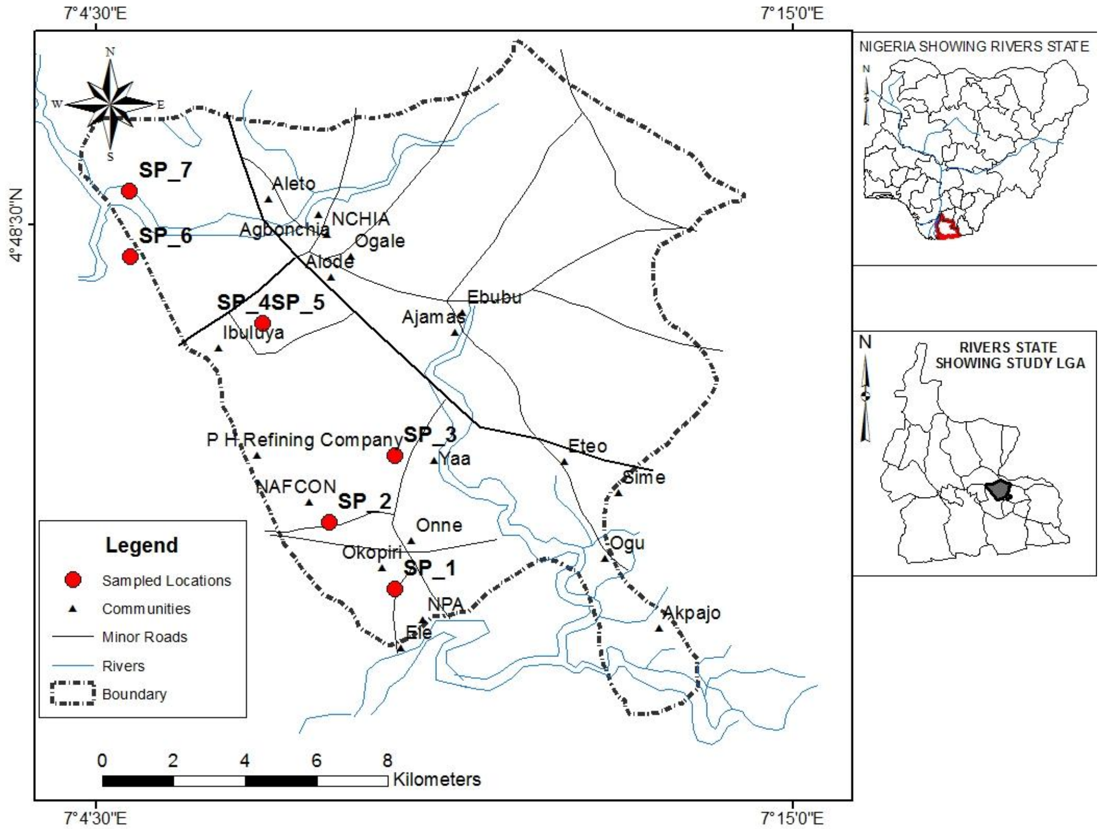

Figure 1: Eleme showing Sampling Points of the Study Area

III. Presentation Of Results

Air Quality Assessment of Eleme Area

Concentrations of Sulphur Dioxide (SO_2) in Eleme Area

Results (shown in Figure2) obtained in the dry season showed that concentrations of sulphur dioxide ranged from 1.0ppm to 1.77ppm with mean deviation of 1.18±0.29ppm. The dry seasons mean values exceeded both the Federal Ministry of Environment (FMEnv) and National Ambient Air Quality Standards (NAAQS) permissible limits of 0.1ppm and 0.14ppm respectively. This might be as a result of industrial activities in Eleme area.

