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Determination and Source Tracking of Air Pollutants in Atmospheric Air of Isiokpo Environment, Niger Delta, Nigeria

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ABSTRACT

The present study employs various strategies to check the concentrations and sources of ambient air pollutants in atmospheric air within selected areas of Isiokpo town of Rivers state. This was achieved through determination of the levels of particulate matters (PM2.5 and PM10), NO2, SO2, CO, CO2 O3, CH4, NH3, and identification of its possible sources. In-situ portable aeroqual gas detector and particulate matter counter were used to check for these pollutants in the air. The AQI and health risk assessment for criteria pollutant was estimated using standard USEPA equations. The source identification was done using principal component analysis method. The mean of air pollutants of Isiokpo obtained were; PM2.5 –Ogbodo; 0.007±0.00 mg/m3, Adanta; 0.005±0.001 mg/m3; Nkarahia; 0.010±0.00 mg/m3, Agwara; 0.004±0.00 mg/m3, Mgbuowhara; 0.008±0.00 mg/m3, Alimini; 0.008±0.00 mg/m3, PM10; Ogbodo; 0.013±0.001 mg/m3, Adanta was 0.011±0.001 mg/m3; Nkarahia; 0 .019±0.001 mg/m3, Agwara 0.010±0.000 mg/m3, Mgbuowhara; 0.010±0.00, Alimini; 0.015±0.001 mg/m3. CO2, CO, VOC and CH4 were also detected in the air but at minimal levels. However, NO2, H2S, NH3, SO2 and O3 were not detected. Air Quality Index (AQI) rating of Isiokpo reveals that the air quality is not severe. Principal component investigation reveals varying sources of air pollutants with traffic and incineration more prominent. This investigative study has revealed that selected meteorological factors had minimal effect on the quality of the atmospheric air within the areas selected for this study. The non-carcinogenic risk factor indicated that air pollutants are of great risk for infants than adults. There should be provision of laws and regulations to ensure that release of pollutants of harmful nature are prohibited and defaulters punished accordingly.

Keywords: Air Pollution, Source Tracking, Isiokpo, Meteorological factors.

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INTRODUCTION

As far as air pollution is concerned, the worldwide aim is to reduce the concentrations of pollutants owing to the increasingly strong restrictions which national and international organizations unanimously impose. Several guidelines and regulations have been adopted to define air quality levels. The World

