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Determination of Some Air Pollutants and Meteorological Parameters in Ibeno L.G.A.: Niger Delta Region of Nigeria

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----------*ABSTRACT*----------
The determination of air pollutants in Ibeno LGA was carried out using standard analytical techniques. The pollutants monitored were NO_2, SO_2, H_2S, CO, NH_3, Cl_2, TVOC, CH_2O, $PM_{2.5}$ PM_{10}, andmeteorological parameters were: Temperature, relative humidity (RH), pressure and Wind Speed (WS). The results for the concentration of air pollutants and their AQI reveals as follows: NO_2 (0.216±0.113ppm, AQI=216), SO_2 (0.294±0.171ppm, AQI=58.8), H_2S(0.438±0.0164ppm, AQI=21.9), CO (4.864±5.133ppm, AQI=97.28), NH_3 (3.042±1.688ppm, AQI=60.84), Cl_2 (1.1±1.203ppm, AQI=1100), HCN (0.302±0.37ppm, AQI=3023), TVOC (1.607±1.023Mg/m^3, AQI=321.4), CH_2O (0.457±0.387Mg/m^3, AQI=3808.34), $PM_{2.5}$ (46.6±5.953Ug/m^3, AQI=186), PM_{10} (28.4±13.85Ug/m, AQI=165), Temp. (22.6±1.356^{0}C), RH (83±2.757%), Press (1012.06±1.378Kpa) WS (1.46±0.944m/s). The result showed that SO_2, NH_3 and Particulate Matters were higher than the FEPA standard limit. The correlation analysis revealed that NO_2 showed positive relationship with SO_2, H_2S, CO and HCN at p< 0.01 level and a negative relationship with $PM_{2.5}$ and WS at p< 0.05 level. SO_2 revealed a strong positive correlation with HCN and Temp at 0.01 level and at 0.05 level with H_2S and CO. H_2S show a strong correlation with CO and HCN at p< 0.01 level. NH_3 also showed a positive relationship with $PM_{2.5}$ and PM_{10} atp< 0.01 level and a negative association with TVOC at 0.01 level and 0.05 level with WS. Chlorine correlated positively atp< 0.01 level with Temp and atp< 0.05 level but negatively with RH. TVOC on the other chlorine correlated positively with WS atp< 0.01 level and negatively with $PM_{2.5}$, PM_{10}, and RH atp< 0.01 level.$PM_{2.5}$ correlated positively atp< 0.01 level with PM_{10} and RH and negatively atp< 0.01 level with WS. PM_{10} revealed a positive relationship with RH atp< 0.01 level and a negative correlation with WS atp< 0.01 level. There was also a correlation but negatively between Press and WS at 0.01 level. This result is an indication of the presence of possible air pollutants in the air of the study area which may result in many health problems

Key words: *Pollution, Air Pollution and meteorological parameters.*

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I. INTRODUCTION

Man's environment is under constant threat from his own activities. Man's expanding population, industrialization and intensive agriculture have caused tremendous damages to our environment. Man's ignorance of law of nature in his over – exploitation of nature resources has further aggravated the problem. The composition of clean air are 78.1% Nitrogen, 20.8% Oxygen and other gases such as Argon, Carbon Dioxide, Methane and water vapor making up of about 1%, Man in his quest to live a comfortable life on earth, has introduce some dangerous gases into the atmosphere thereby changing the composition of air environment from its original status. However, Human being need clean air that can protect them from the hostile environment of the upper atmosphere. The introduction of high level of foreign elements into the atmosphere by the activities of man has polluted the air environment making it injurious to the inhabitant. The situation is worse in the Southern part of Nigeria where some areas in Akwa Ibom State and Delta Region have over 1000 flaring point making it one of the major sources of air pollutants (Efes, 2003). Other sources of air pollution in the region include Vehicular emission, power and heat generation, industrial processes, road construction and burning of solid waste. Several studies have been conducted to assess the quality of air environment within Niger Delta region and result obtained has always shown very high level of toxic substance in the atmosphere.

