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Studies On the Levels and Sources of Air Pollutants in Port Harcourt Metropolis and Its Environment

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ABSTRACT

The current study uses various approaches to assess the levels and possibly identify the source of atmospheric air pollutants in ambient air within designated areas of Port Harcourt metropolitan city of Rivers state. The pollutants of interest were particulate matters (PM2.5 and PM10), NO2, SO2, CO, CO2 O3, CH4, and NH3. The concentrations of air pollutants were evaluated using in-situ portable aeroqual gas detector and particulate matter counter. The source identification was carried out using principal component analysis (PCA). The average value for air pollutants in Port Harcourt zone were as follows: PM2.5 – Rumuokoro; 0.138±0.01 mg/m3, Mile III; 0.118±0.02 mg/m3, Old Township; 0.109±0.010 mg/m3, Trans Amadi; 0.072±0.00 mg/m3, Old GRA; 0.021±0.01 mg/m3, Industry Road; 0.060±0.00 and PM10 - Old Township; 0.682±0.01 mg/m3, Mile III; 0.549±0.07 mg/m3, Rumuokoro; 0.445±0.02 mg/m3, Trans Amadi; 0.117±0.01 mg/m3, Old GRA; 0.030±0.00 mg/m3, Industry Road; 0.084±0.00 mg/m3. The air pollution levels of the locations reveal more pollutants in Rumuokoro and Mile III. SO2, NO2, O3, and NH3 were not detected in the study. Air Quality Index (AQI) rating reveals that the air quality of Port Harcourt areas had varying pollution statuses. The source apportionment estimation reveals multiple sources of air pollutants with vehicular emission, indiscriminate burning of refuse, combustion activities and household pollution. This research work has proven that some weather-related factors had negligible effect on the levels of pollution of the atmospheric air of the current study areas. It is appropriate to state that inhabitants of the study area may need to minimize certain activities to avoid the release of air pollutants to the environment which could endanger human health.

Keywords: Pollutants, Source Apportionment, Port Harcourt, and Air pollution

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INTRODUCTION

City development is a necessary process that is inevitable and comes with numerous issues. According to the United Nation (UN), over 90% of city growth is occurring in the local areas of the world called the developing countries (UN-Habitat, 2006). Report has it that the population of the cities within the developing countries will get to an estimated two billion in the next twenty years and having an increase of over seventy million per year. The populations in the urban areas of Africa and Asia will be double at that time. By 2030, 80% of the total world's urban population will be living in developing countries. Nigerian oil-bearing areas are recently urbanizing. It is estimated that over 50% of the population will be living in the cities in 2050 compared to 20% in 1990. This will put more pressure on the air environment as more obnoxious gases will be released into the atmosphere (World Bank, 2009b). Nigerian Niger Delta region is undergoing a rapid process of urbanization and modernization process which is not slowing down due to the system (World Bank, 2009a). Currently, there is a serious need for environmental experts with competent specialized knowledge who can be responsible for improving the environmental conditions, especially in urban and industrial areas. In most urban centres, there are many environmental problems and the air pollution problems in particular are also accelerating. Air quality is important simply because we have to breathe the air around us. People who live in industrial cities should be especially concerned, since we are exposed to a greater amount of pollutants coming from industries, automobile traffic, commercial, as well as other sources. (Environmental assessment and policy, 2010). Air pollutants can cause a variety of health problems - including breathing problems; lung damage; bronchitis; cancer; and nervous system damage. Air pollution can also irritate the eyes, nose and throat, and reduce resistance to flu and other illnesses. Air pollution causes haze and smog, reduces visibility, dirties and damages buildings and other landmarks, and harms trees, lakes and animals. (Environmental assessment and policy, 2010). Air pollution is responsible for thinning the protective ozone layer in the upper atmosphere that protects us from harmful ultraviolet radiation from the sun, and may be contributing to the phenomenon known as global warming- the steady increase in average temperature of the global climate. (Environmental assessment and policy, 2010). Air quality monitoring is important so as to determine whether a limit value or guideline has been exceeded. Air quality monitoring systems should mainly address population exposure to air pollution. Cedigaz (2000), Nigeria holds the highest record (19.79%) of natural gas flaring globally and is responsible for about 46% of Africa's total gas flared per tonne of oil produced. Until present, there are not less than 123 flaring sites in the region making Nigeria one of the highest emitters of greenhouse gases in Africa (Uyigue & Agho, 2007). Similarly, analytical assessment of the statistical bulletin of the Central Bank of Nigeria, (2004) showed that the average rate of gas flaring in Nigeria during the period 1970-1979 stood at 97%, while 97% and 95% were flared between 1980 and 1989, and 1990 to 1999 respectively; between 2000 and 2004, 51% was flared. In the same vein, between 1970 and 2004 Nigeria has flared an average of 76% of the total gas produced. Much of the natural gas extracted in oil wells in the Niger Delta is immediately flared into the environment at a rate that approximates 70 million /m3 per day. This is equivalent to 40% of African natural gas consumption and forms the single largest source of greenhouse gas emissions on the planet (Moffat & Linden, 1995). This current study employs various standard methods to assess the levels of air pollutants and their possible sources in air samples of Port Harcourt Metropolis and its environment, Niger Delta, Nigeria.