Health Organisation (WHO) considers the Guideline Values (GD); the EU labels the Limits Values for Air Quality (LVAQ), while the US Environmental Protection Agency defines the National Ambient Air Quality Standards (NAAQS). Guidance on indoor air quality and concentrations of PM2.5 and CO is provided by the World Health Organisation (WHO) (World Health Organization, 2016). To prevent harmful health consequences, the WHO recommends keeping PM2.5 concentrations at less than 25 μg m−3 when averaged over a 24 h period, with the guidance also recommending CO should not exceed 6 ppm over 24 h (WHO, 2016). However, in poor countries like the majority of African countries and those with generally low average incomes, concentrations of air pollutants remain high and the tendency will be to increase their emission levels as they develop, making the problem even worse than it is at the moment. In many African countries, Pollution control falls within the context of competing priorities for basic service provision and economic development (Tumwesige et al., 2017). Further challenges include the lack of political will, the limited use of planning tools, and a non-strategic approach to Air Quality Management (Morakinyo et al., 2018). Developed countries are building up strategies in order to reduce air pollution while most African countries have neither air quality regulations, nor the tools for monitoring the same (Ozer et al., 2007). Despite the health risks this situation presents, air quality programs, particularly in sub-Saharan Africa, have stalled or completely stopped in recent years (Petkova et al., 2013). Studies have concluded that minimal attention is given to air quality and air pollution control related programmes. For example, one study revealed that out of about 27 countries, only 7 have operational routine monitoring systems: these are Botswana, Ethiopia, Ghana, Madagascar, Tanzania, Zambia, and Zimbabwe (Tumwesige et al., 2017). While in South Africa, air quality management has focused on industrial, domestic coal burning and vehicles as emission sources of air pollutants (Mentz et al., 2018). A few studies have revealed mitigation measures being implemented in Africa. The interesting part is that the few measures that have been implemented in the few areas have revealed very positive and encouraging results. A study in South Africa, for example showed that household PM2.5 concentrations greatly decreased when households in Kikati areas switched from use of firewood to biogas for cooking (Tumwesige et al., 2017). It has been suggested by another study that advanced stoves, which burn fuel more efficiently and reduce smoke emissions, could help to reduce indoor air pollution in poor, rural areas (Sundell, 2004). The results from other studies also suggest that economic growth and rising incomes may matter in African countries in order to curb pollution, but more stringent policy measures, especially at the industrial level would be required to curb environmental degradation (De Longueville et al., 2013). Some Courtiers such as South Africa have already set up targets for mitigation strategies. It is estimated that these targeted potential mitigation strategies can avoid up to about 37% of the estimated annual premature deaths by 2030 with the largest opportunity being a reduction of 10 868 annual deaths from switching half of the energy generation in South Africa to renewable technologies (Eliasson et al., 2009). However, another study revealed that South African face several challenges in implementing AQA as pollution control falls within the context of competing priorities for basic service provision and economic development (Kinney et al., 2011). Exploring the effects of different types of PM2.5 is necessary to reduce associated deaths, especially in developing African countries (Petkova et al., 2013). Industrialization and city expansion have aided the rate of air pollution in the world. The emission form is also necessary in discussing the effect of air pollution. The Niger delta is home to air pollution. The Isiokpo axis is an exit route for vehicles going to Owerri and other eastern states of Nigeria. The number of meteorological research or information within Rivers state or around the study locations is another striking issue as it affects the data management of pollution. Rivers State is situated at the centre of the Niger delta, with numerous road networks linking all the other cities within Nigeria, especially because of the hydrocarbon refining operations within the state. The area of the study can boost of varied high traffic points especially coming from high movement of vehicles. The presence of a lot of depots within Isiokpo is also another reason for the movement of heavy-duty vehicles to and from the area hence resulting in air pollutions. The burning of refuse composed of different wastes also contributes immensely to the high level of pollution within the area. This research focuses on the determination of the concentrations and sources of ambient air pollutants in atmospheric air within selected sections of Isiokpo metropolitan areas of Rivers state, and was achieved through: estimation of the levels of particulate matters ($PM_{2.5}$ and PM_{10}), NO_2, SO_2, CO, CO_2 O_3, CH_4, NH_3 in samples from selected areas and Source identification of the origin of the contaminants from selected areas

2.0: MATERIALS AND METHODS

2.1 The study Area

Isiokpo (IS) part of Rivers State one of the states that makes up the south-south region of Nigeria and it is also part of the oil rich Niger Delta region of Nigeria. The total land area of the state is about 11,077 km^2 (4,277 square miles) and the total population is 5,198,716 million people according to the 2006 census figures. Osiokpo, is the local government headquarters of Ikwerre Local government area, the area is a centre for commercial, light industrial activities and residential zone for indigenes/locals of the said local government area. The commercial sites include the Isiokpo main market, and Isiokpo Motor Park which also have moderate traffics.

The selected locations for this research are high traffic and commercial environment. These stations are frequently hectic within 8.00 am – 11.30 am, when human activities commences and 2.30 pm – 5.30 pm normal daily activities.

2.2 Monitoring of Air Quality parameter

The air quality measurement involved monitoring of the different parameters using specific instrument and method for each parameter. The various methods and instruments applied for the analysis are discussed below.

2.3 Anemometer for wind, temperature, pressure and humidity

A multi-parameter digital anemometer Model No. 45170 was employed in the measurement of the wind speed, and direction in m/s. The measurement involves holding up in an open space with a consideration of a distance. This is to avoid unnecessary interference from shades. Measurement was taken on an hourly basis each day for eight hours. This anemometer is multi-functional: It has the capacity to measure temperature in ^{0}C, Absolute Pressure in Pascal, and Relative Humidity as %. The five parameters were measured at one shot.