According toRobinson, 2015; Habre, 2014, air pollution is a major problem of recent decades, which has a serious toxicological impact on human health and the environment. The sources of pollution vary from small unit of cigarettes and natural sources such as volcanic activities, large volume of emission from motor engineof automobiles and industrial activities. Long- term effect of air pollution can cause diseases such as respiratory infection and inflammations, cardiovascular dysfunctions, and cancer. (Rumanaet al., 2014;

Yamamotoss, et al., 2014; Zhang et al., 2014; Brucker et al., 2014). Hence, air pollution is linked with millions of deaths globally each year (Biggeriet al., 2014; Vermaelen and Brusselle, 2013; Kan et al., 2010). A recent study has revealed the association between male infertility and air pollution (Zhou et al., 2014). Report have shown that air pollution is the major causes of cardiovascular diseases, immune system impairment, exacerbation of asthma and chronic respiratory disease (Akpan, 2008; Hammitt andZhou, 2005; Kan and Chen, 2014; Raaschou-Nelson, 1995; Savile, 1993; Schwela, 2000; USEPA, 1994). Nevertheless, the authorities concern has not done much to reduce or control air pollution in the region under investigation. Since 1956 when Nigeria discovered crude oil within the Niger Delta region of the country, the Zone has suffered immense negative environmental consequences of oil and the associated activities, which revealed high health risk posted by the elevated levels of Nitrogen (IV)oxide and suspended particulate matter. It has also been reported that the major air pollution in Niger Delta Area of Nigeria are CO_2, CH_4, SO_2, N_2O, NH_3, VOC_S, SPM, PAH_S and trace metal (Tawari and Abowei, 2012).

II. MATERIALS AND METHOD

Study Area

Ibeno is located in the South-South region of Nigeria, a local government area of Akwa Ibom State and is located between latitude 04^o 82’ 23.3” and longitude 008^o 00’ 0509”. in Akwa Ibom State. Couple with the fact that Ibeno occupies the largest Atlantic coastline of more than 129km.Ibeno lies in the Mangrove Forest Belt of the Niger Delta region of Nigeria, it is bounded in the West by Eastern Obolo local Government areato the North by Onna,EsitEket and Eketto the South by the Atlantic Ocean. In Akwa Ibom State, the air pollutant has zone through serious modifications. The location chosen for the study was areas with high atmospheric particulates and aerosol because of oil exploration.