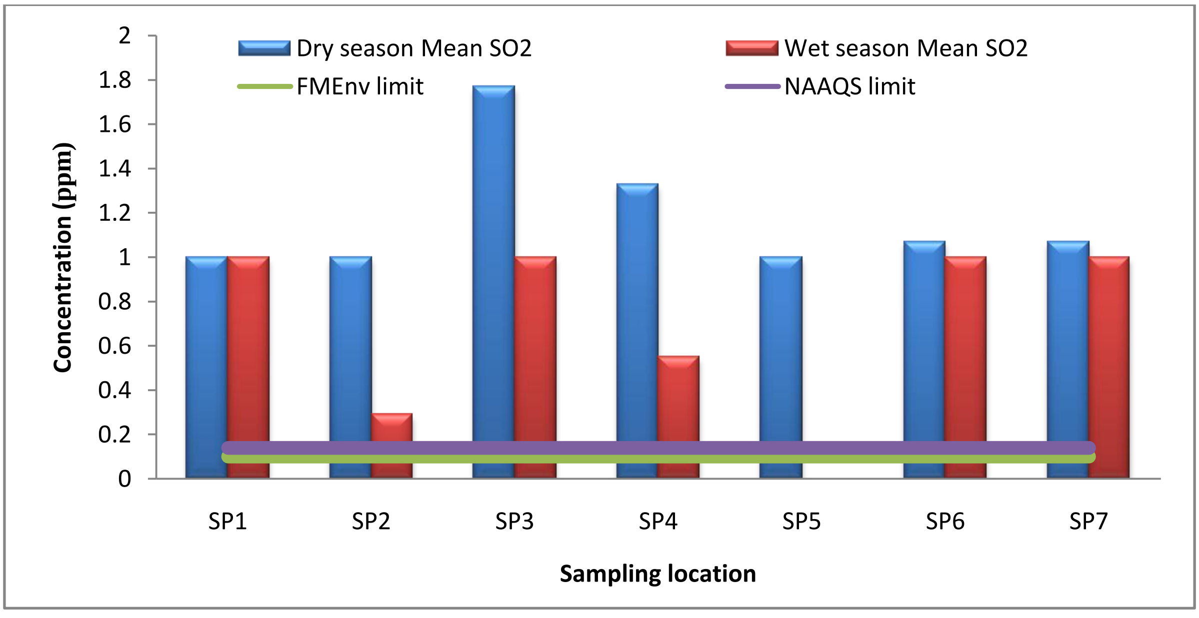

Figure 2: Concentrations of Sulphur Dioxide in Eleme Area

Concentrations of Nitrogen Dioxide (NO_2) in Eleme Area

Field results (shown in Figure 3) obtained in the dry season showed that concentrations of nitrogen dioxide ranged from 0.33ppm to 1.23ppm with mean deviation of 0.89±0.30ppm. The mean values exceeded both the FMEnv and NAAQS limits in the dry seasons. This might be caused by industrial activities in Eleme area. Concentration levels of NO_2 in Eleme area in the dry season are shown in Figure 3.

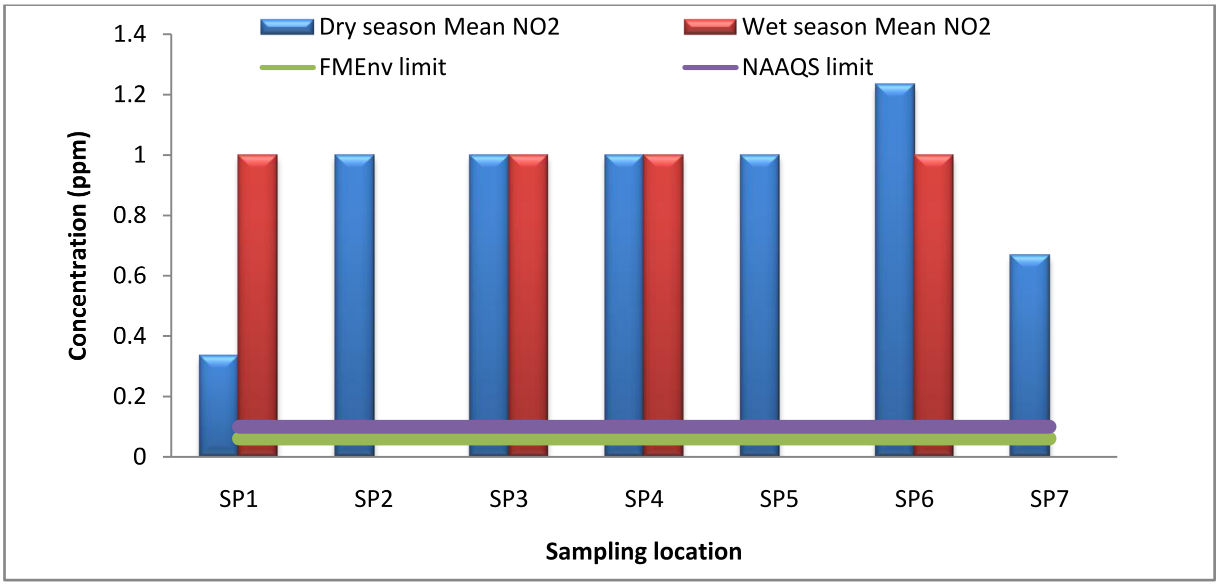

Figure 3: Concentrations of Nitrogen Dioxide in Eleme Area

Concentrations of Hydrogen Sulphide(H_2S) in Eleme Area

The concentrations of H_2S (Figure 4) obtained in Eleme area in the dry season ranged from 0.67ppm to 3.67ppm with a mean deviation of 1.87±1.01ppm;.