2.4 Gas Analyser (TESTO)

A portable gaseous discharge analyzer, the TESTO 350-XL, obtain from Testo Inc. (Testo, 2009), which has the ability to collects and stores data independently for up to 48 hours. It has the ability to measure the concentrations of O_2, CO, NOx, NO, NO_2, SO_2, HC, and H_2S at the same time in the atmospheric air. Features include a menu driven user interface and LCD display. Auto calibration and probe blow back is offered. Flow rate and sensor temperature monitoring for US EPA CTM-030, -034 and ASTM D6522 requirements. For Simple onsite sensor, calibration capability including diagnostics and sensor output is from about (0– 100%). **2.5 Particulate matter**

A Mini Volume instrument, Aerosol gas monitor was used to measure the Particulate Matter. Mini-Volume Portable Air Sampler manufactured by Air metrics is a portable ambient air sampler for particulate (PM_{10} and $PM_{2.5}$) and/or nonreactive gas CO. This instrument was conjointly technologically advanced by EPA and the Lane Regional Air Pollution Authority LRAPA. The sampler consists of a vacuum system and filter housed in a shelter and operates on the same principle as a vacuum cleaner. A known volume of air was drawn through a pre-weighed filter for an 8-hour period. The filter was then re-weighed to determine the mass of the particles collected (WHO, 2016).

2.6 Air quality index

Table 1 below reveals the AQI for criteria pollutants. This is the assessment set by USEPA for determining the quality of the ambient air. The AQI is an index for air quality daily report. It tells you how clean and polluted your air is, and what associated health effects might be of concern for you. The AQI is based on the five "criteria" pollutants regulated under the Clean air act: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. There was a comparative analysis of the results of this study and the USEPA ambient air ratings obtained in the table. The ambient air pollutants are classified into categories ranging from very good to very poor. From (0 – 15) AQI rating is A which is very good, (16 – 31) AQI is B which is good, (32 – 49) AQI is C which is moderate, (50 – 99) AQI is D which is poor and (100 and above) AQI is E is very poor, showing critical values.

AQI pollutant = $x = \frac{\text{Conc.of Pollutant}}{\text{Standard limit}}\ x\ 100$……………………………………………..(1)

Table 1: Air quality index for criteria pollutants

AQI Category	AQI rating	PM_{10} µg/m^3	CO (ppm)	NO_2 (ppm)	SO_2 (ppm)
Very good (0 -15)	A	0 – 15	0 -2	0 – 0.02	0 – 0.002
Good (16 -31)	B	51 – 75	2.1 – 4.0	0.02 – 0.03	0.02 – 0.03
Moderate (32 – 49)	C	76 – 100	4.1 – 6.0	0.03 – 0.04	0.03 – 0.04
Poor (50 – 99)	D	101 – 150	6.1 – 9.0	0.04 – 0.06	0.03 – 0.04
Very Poor(100 or over)	E	>150	>9.0	>0.06	>0.06

Source: USEPA 2000

2.7 Principal Component Analysis

Principal component analysis (PCA) was performed using the SPSS statistical packages (SPSS Inc, USA). PCA is often used in data dimension reduction to identify a small number of factors that explains most of the variance observed in a much larger number of manifest variables (Guo et al., 2004). In this study, VOC concentrations below the detection limits were replaced with 1/2 MDL, and extract factors with eigen-values greater than one were chosen (Lan et al., 2014). We decided that VOCs with values more than twenty percent below the detection limits were excluded from the analysis. The Kaiser Meyer Olkin and the Bartlett's test values also were used for analysis. Variables with factor loadings greater than 0.7 are considered relevant, which indicate a possible emission source. The correlation between the concentration of a particular pollutant and a component increases with its loading (Cheng et al., 2016). PCA was operated on z-score transformed data, which converts the experimental data into zero (mean) and unity (variance) to neutralize the effects of multidimensionality and the different units of the parameters (Pandey et al., 2015). The variance of individual factors in PCA indicate the relative magnitudes among the dominant potential sources (Huang et al., 2012). The SPSS data system helps in proper analysis of the source of the air pollutants which could give a clear road map on the origin of the pollutants.

3. RESULTS AND DISCUSSIONS

The mean of air pollutants in air samples of Isiokpo are displayed in table 2.