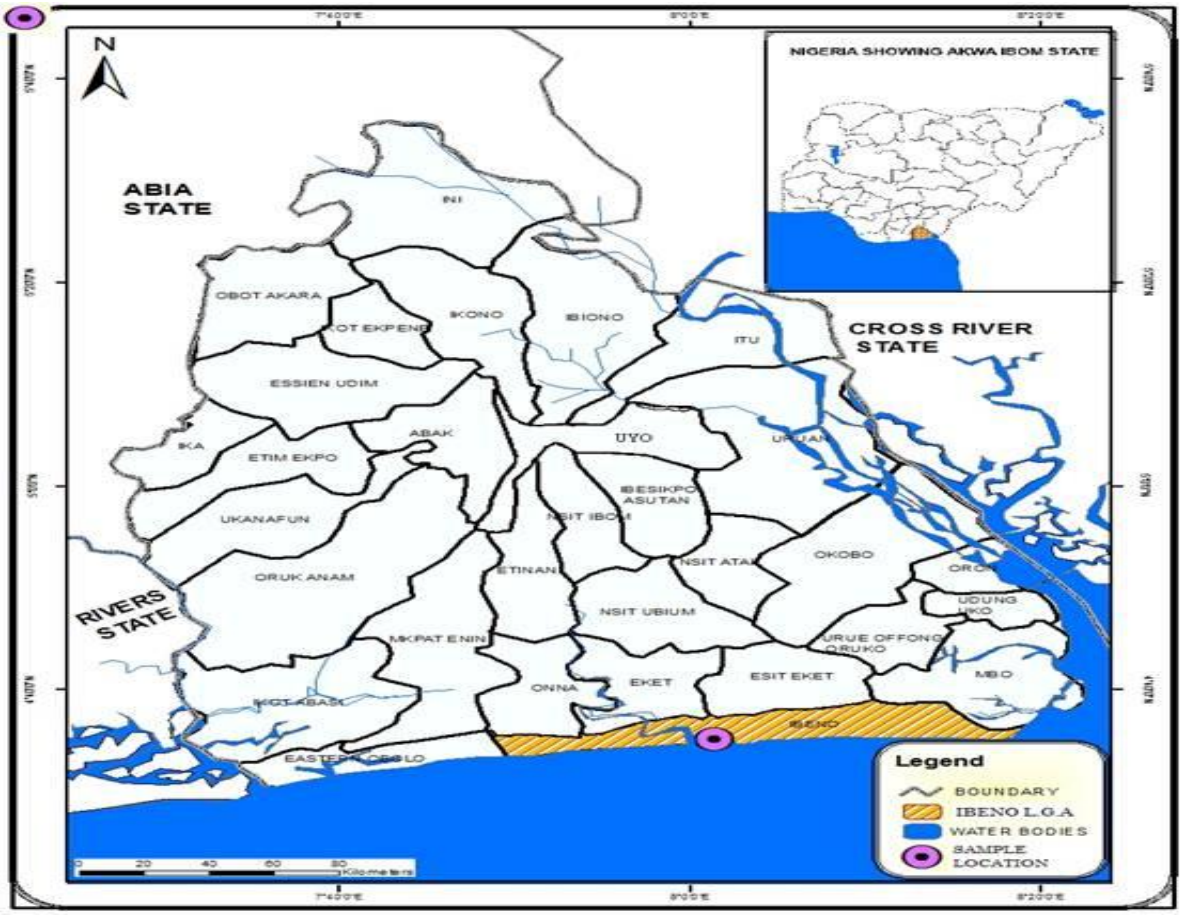


Figure 1: Map of Ibeno LGA showing the study area.

Materials
Equipment used in detecting the air pollutants are listed in the table below.

Table 1: Materials used in determining the air pollutants

Parameters	Equipment's Model
NO_2	NO_2 gas monitor Gasman Model 19648H
SO_2	SO_2 gas monitor Gasman Model 19831H
H_2S	H_2S gas monitor Gasman Model 19502H
CO	CO gas monitor Gasman Model 19252H
NH_3	NH_3 gas monitor Gasman Model 1973OH
Cl_2	Cl_2 gas monitor Gasman Model 19812H
HCN	HCN gas monitor Gasman Model 19773H
TVOC	TVOC gas monitor Gasman Model Air Ae Steward air quality monitor
CH_2O	CH_2O gas monitor Gasman Model Air Ae Steward air quality monitor
$PM_{2.5}$	$PM_{2.5}$ gas monitor Gasman Model Air Ae Steward air quality monitor
PM_{10}	PM_{10} gas monitor Gasman Model Air Ae Steward air quality monitor

Other instrument was, Max/Min Thermometer (Model No: KTJTA 318) used for measuring the temperature and digital Anemometer (MASTECH MS 6252A)

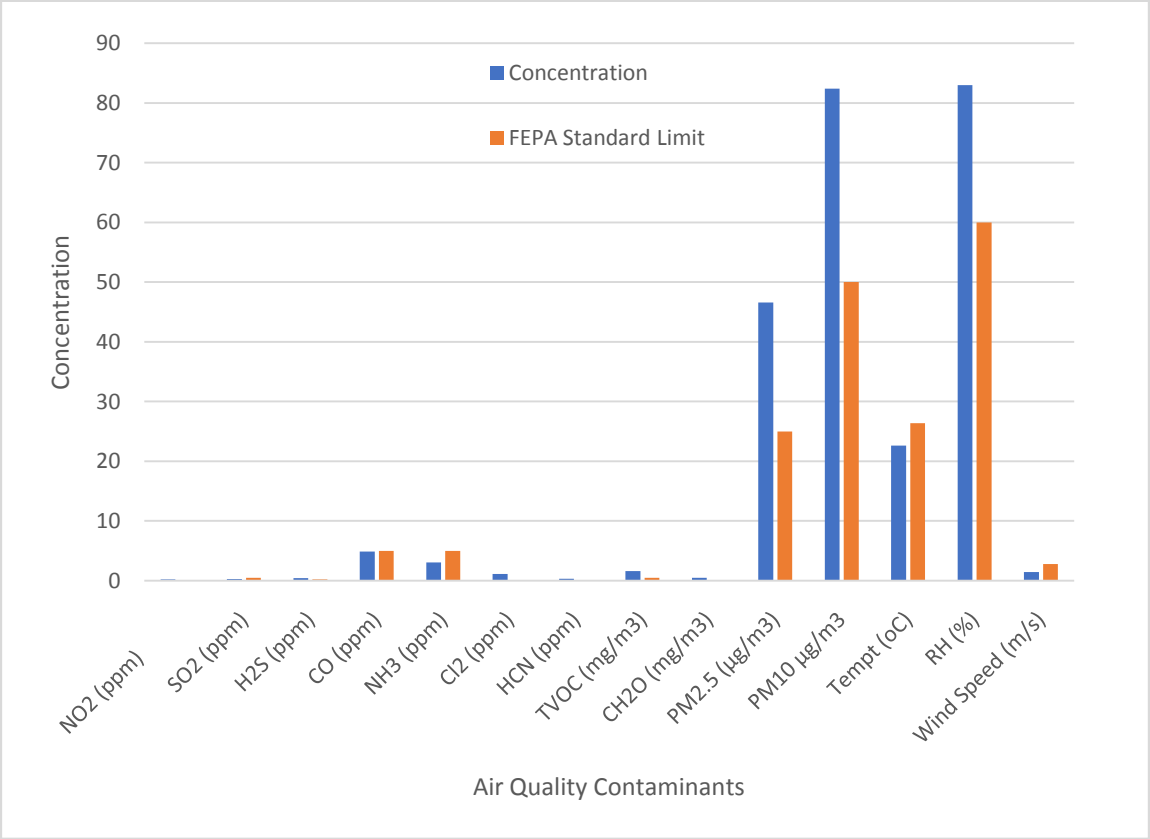
Determination of Air Quality Index
Air quality index (AQI) is an overall measure of the status of a place under consideration. On the basis of air quality index "Q", the quality rating of each parameter was obtained by the formula given below (Agar-walet al., 2008).
$Q = (O/Ps) X 100$