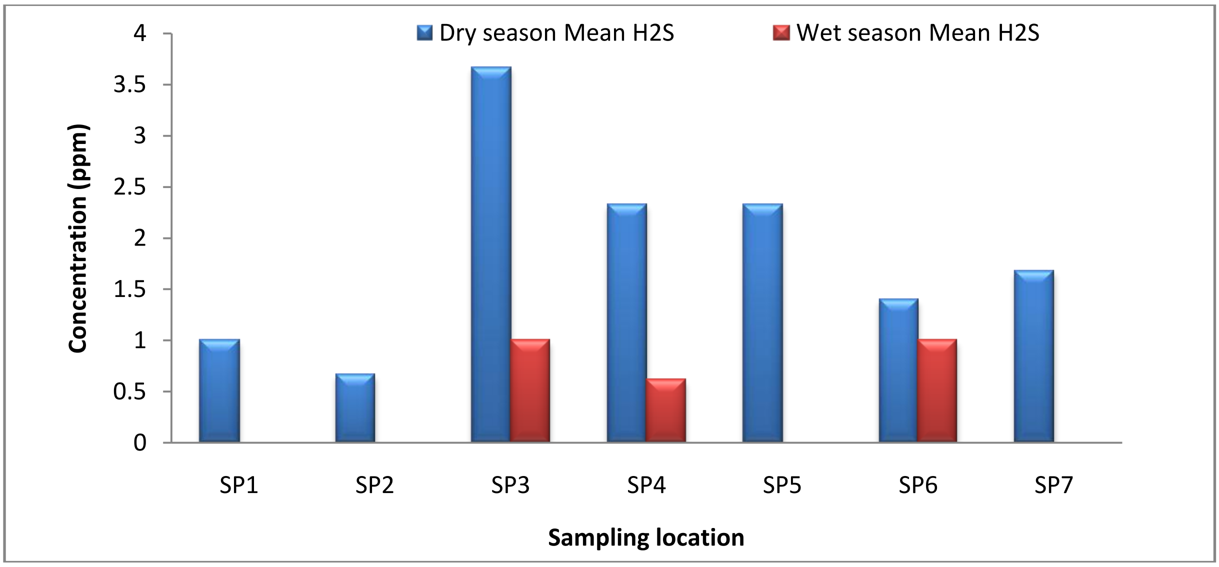

Figure 4: Concentrations of Hydrogen Sulphide in Eleme Area

Concentrations of Volatile Organic Compounds (VOCs) in Eleme Area

VOCsConcentrations (Figure 5) measured in the Eleme area in the dry season ranged from 2.73ppm to 12.67ppm with a mean deviation of 6.82±3.51ppm. Concentrations levels of VOCs obtained in Eleme area in the dry seasonare shown in Figure 5.

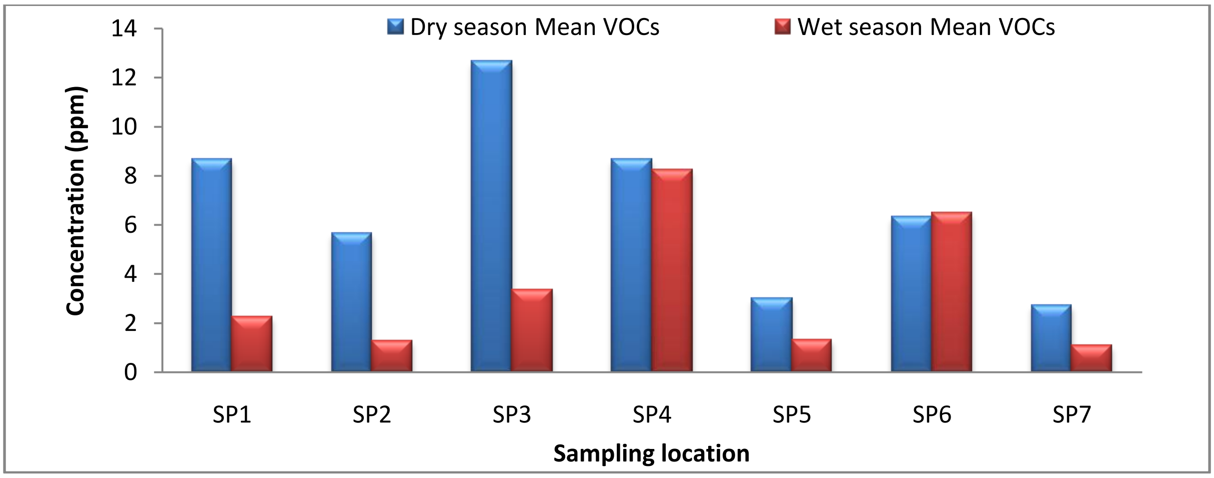

Figure 5: Volatile Organic Compounds Concentration Measured in Eleme Area

Concentrations of Carbon Monoxide (CO) in Eleme Area

The dry season CO concentrations ranged from 9.0ppm to 31.0ppm with a mean deviation of 21.06±10.48ppm. The mean value exceeded the FMEnv and NAAQS limits in the dry season. Concentrations of CO measured in Eleme area in the dry season are shown in Figure 6.

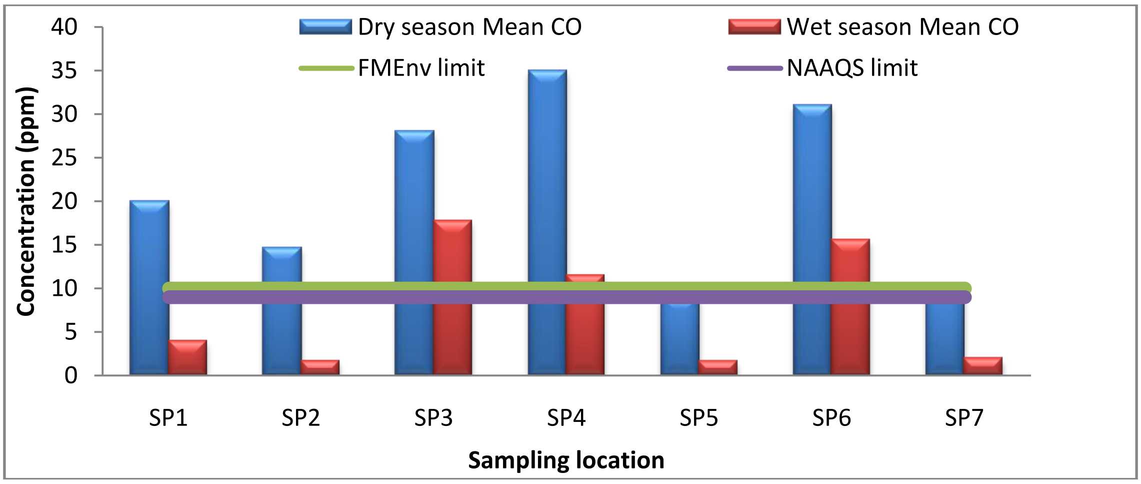

Figure 6: Concentrations of Carbon Monoxide in Eleme Area

Concentrations of Ammonia (NH_3) in Eleme Area

The concentrations of ammonia measured in the dry season ranged from 2.07ppm to 10.87ppm with a mean deviation of 5.98±3.53ppm. The dry season concentrations of NH_3 measured in the Eleme area are shown in Figure 7.