Table 2: Mean of air pollutants in air samples of Isiokpo study area

Parameter	Ogbodo	Adanta	Nkarahia	Agwara	Mgbuowhara	Alimini
PM2.5 (mg/m^3)	0.007±0.00	0.005±0.00	0.010±0.00	0.004±0.00	0.008±0.00	0.008±0.00
PM10(mg/m^3)	0.013±0.00	0.011±0.00	0.019±0.00	0.010±0.00	0.010±0.00	0.015±0.00
CO_2 (ppm)	692.6±4.17	321.7±5.12	321.2±5.12	286.3±3.06	337.1±5.30	408.1±5.55
CO (ppm)	ND	0.009±0.00	0.001±0.00	0.016±0.01	0.004±0.00	0.007±0.00
NO_2 (ppm)	ND	ND	ND	ND	ND	ND
VOC (ppm)	0.364±0.01	0.154±0.01	0.133±0.01	0.152±0.03	0.149±0.01	0.124±0.02
H_2S (ppm)	ND	ND	ND	ND	ND	ND
NH_3 (ppm)	ND	ND	ND	ND	ND	ND
CH_4 (ppm)	0.022±0.01	0.008±0.00	0.004±0.00	0.010±0.00	0.010±0.00	0.032±0.01
SO_2 (ppm)	ND	ND	ND	ND	ND	ND
O_3 (ppm)	ND	ND	ND	ND	ND	ND

In table 2 above, the result of the calculated mean value of air pollutants in air samples for Isiokpo study locations are shown. The findings in table reveal that SO_2, NO_2, O_3, H_2S and NH_3 were not detected in all the locations during the monitoring periods at Isiokpo study area. The $PM_{2.5}$ mean value were as follows; Ogbodo area had mean values at 0.007±0.00 mg/m^3, Adanta was 0.005±0.001 mg/m^3; Nkarahia was 0.010±0.00 mg/m^3, Agwara was 0.004±0.001 mg/m^3, Mgbuowhara and Alimini had 0.008±0.001 mg/m^3 respectively. Adoki, (2012) reported air quality of selected locations of the Niger delta with most of their values over 100 $\mu g/m^3$ which is higher than this present report. The report shows that across the six locations of Isiokpo $PM_{2.5}$ was considerably low which could be due to a lot of factors, including climate change, global warming, seasonal variation of temperature and sunshine etc. Ibe et al. (2019) had reported on estimates for the Long-Range Transport of Air Pollutants. The presence of $PM_{2.5}$ at the short time could lead to associated premature mortality, heart and lung sickness and respiratory disorders etc. The mean of PM_{10} from the locations of Isiokpo locations were; Ogbodo; 0.013±0.001

mg/m^3, Adanta was 0.011±0.001 mg/m^3; Nkarahia location mean was 0.019±0.001 mg/m^3, Agwara was 0.010±0.001 mg/m^3, Mgbuowhara 0.010±0.001 mg/m^3, and Alimini; 0.015±0.001 mg/m^3 respectively. The various means across the six locations from this study was low as compared to air quality work of Okeh-Wokeh et al. (2020), on two cities of Aba and Port Harcourt which their values was 500 µg/m^3. The value of PM_{10} in the study could be ascribed to a bit high relative humidity recorded in the study during various months, as low humidity enhances higher accumulation of particulate matter while high reduces it. It can be noted that Nkarahia and Alimini had the highest PM_{10} values; the traffic was higher within these zones at the time of this monitoring. Researches have proven that PM_{10} penetrate deep into the lungs as such its high amount is not good for inhabitant of an area. This study suggests a PM_{10} that is not too high but its accumulation may not be friendly to those residing within the area of these research, therefore the need for a cleaner air and a better life of these people.

The level of CO_2 ranged from 286.3 to 692.6 ppm for the six locations monitored in the Isiokpo zone. The mean value of CO_2 was highest mean for Ogbodo at 692.6±4.12 ppm.