Where:
Q = Quality Ratings
O = Observed value
Ps = Prescribed Standards as Permissible Limit.
Subsequently, the geometric mean of this "n" number of quality ratings "Q" was estimated, which is known as AQI.

III. RESULTS AND DISCUSSION

Results

Figure 2: The Result of Some Air Pollutants and Meteorological Parameters in Ibeno Local Government Area.



FEPA-Federal Environmental Protection Agency

Table 2: The Air Quality Index of Air Pollutants Analyzed

Air Quality Contaminant	AQI
NO_2 (ppm)	216
SO_2 (ppm)	58.8
H_2S (ppm)	21.9
CO (ppm)	97.28
NH_3 (ppm)	60.84
Cl_2 (ppm)	1100
HCN (ppm)	3020
TVOC (mg/m^3)	321.4
CH_2O (mg/m^3)	3808.34
$PM_{2.5}$ ($\mu g/m^3$)	186
PM_{10} $\mu g/m^3$	165

Table 3: Air quality categorizes based on the air quality index by central pollution control board (CPCB), 2009.

S/N	AQI of Ambient Air	Prescription of Ambient Air Quality
1	<10	Clean
2	10 – 25	Clean
3	25 – 50	Fairly Clean
4	50 – 75	Moderately Polluted
5	75 – 100	Polluted
6	100 – 125	Heavily Polluted
7	>125	severely polluted

board (CPCB), 2009.

Source: CPCB (2009), AQI-Air Quality Index

IV. DISCUSSION

Nitrogen (iv) oxide (NO_2) recorded a mean concentration of 0.216 ± 0.113 (ppm) which is above the standard limit of 0.004 – 0.1 (ppm) recommended by the (FEPA). Prolonged inhalation of NO_2 has been reported to cause premature death, stroke, heart disease, lung cancer, lung infection, asthma and chronic obstructive pulmonary disease. In another report, it is suggested that the level of nitrogen oxide between 0.2 and 0.6 ppm is harmless for the human population (Hostorberget al., 2009). However, the Air Quality Index (AQI= 216) reveals that the air is severely polluted.

The mean concentration of Sulphur (iv) oxide (SO_2) recorded was 0.294±0.171 (ppm). This value is within the standard limit of 0.05 – 0.5ppm recommended by the FEPA. Although the level of SO_2 in the study site is within the safe limit, however, consistent inhalation of air around the study site may result in cough, shortness to breath and low birth weight (Chen et al., 2007). However, when subjected it to Air Quality Index (AQI= 58.8) it reveals that the air is moderately polluted.

The mean concentration of Hydrogen Sulphide (H_2S) recorded was 0.438±0.164 (ppm). This value is above the standard limit of 0.15 – 0.2 (ppm) recommended by the FEPA. H_2S can cause severe toxification resulting in respiratory and neurological damage and even death.

However, the air quality index (AQI= 21.9) reveals that the air is moderately polluted.

The mean concentration of carbon monoxide (CO) recorded was 4.864±1.688 (ppm). This value is within the stand limit of 1.0 – 5.0 ppm recommended by the FEPA. Prolong exposure to this high level of CO may result in death as the gas combined readily with hemoglobin in the red blood displacing oxygen and forming carboxyl hemoglobin. Study have shown that CO is asphyxiate and can cause damages after prolong exposure and its affinity for hemoglobin (as an oxygen carrier in the body) is about 250 times greater than that of oxygen (Allred et al., 2000). However, the air quality index (AQI= 97.28) revealed that the air is polluted in respect to CO.