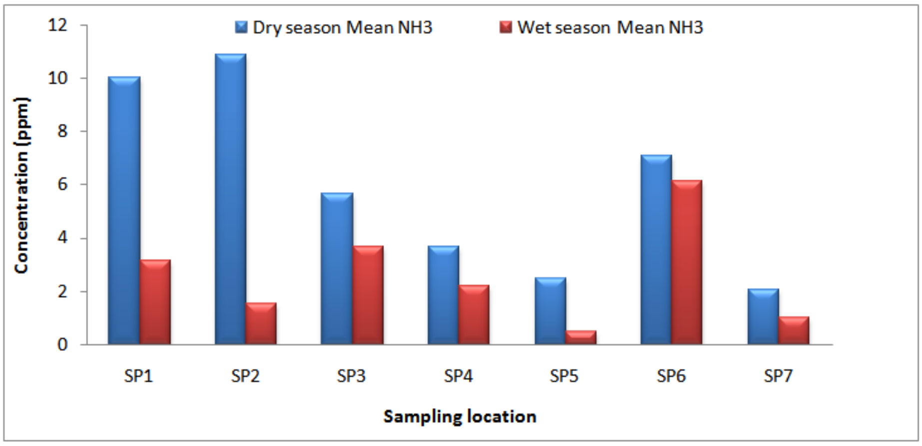

Figure 7: Concentrations of Ammonia in Eleme Area

Concentrations of Methane (CH_4) in Eleme Area

The dry season concentrations of methane monitored in Eleme area ranged from 3.0ppm to 22.1ppm with a mean deviation of 7.5±6.91ppm. Concentration levels of methane in Eleme area are shown in Figure 8.

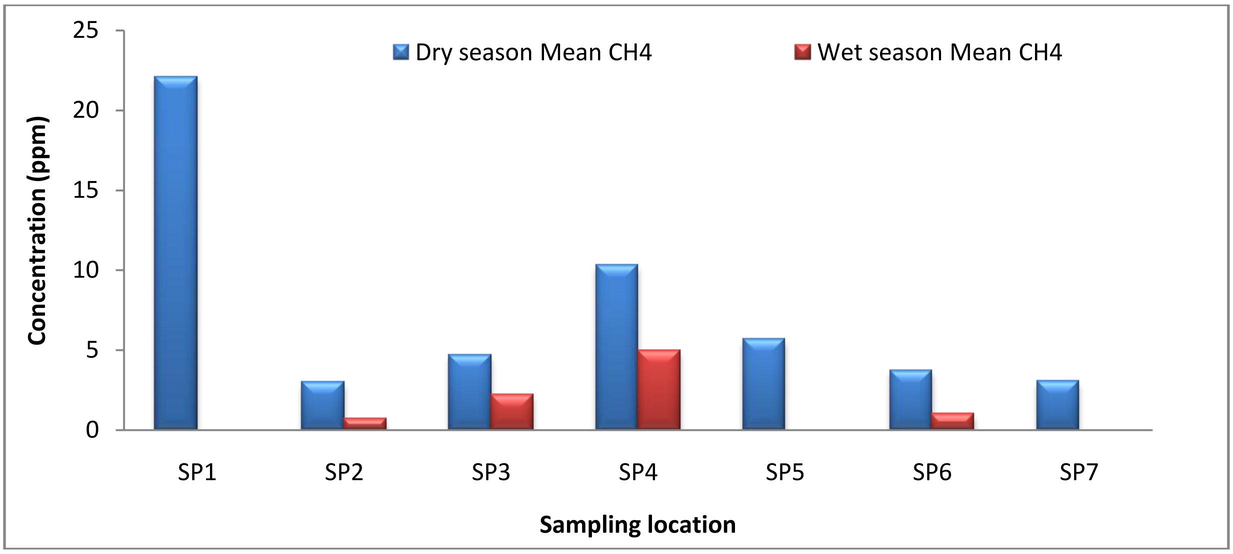

Figure 8: Concentration of Methane in Eleme Area

Concentrations of Total Suspended Particulate Matters (TSP) in Eleme Area

Concentrations of TSP obtained in the dry season ranged from 326.73µg/m^3 to 1102.1µg/m^3 with a mean deviation of 583.19±279.19µg/m^3. The mean concentrations of TSP measured in dry season in Eleme area far exceeded both FMEnv and NAAQS limits. Concentrations of TSP measured in the area during field survey are shown in Figure 9.