The value for CO differed considerably from one location to another across the various locations of Isiokpo study area. The air pollutant was not detected in Ogbodo community. The most mean was for Agwara with value at 0.016±0.01 ppm which was higher than the standard limit of 0.01 ppm. This higher value indicates that vehicular and human activities is high at the said location. The high level of CO may be deleterious to humans who might inhale the gas. The presence of CO in the blood stops transmission of blood to other parts of the body, because CO combine with haemoglobin by displacing oxygen to form carboxy-haemoglobin instead oxy-haemoglobin which is the carrier of blood to parts of the body, this singular action can lead to death. This is the reason for the many incidences of death from generator exhaust fume. A level of 50% carboxy-hemoglobin may result in seizure, coma, and death. These effects can take place over short durations, as carbon monoxide absorption is cumulative, with a half-life of about 5 hours in fresh air.

The volatile organic compounds (VOC) were in a significant amount in all the study locations of Isiokpo. The highest mean was for Ogbodo at 0.364±0.04 ppm, and the least was for Adanta at 0.154±0.01 ppm. These volatile organic compounds mean values were higher than works by Widiana et al. (2017), on VOC around municipal wastewater treatment plant in North Taiwan, with their values at over 2000 ppb. These VOCs are suspected and proven carcinogens which can easily endanger human health if inhaled at relative amount. They also contribute to the formation of ground level ozone.

The methane was found in all the air samples of the study. The highest level of methane was at Alimini; 0.032±0.01 ppm and the least was for Ogbodo; 0.022±0.00 ppm. The levels of the methane can be from variety of sources like landfills, mobile combustion and waste treatment processes. The abundance of methane can lead to climate change due to its ability to trap heat in the atmosphere. Presence of methane can enhance the abundance of tropospheric ozone.

The pollution levels were higher in some areas as compared to others but not relatively high as it might not easily noticeable.

Table 3 Estimated meteorological parameters of Isiokpo study locations

Parameter	February-March	April - May	June – July	August – September
RH (%)	75.00	76.00	85.90	87.60
WS (m/s)	2.000	0.9	1.00	1.500
WD(^{o})	NW 71^o	NE 91^o	NW 58^o	SE 41^o
Temp. (^{o}C)	34.10	32.01	30.09	29.80
Pressure (Pa)	1015	1012	1009	1009
Altitude	32.00	32.00	32.00	32.00
Noise (decibel)	75.80	72.30	68.20	66.90

RH = Relative humidity, WS = Wind speed, Temp. = Temperature

Table 3 present the meteorological parameters of Mgbuowhara area of Isiokpo which also affects the amount of pollutants in the atmosphere at a particular time. The range values were thus: relative humidity was from 75.00 to 87.60% in the period stipulated, wind speed was 2.0 m/s to 0.90 m/s, Temperature was 34.10 to 29.80^{o}C, pressure was from 1015hPa to 1009 hPa, the height was 32.0m, and the highest noise level was 75.80 dB.