The mean concentration of Ammonia (NH_3) recorded was 3.042±1.688(ppm) which is within the standard limit of 2.0 – 5.0 ppm recommended by FEPA. Ammonia usually has a choking smell and may affects the lungs if exposed to it for a prolonged period of time. Consequently, adequate control measure should be put in place. However, when subjected it to Air Quality Index (AQI= 60.84) reveals that the air is moderately polluted.

The mean concentration of Chlorine (Cl_2) recorded was 1.1±1.203 (ppm). This value is slightly above the standard limit of 0.03 – 0.1 ppm recommended by the FEPA. Most harmful chlorine exposures are as a result of inhalation. It has been reported to cause airway irritation, wheezing, difficulty in breathing, sore throat, cough, chest tightness, eye irritation and skin irritation. Breathing high levels of chlorine causes fluid build-up in lungs, a condition known as pulmonary edema. However, when subjected it to Air Quality Index (AQI= 110) it reveals that the air is heavily polluted.

The mean concentration of Hydrogen Cyanide (HCN) recorded was 0.302±0.37 (ppm). This value is higher than the standard limit of 0.01ppm recommended by FEPA. High levels of cyanide exposure have been reported to cause weakness and confusion, headache, nausea/feeling sick to the stomach, gasping for air and difficulty in breathing, loss of consciousness/passing out. However, the Air Quality Index (AQI= 3020) reveals that the air is severely polluted.

The mean concentration of Total Volatile Organic Compounds (VOCs) recorded was 1.607±1.023 mg/m^3. This value is higher than the standard limit of 0.33 – 0.5 mg/m^3 recommended by the FEPA. However, consistent inhalation from the study site may cause headache, loss of coordination, nausea and damage to the liver, kidney and central nervous system. Some organic can cause cancer in animals, some are suspected or known to cause cancer in humans. But when subjected it to Air Quality Index (AQI= 321.4) it reveals that the air is severely polluted.

The mean concentration of formaldehyde (CH_2O) recorded was 0.457±0.387mg/m^3. This value is above the standard limit of 0.012mg/m^3 recommended by the FEPA. The most common problems in people exposed to (CH_2O) may cause occupational asthma, but this seems to be rare. However, when subjected it to Air Quality Index (AQI= 3808.34) it reveals that the air is severely polluted.

Particulate Matter ($PM_{2.5}$) recorded theconcentration of 46.6±5.953 (µg/m^3) and (PM_{10}) recorded the concentration of 82.4±13.85(µg/m^3). Thesevalueswere abovethe standard limit of 25µg/m^{3}and50µg/m^{3}recommended for ($PM_{2.5}$) and (PM_{10}) by the FEPA.Exposure to high concentration of $PM_{2.5}$ can also exacerbate lung and heart conditions, significantly affecting quality of life, and increase deaths and hospital admissions. However, when subjected to Air Quality Index (AQI= 186.0) it reveals that the air is severely polluted.

Exposure to high concentration of PM_{10} can result in a number of health impacts ranging from coughing and wheezing to asthma attacks and bronchitis to high blood pressure, heart attack, stroke and premature death. However, when subjected to Air Quality Index (AQI= 165.0) reveals that the air is severely polluted.

TABLE 4: correlation of gaseous pollutants with some meteorological parameters.

	NO_2	SO_2	H_2S	CO	NH_3	Cl_2	HCN	TVOC	CH20	$PM_{2.5}$	PM_{10}	TEMP	RH	Press	W.S
NO_2	1														
SO_2	0.764098**	1													
H_2S	0.868542**	0.553073*	1												
CO	0.984651**	0.645373*	0.891233**	1											
HCN	0.8858**	0.917131**	0.82945**	0.818644**	-0.14065	0.055513	1								
TVOC	-0.30092	-0.0888	0.008168	-0.28799	-0.770**	0.102572	0.039611	1							
$PM_{2.5}$	-0.05*	-0.32443	-0.19119	-0.02259	0.740118**	-0.23761	-0.39415	-0.892**	0.655127*	1					
PM_{10}	0.003154	-0.27785	-0.02603	0.02629	0.725344**	-0.2742	-0.28336	-0.812**	0.806128**	0.957894**	1				
TEMP	0.334175	0.742155**	-0.10167	0.194206	0.438415	0.715701**	0.425958	-0.31401	-0.54518*	-0.07312	-0.19372	1			
RH	0.394435	-0.09653	0.220999	0.45812	0.428384	-0.55143*	-0.04606	-0.88585**	0.336821	0.847033**	0.791791**	-0.0535	1		
WS	-0.59831*	-0.21293	-0.36613	-0.61692*	-0.51559*	0.380221	-0.2244	0.917027**	-0.22985	-0.7619**	-0.73094**	0.1841	-0.9493**	0.33416	1

** Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

Correlation Analysis

Correlation matrix as presented in table 4 shows the relationship among the air particulates monitored.