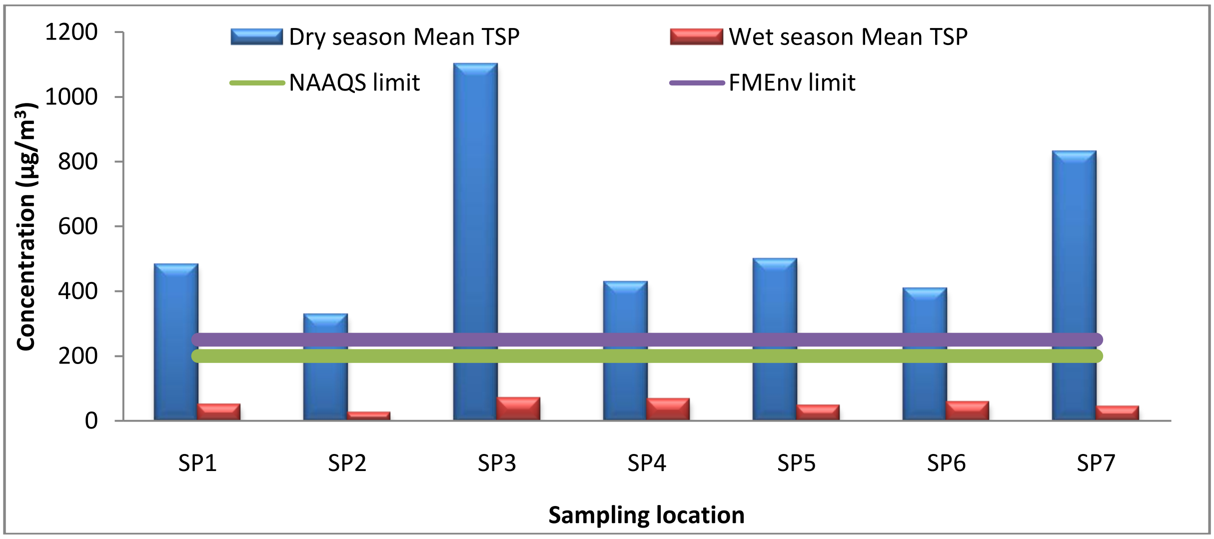

Figure 9: Concentration of Total Suspended Particulate Matter in Eleme Area

Concentrations of PM_{10} Particulate Matter in Eleme Area

The concentrations of PM_{10} measured in the dry season ranged from 270.6µg/m^3 to 734.1µg/m^3 with a mean deviation of 461.27±175.23µg/m^3. The dry season mean concentrations of PM_{10} exceeded NAAQS limits of 150µg/m^3. The concentrations of PM_{10} measured during field monitoring are shown in Figure 10.

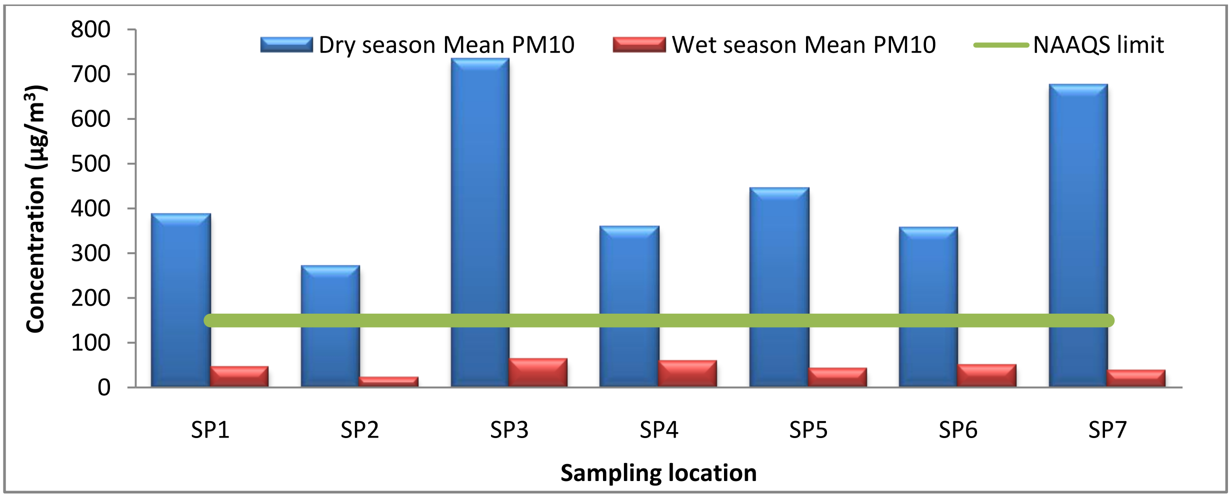

Figure 10: Concentrations of PM_{10}Particulate Matter in Eleme Area

Concentrations of $PM_{2.5}$ Particulate Matter in Eleme Area

The dry season concentrations of $PM_{2.5}$ obtained in Eleme area ranged from 68.27µg/m^3 to 101.6µg/m^3 with a mean deviation of 92.48±13.13µg/m^3. The dry season mean value exceeded the limit by 164.23%. The concentrations of $PM_{2.5}$ measured during field survey are shown in Figure 11.