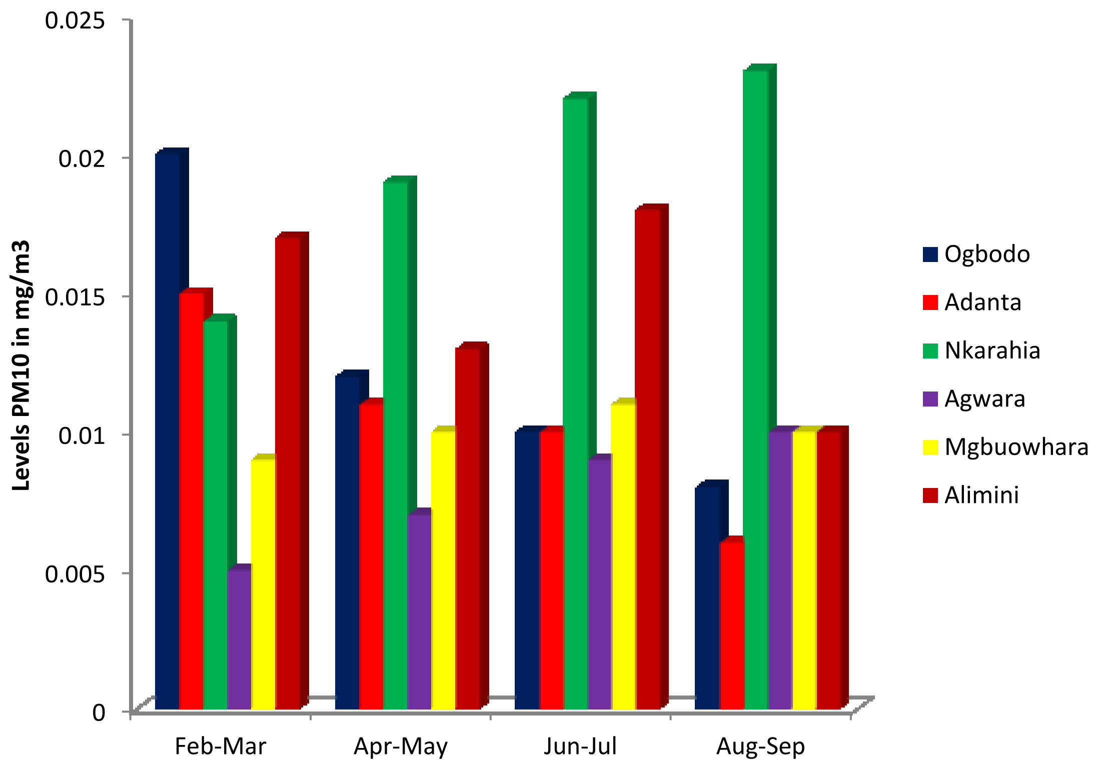

Figure 1: Differences in levels of PM_{10} across different months in air samples of Isiokpo

Figure 1 present the monthly and locational variations of PM_{10} for air quality of Isiokpo study areas. The orders were as follows: February to March; Ogbodo>Alimini>Adanta>Nkarahia>Mgbuowhara>Agwara, April to May; Nkarahia>Alimini>Ogbodo>Adanta>Mgbuowhara>Agwara, June to July; Nkarahia>Alimini>Mgbuowhara>Adanta>Ogbodo>Agwara, August to September; Nkarahia>Mgbuowhara>Agwara>Adanta>Ogbodo>Alimini. The overall pollution levels of the locations are thus: Nkarahia>Alimini>Ogbodo>Adanta>Mgbuowhara>Agwara.

The presence of PM_{10} is more in Nkarahia and Alimini areas of the study.