MATERIALS AND METHODS

2.1 The Study Area

The selected locations for this research are industrial, mining, commercial, high traffic, and vehicular emission areas. These stations are frequently hectic within 8.00 am – 10.00 am, when human activity commence and 3.00 pm – 6. 00 pm normal daily activities. Port Harcourt is a city with over three million persons, this have led to numerous anthropogenic activities at a very high level. It is the commercial, industrial and mining nerve center of Rivers State, it serves as the capital of the state in the Niger delta district of Nigeria. Port Harcourt city is a city in Nigeria that is highly urbanized and has a very high population with a daily influx of people who come for their daily bread. The study area which is Port Harcourt is a multicultural city with numerous anthropogenic happenings. Port Harcourt and its environment comprise of different local government; Port Harcourt City Local Government, Obio/Akpor Local Government, Oyigbo Local Government area, Okrika Local Government, Eleme local Government and Ikwerre Local Government areas. The city covers about 369 km2 (142 sq miles) in land area and 9 km2 in water area, while the metropolitan area of the city is about 1900 km2. The coordinates of the city of Port Harcourt are 4o 49’ 27’’ N and 7o 2’ 1” E. The Port Harcourt city is the commercial hub, boat building, fishing, mining and industrial centre with several industries (UN-Habit, 2006). Rumuokoro is a major town inside the city of Port Harcourt; the roundabout is the meeting point of five major roads like the major east west road, Ikwerre road, Rumuagholu, Airport Road, Eligbolo road respectively. Rumuokoro junction has bus and taxi terminals which are point of discharge of passengers by bus and taxi drivers. It is the first point of call arriving from lagos, Benin city, Abuja, Owerri, Onitsha and the Port Harcourt International Airport. It houses multiple bus stops which travellers’ catches taxis and buses to leave the city for other part of Nigeria. The other commercial centers are the mile I, and mile III areas and are characterized heavy traffic flow from auto commercial vehicles and individual vehicles too, with car parks where they load to all parts of the Niger delta and Nigeria. Mile III junction is a popular traffic junction in Port Harcourt situated along Ikwerre road enroute to Rumuokoro. It is also a bus terminal for buses and taxis leaving for different part of Rivers State. It has a major market which increases the inflow of traffic as traders and commuters bring in goods and also come to the market for buying and selling. Port Harcourt also have industrial centers with numerous companies and industries, this aid emission from cars, generating sets, industrial machines etc. Notable amongst companies are Total Exploitation and production Nigeria Limited (TEPNL), Nigeria Agip Oil Company (NAOC) and Shell Petroleum Development Company (SPDC). Apart from that, the closeness of these industrial layouts to the study area, also plays a very important role in the levels of contamination of the ambient air of districts within the Port Harcourt Metropolis. The presence of industries around Industry Road plays a key role in polluting the ambient air within the study area (Agarwal & Melkania, 2018).

2.2 Sampling Equipment

The monitoring was done using modern portable digital hand-held air monitors. PM2.5 and PM10 was determined with Kanomax 3900 particle counter which has a high resolution and ability to detect particulate matters even at very small amount.

The other equipment includes an aeroqual environmental gas monitor equipped with the infrared sensor and was used to measure CO, NO2, and SO2.

The VOCs and O3 was monitored with Aerocet 531 particle mass monitor which has the capacity to detect presence of the contaminants at very small amount. The wind speed and direction, temperature, and relative humidity was sampled using digital hand held cole – parmer combination Anemometer (Adoki, 2012).