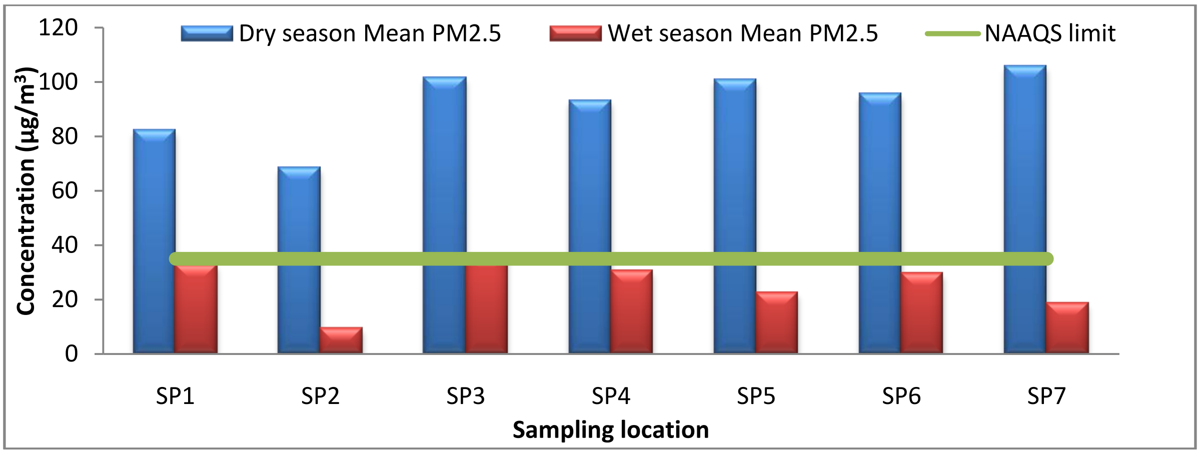

Figure 11: Concentration of $PM_{2.5}$ Particulate Matter in Eleme Area

IV. Discussion

a. Data Analysis of Air Quality in Eleme Area

Computed coefficients of variations in the dry season indicate that $PM_{2.5}$ and SO_2 have lower dispersion followed by NO_2 and PM_{10} while methane (CH_4) has high dispersion rate followed by NH_3.

The exceedance factor (EF) for each criteria pollutant in the area was calculated using the measured value of the ith parameter and the NAAQS regulatory permissible standard value. Exceedance factor less than 100 (EF < 100) is below prescribed limit, while exceedance factor greater than 100 (EF > 100) exceeds prescribed limit. Computed exceedance factors for all the criteria pollutants in the dry season were greater than 100 (>100) and are thus rated as very high. This indicates that the mean values of all the criteria pollutants in the area exceeded stipulated NAAQS limits in the dry season and constitute hazards to human health in the dry season period.

b. VARIATION OF CARBON MONOXIDE (CO) WITH METEOROLOGICAL PARAMETERS IN THE DRY SEASON

Results (shown in Figure 12 (a-e)) showed that concentrations of CO correlated significantly with wind speed in a positive manner. The stepwise regression linear models (shown in Table 1) show that the linear relationships between concentrations of CO and wind direction, relative humidity, temperature and air pressure are not significant at 0.05 confidence levels. However, the relationship between wind speed and concentrations of CO is highly significant at 0.01 confidence level for a 2-tail test with a coefficient of determination (R^2) of 0.088. This implies that though concentrations of CO vary positively with wind speed, only a fraction of 8.8% of the variation can be explained.