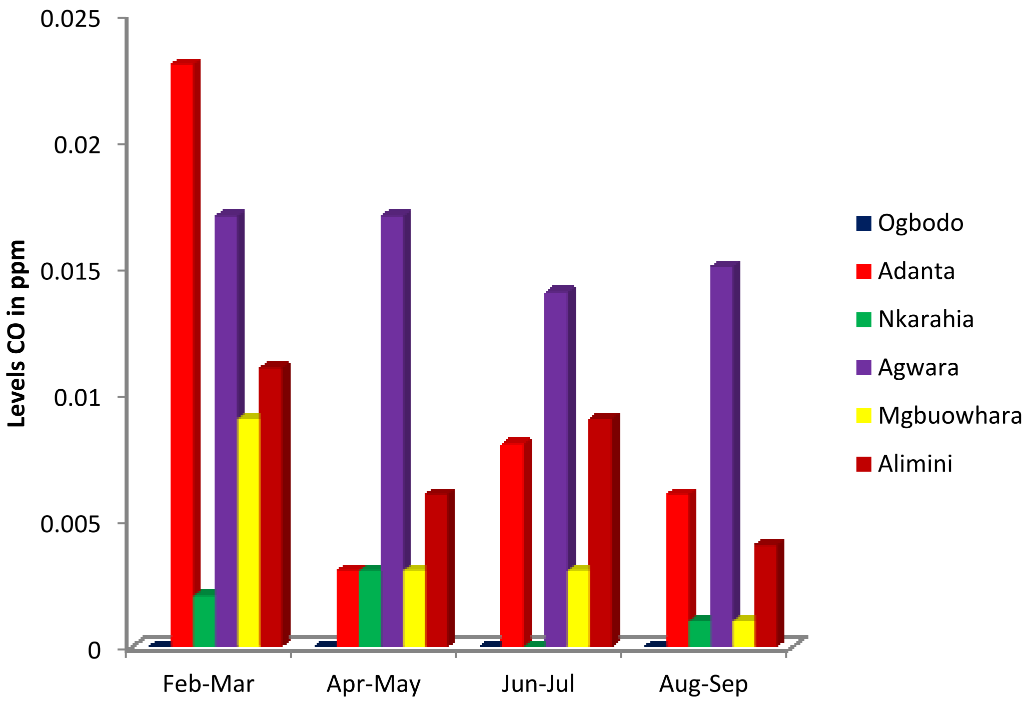

Figure 2: Differences in levels of CO across different months in air samples of Isiokpo

Figure 2 present the differnces in pollution levels of the study sites in Isiokpo due to the presence of CO. The overall CO level shows that the dominant period was from February to March, followed by June to July, April to May was third and the least polluted period was August to September. The meteorological factors must have played a significant role on this.

CO had higher pollution in air samples of Agwara followed by Adanta, Alimini and Mgbuowhara while the pollution from CO were low for Nkarahia and Ogbodo.

Table 4: Relationship between the different mean of air pollutants in samples of Isiokpo study area

Parameter	Ogbodo	Adanta	Nkarahia	Agwara	Mgbuowhara	Alimini
PM2.5 (mg/m^3)	0.007±0.00^{b}	0.005±0.00^{a}	0.010±0.00^{b}	0.004±0.00^{a}	0.008±0.00^{b}	0.008±0.00^{b}
PM10(mg/m^3)	0.013±0.00^{a}	0.011±0.00^{a}	0.019±0.00^{b}	0.010±0.00^{a}	0.010±0.00^{a}	0.015±0.00^{b}
CO_2 (ppm)	692.6±4.17^{d}	321.7±5.12^{b}	321.2±5.12^{b}	286.3±3.06^{a}	337.1±5.30^{b}	408.1±5.55^{c}
CO (ppm)	-	0.009±0.00^{b}	0.001±0.00^{a}	0.016±0.01^{c}	0.004±0.00^{a}	0.007±0.00^{b}
NO_2 (ppm)	-	-	-	-	-	-
VOC (ppm)	0.364±0.01^{b}	0.154±0.01^{a}	0.133±0.01^{a}	0.152±0.03^{a}	0.149±0.01^{b}	0.124±0.02^{a}
H_2S (ppm)	-	-	--	-	-	-

NH_3 (ppm)	-	-	-	-	-	-
CH_4 (ppm)	0.022±0.01[b]	0.008±0.00[a]	0.004±0.00[a]	0.010±0.00[a]	0.010±0.00[a]	0.032±0.01[c]
SO_2 (ppm)	-	-	-	-	-	-
O_3 (ppm)	-	-	-	-	-	-

Table 5: Air quality index of selected pollutants in ambient air of Isiokpo study locations

Parameters	Ogbodo	Adanta	Nkarahia	Agwara	Mgbuowhara	Alimini
PM2.5	B (Good)	B (Good)	C (Moderate)	B (Good)	C (Moderate)	C (Moderate)
PM10	A (Very good)	A (Very good)	A (Very good)	A (Very good)	E (Very poor)	E (Very poor)
CO	-	D(Poor)	E (Very poor)	E (Very poor)	C (Moderate)	D(Poor)

In terms of Air Quality Index (AQI) rating, table 4 reveals that the air quality ranking due to $PM_{2.5}$ across all the sampling locations in Isiokpo metropolis shows Good to moderate air quality.

PM_{10} contamination level showed that the air quality was very good in all the stations sampled within Isiokpo and its environment. CO was revealed that the air quality was very poor for Nkarahia and Agwara, poor for Adanta and Alimini, and moderate for Mgbuowhara while the Ogbodo had no CO detection.