NO_2 shows a strong positive correlation with SO_2, H_2S, CO and HCN at p< 0.01 level with (r = 0.764098, 0.868542, 0.984651 and 0.8858 respectively). This is an indication that, the present of these pollutant in the air within the study area may have been emanated from the same source, according to Romic and Romic (2002). However, there was a correlation but negatively atp< 0.05 level with Wind Speed (r = -0.59831). This indicated that as NO_2 increases WS decreases.

SO_2 shows a strong positive correlation with HCN and Temp atp< 0.01 level (r = 0.917131 and 0.742155 respectively). This revealed the common source of this pairs of air contaminants. However, there was a positive correlation at p<0.05 level with H_2S and CO with r value of0.553073 and 0.645373, This indicates that as SO_2 increases H_2S and CO decreases.

H_2S correlated positively with CO and HCN atp< 0.01 level with r value of 0.891233 and 0.82945 respectively. Result shows that the pollutants may be from the same source.

CO correlated positively but significantly with HCN atp< 0.01 level limit with r value of 0.818644. This result shows that the pollutants may have emanated from the same source. However, there was a negative relationship with Wind Speed (W.S) atp< 0.05 level with r = -0.616692. Results obtained indicated that they are from different sources.

NH_3 shows a strong positive correlation with $PM_{2.5}$ and PM_{10} at p<0.01 level with r = 0.740118 and 0.725344 respectively. This revealed the common source of this pairs of air contaminant. However, there was a

correlation but negatively atp< 0.05 level with WS (r = 0.51559) and p<0.01 level with TVOC (r = - 0.770). This indicates that as NH_3 decreases, WS and TVOC increases and vice versa.

Cl_2 correlated positively with Temp atp< 0.01 level with r value of 0.715701 and show negative significant correlation with RH at p<0.05 with r value of -0.55143. The positive correlation shows that the pollutant may be from the same source while the negative indicates that they are from different sources.

TVOC shows a strong negative correlation with $PM_{2.5}$, PM_{10} and RH atp< 0.01 level with r value of- 0.892, -0.812 and -0.88585 respectively. This result shows that, they are of different source and as TVOC increases $PM_{2.5}$, PM_{10} and RH decreases and vice versa. There was a positive correlation with WS atp< 0.01 level with r = 0.917027, these indicate that the pollutant may have be from the same source (Romic and Romic, 2002).

CH_2O shows a strong positive correlation with PM_{10} atp< 0.01 level with r = 0.806128 and with $PM_{2.5}$atp< 0.05 level with r = 0.655127 and a negative relationship with Temp atp< 0.05 level with (r = 0.54518). The positive correlation shows that the pollutants may be from the same source while negative indicates that they are from different sources.

$PM_{2.5}$ correlated positively with PM_{10} and RH at p<0.01 level with r = 0.957894 and 0.847033 and negatively with WS at p<0.05 level with r = - 0.7619. The positive correlation shows that the pollutants may be from the same source while negative relationship indicate that they may have been from different sources and as $PM_{2.5}$ decreases WS increases and vice versa.

Correlation analysis between PM_{10} and RH shows a strong positive relationship atp< 0.01 level (r = 0.791791). This revealed the common source of the pairs of air contaminants. Analysis also shows a negative relationship with WS at p<0.01 level with r value = - 0.73094. This shows that WS decreases PM_{10} increases and vice versa.

RH correlated strongly but negatively with WS at 0.01 level with (r = - 0.9493). This indicated that they are from different source.

V. CONCLUSION

Based on the result of this research work, it was concluded that air inIbenoLGA contains concentrations of various pollutants under investigation. The presence of these pollutants at variable levels indicate possible health implications. The presence of these pollutants may be due to some commercial activities within the area. The high concentration of particulate matter, CO and SO_2 may be attributed to oil exploration, smoke emanated from vehicles, combustions of fuel, gas flaring and decomposition of organic wastes as the major sources of these air contaminants/pollutants in the area under investigation.

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