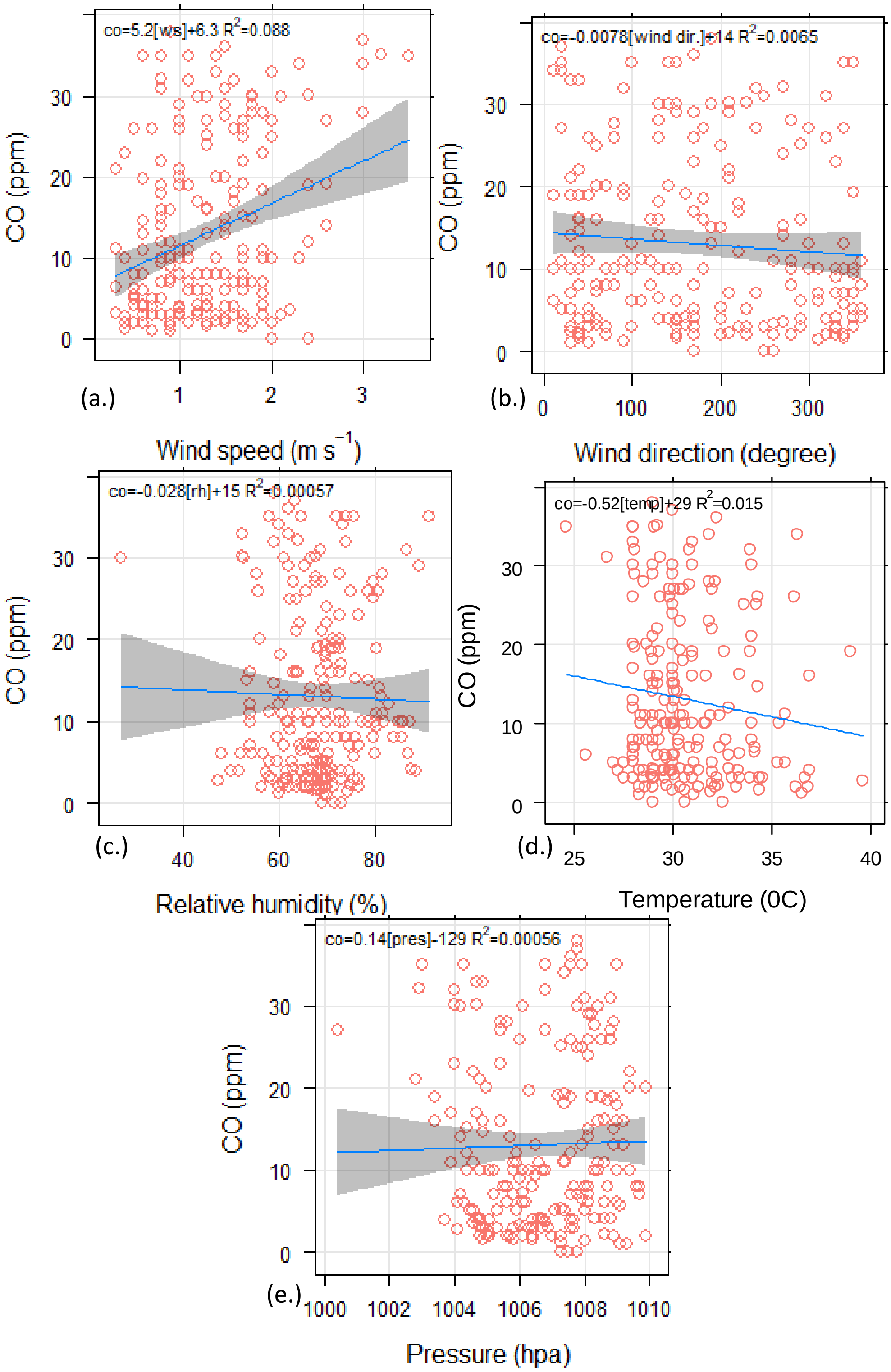

Figure 12 (a-e): Relationship between Predicted CO and Meteorological Parameters in the Dry Season

Table 1:Stepwise Linear Models for Dry Season CO

Pollutant	Model	R^2	t-statistic	Sig. (2-tailed)
CO	= 6.3 + 5.2*Wsp = 14 - 0.0078*Wd = 15.0 - 0.028*Rh	0.088 0.0065 0.00057	4.612 -1.665 -1.921	0.000** 0.097 0.056

	= 29.0 - 0.52*Temp = – 129.0 + 0.14*Pres	0.015 0.00056	-1.901 0.153	0.059 0.878

**Correlation is significant at the 0.05 and 0.01 levels (2-tailed).

A multiple linear regression model for the prediction of CO was developed combining all meteorological parameters as predictor variables. A model for the prediction of CO concentrations was thus derived as shown in Equation (1). The derived Equation (1) was used to predict the concentrations of CO in the study area in the dry season.

$$\mathbf{CO = -24.993 + 5.489*Wsp - 0.011*Wd - 0.171*Rh - 0.608*Temp + 0.063*Pres} \quad (1)$$

Table 2: Analysis of Variance (ANOVA) for Dry Season CO Prediction Model

Model	SSE (ppm)	df	MSE (ppm)	RMSE (ppm)	F	Sig.
Regression (SS_M)	2785.668	5	557.134	23.604	5.650	0.000*
Residual (SS_R)	20413.113	207	98.614			
Total (SS_T)	23198.782	212				

*Significant at the 0.01 level (2-tailed).

The mean square error (MSE) and the root mean square error were computed to be 557.134ppm and 23.604ppm respectively. The model sum of squares error (SS_M), residual sum of squares error (SS_R) and total sum of squares error (SS_T) were computed to be 2785.668ppm, 20413.113ppm and 23198.782ppm respectively as shown in Table 2. The result (Table 2)showed that meteorological parameters significantly (P-value <0.05) influence the concentrations of CO concentration in the area. However, the goodness of fit (Figure 13) between predicted and measured values showed a poor linear relationship between CO concentrations and meteorological parameters with a coefficient of determination (R^2) of 0.120. This implies that meteorological parameters accounted for only 12.0% of the variation of concentrations in the area in the dry season. The goodness of fit between predicted and measured concentrations of CO is shown in Figure 13 while the predicted values are plotted against measured values as shown in Figure 14.