Table 6: Principal Component loadings of air pollutants in samples of Isiokpo area

Parameters	PC1	PC2	Communality
$PM_{2.5}$	0.98	0.14	0.981
PM_{10}	0.86	0.46	0.916
CO	0.86	0.10	0.750
VOC	0.21	0.84	0.750
CO_2	0.24	0.76	0.635
CH_4	0.09	0.71	0.512
Temp.	0.74	0.02	0.548
RH	0.086	0.81	0.660
Eigen value	6.270	1.750	
% Variance	54.09	16.89	
% Cumulative	54.09	70.98	

Temp. = temperature, RH = Relative humidity

The PCA was carried out to assess how the monitored parameters are clustered by generally showing the level of variation between the parameters (Table 6). Principal component investigation enables the classification of the air pollutants and possible sources answerable for the difference in pollutants in the atmospheric air samples. The eigen value was 6.720 for PC1 and 1.750 for PC2. The findings show that PC had an overall percentage of 70.98% of the differences in the perceived variables with the first component accounting for 54.09% while the second component had 16.89% respectively. $PM_{2.5}$ had 0.98 and 0.14 for PC1 and PC2, PM_{10} had the following values; 0.86 for PC1 and 0.46 for PC2, CO; 0.86 for PC1, 0.10 for PC2, VOC; 0.21 for PC1, and 0.84 for PC2, CO_2; 0.24 for PC1, and 0.76 for PC2, CH_4; 0.09 for PC1 and 0.71 for PC2. The PC values for temperature were 0.74 for PC1 and 0.02 for PC2, while relative humidity had 0.086 for PC1, and 0.81 for PC2.

The results of the PCA showed that air pollutants concentration across the Isiokpo locations were highly influenced to a large extent by particulate matter-related activities during the 8 months interval. PM is produced from agricultural field operations and animal production activities (Oyebanji et al., 2019). This observation is in tandem with the study of Forero et al. (2017) which stated that total suspended solids (TSP) is released during planting seasons 6.2 times higher than land tilling and other wind events. The components of particulates are diverse (Morankinyo et al., 2016), and this explains the reasons for having PM and other pollutants in the same group. Ibe et al. (2020), recognized that to unravel the PM menace, anthropogenic point sources of PM are very significant. Also, temperature and relative humidity were sources of variations in PC1 and PC2, respectively, during the August to September period. The behaviour of air pollutants is often predisposed by climatic conditions like rainfall, which is related to relative humidity because of the scavenging effects on particulate concentrations and the impact of temperature to determine the motion and speed of air pollutants (Jayamurugan et al., 2013).

CO is loaded on this PC1 which is the result of incomplete combustion of fuel in vehicle engine due to acceleration, load and poor maintenance. Its concentration varied with traffic circulation level and air/fuel ratio (Zakari et al., 2018). Furthermore, the vehicles at the nearby traffic light intersection is in inactive position with engine exuded more CO compared to free flow condition (Kim & Kim, 2020). The removal of CO as it reacts with OH radicals produced by the photolysis of O_3 contributes in the variation of its concentration (Deng et al., 2019). PC2 represents global warming gases as CO_2 and methane were loaded on it with values 0.76 and 0.71 respectively. The main source of CO_2 is the fuel combustion in vehicles and in heating at homes during the cold season winter. On the other hand, decaying of organic domestic waste in the nearby residential area and wastewater are the main sources of methane.

4.0 CONCLUSION

The findings from the study revealed that all the air pollutants did not exceed the stipulated permissible limit except for H_2S which could be due heavy traffic, seasonal and climatic variations, within the zones of this recent study. This investigative study has revealed that selected meteorological factors had minimal effect on the quality of the atmospheric air within the areas selected for this study. The findings suggest that Nkarahia had most pollutants in the atmospheric air and the order due to PM2.5 presence is as follows; Nkarahia>Alimini>Mgbuowhara>Ogbodo>Agwara while PM10 was Nkarahia>Alimini>Ogbodo>Mgbuowhara>Agwara. Port Harcourt had PM2.5 in the following order Rumuokoro>Mile III>old Township>Trans Amadi>Industry Road>Old GRA, while PM10 was Old Township>Rumuokoro>Trans Amadi>Old GRA. The findings showed that majority of the pollutants were of diverse sources. It is recommended that provision of laws and regulations to ensure that release of pollutants of harmful nature is prohibited and defaulters punished accordingly.

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