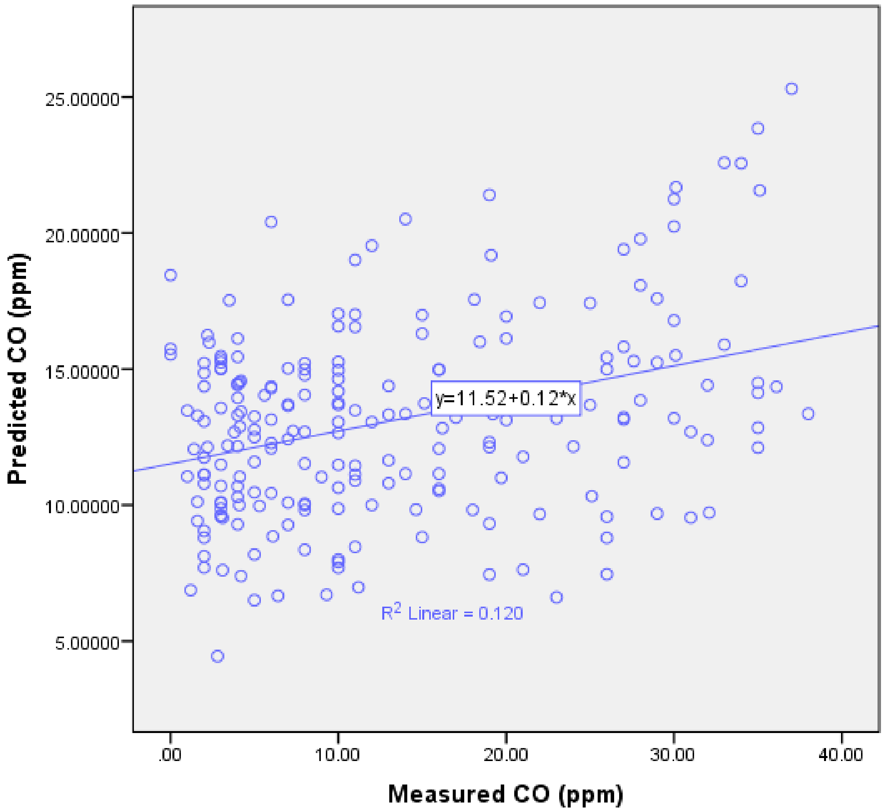

Figure 13: Relationship between Predicted CO and Measured CO in the Dry Season

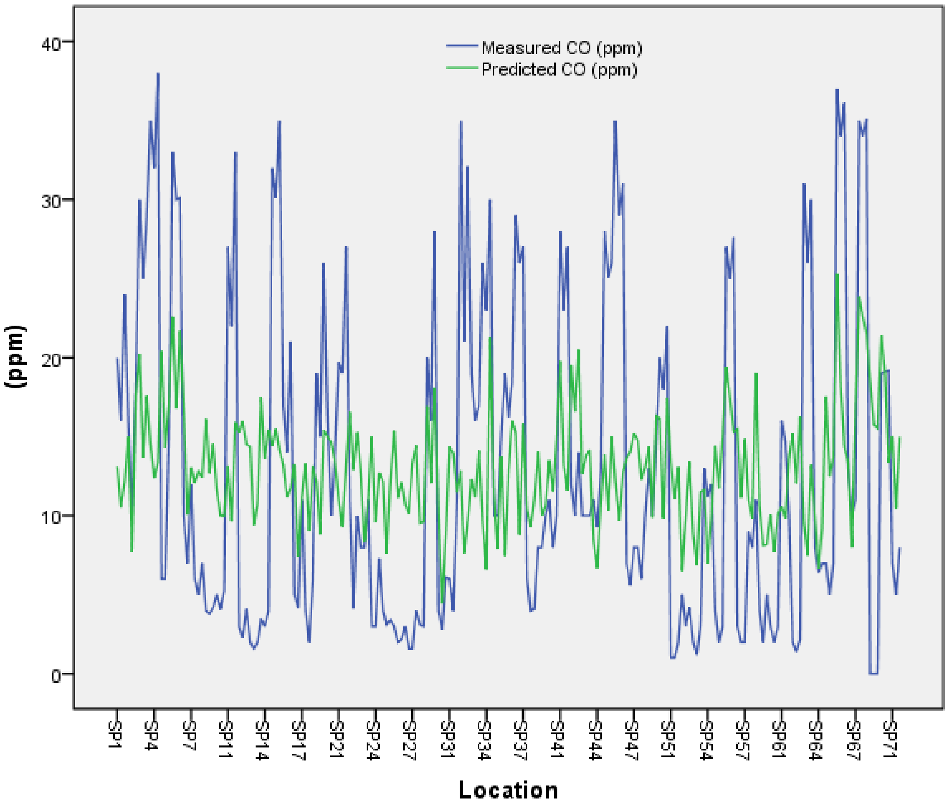

Figure 14: Predicted CO versus Measured CO in the Dry Season

c. Pollution Levels Assessment

The computed pollutant standard index(PSI) for each pollutant in the dry season in Eleme area showed high values of SO_2, NO_2 and $PM_{2.5.}$ This implies that SO_2, NO_2 and $PM_{2.5}$ are the main air pollutants prevailing in the Eleme area. This may be as a result of industrial activities in the area.

The air quality indices computed for the Eleme area in the dry season (Table 3) showed very unhealthy values (between 201 and 300) at stations SP1, SP2, SP5 and SP6. This may potentially affect the entire exposed population, thus the people in these areas may experience more serious health effects. Similarly, stations SP3, SP4 and SP7 (Table 3) showed hazardous values (between 301 and 500). This implies that the entire people in these areas may experience more severe health effects.

Table 3: Dry Season Pollutant Standard Index and Air Quality Index in Eleme Area

Sampling Points	SO_2 PSI	NO_2 PSI	CO PSI	PM_{10} PSI	$PM_{2.5}$ PSI	AQI	AQI rating
SP1	499.5	77.7	234.7	253.9	128.5	238.9	Very Unhealthy
SP2	499.5	266.5	197.6	160.3	114.0	247.6	Very Unhealthy
SP3	887.1	266.5	288.6	634.1	149.1	445.1	Hazardous
SP4	665.7	266.5	350.7	214.0	140.2	327.4	Hazardous
SP5	499.5	266.5	104.4	330.0	148.4	269.8	Very Unhealthy
SP6	534.8	303.2	309.1	208.7	142.6	299.7	Very Unhealthy
SP7	534.8	211.1	115.3	576.6	153.4	318.2	Hazardous

V. Conclusion

The study revealed that SO_2, NO_2 and $PM_{2.5}$ are the main criteria air pollutants prevailing in the Eleme area caused by industrial activities and influenced by the dry season factors in the study area.Computed air quality indices in Eleme indicated very unhealthy and hazardous air pollution in the dry season that may affect public health severely.

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