The measurements with the different monitors were carried out by initial warming of the instrument for some minutes (3minutes); this was done in other to burn off any pollutant on the sensor of the device. The sampling was carried at individual sampling points for 3 days on 24 hours interval. The instrument was placed at a height 1.5m above the ground level to ensure accurate capturing of the data.

2.3 Frequency of Sample Collection

The monitoring of ambient air quality is a prerequisite to knowing the extent of quality of air in any chosen area of study. The monitoring was an hourly sampling for a period of eight hours in a day starting from 8.00 am to 4.00 pm and the average taken for each location. This was done continuously for the period of the sampling as to ascertain the true content of the pollutants in the air. This was done in a period of three months between April – June 2021 that covers for the late dry and early wet season period.

2.4 Analysis of Data

The major data analysis especially mean, variability, histogram and graphical analysis, standard deviation, correlation and multivariate was carried out using excel spreadsheet.

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

Table 1 shows the AQI for criteria pollutants. This is the rating set by USEPA for determining ambient air quality. The AQI is an index for air quality daily report. It tells you how clean and polluted you 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, sulphur dioxide, and nitrogen dioxide. The results of this research work and the ambient air measurement will be compared with the USEPA ambient air ratings obtained in the table. The pollutants are classified into the following categories. 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.

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

2.5 Source apportionment via Principal component analysis (PCA)

The possible sources of the pollutants were obtained from data of the principal component analysis (PCA) performed using the SPSS statistical packages (SPSS Inc, USA). 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).

3 RESULTS AND DISCUSSIONS

3.1 Mean of Air Pollutants

The mean of air pollutants in air samples of the current study are displayed in table 1 and the result presentation and discussion as follows.

Table 2: Mean of air pollutants in air samples of Port Harcourt study area

Parameter	Trans Amadi	Old GRA	Industry Road	Rumuokoro	Mile III	Old Township
$PM_{2.5}$ (mg/m^3)	0.072±0.00	0.021±0.01	0.060±0.00	0.138±0.01	0.118±0.02	0.109±0.01
PM_{10}(mg/m^3)	0.117±0.01	0.030±0.00	0.084±0.00	0.445±0.02	0.549±0.07	0.682±0.01
CO_2 (ppm)	678.8±7.94	752.8±11.3	622.0±9.87	473.6±4.23	537.1±5.30	540.1±7.30
CO (ppm)	ND	ND	ND	0.009±0.0	0.003±0.00	0.005±0.00
NO_2 (ppm)	ND	ND	ND	ND	ND	ND
VOC (ppm)	0.197±0.02	ND	0.044±0.01	0.021±0.00	ND	ND
H_2S (ppm)	0.108±0.01	ND	0.090±0.01	ND	1.610±0.18	1.341±0.08
NH_3 (ppm)	ND	ND	ND	ND	ND	ND
CH_4 (ppm)	0.031±0.01	ND	1.1680±0.01	0.011±0.01	ND	ND
SO_2 (ppm)	ND	ND	ND	ND	ND	ND
O_3 (ppm)	ND	ND	ND	ND	ND	ND

Table 2 represents the average value of air pollutants in the selected areas of Port Harcourt and its environment. The table shows that the following pollutants; SO_2, NO_2, O_3, and NH_3 were not among the detected pollutants. There were variations of the mean values across the six areas sampled in the Port Harcourt zone of this current study. The overall result indicated some locations were high as compared to others. The mean for $PM_{2.5}$ were highest for Rumuokoro at 0.138±0.01 mg/m^3, Mile III at 0.118±0.02 mg/m^3, and Old Township was 0.109±0.010 ppm. The presence of $PM_{2.5}$ has a great effect on humans and the environment, it travels deeply into the respiratory tract reaching to the lungs. The result in the Port Harcourt area was lower than report by Njoku et al. (2016), on sites around Lagos for SPM (0.14 – 4.82 ppm). This result indicates levels of impact from closer sources but is minimal. The air pollutants were all below the permissible limit for parameters checked. It goes to show that human activities had a lesser impact on the air quality as compared to the highly industrialized zone. The table also presented mean values for PM10 for the following locations: Old Township; 0.682±0.01 mg/m^3, Mile III; 0.549±0.07 mg/m^3, and Rumuokoro at 0.445±0.02 ppm. These mean results were all higher than standards by USEPA and DPR for the presence of pollutants in ambient air. The levels of pollutants may be as a result of the numerous activities within Port Harcourt and its environs. There are numerous factories while some are operational, others are shutdown at some time. This might have the singular reason why the air pollutant was minimal in some of the area under consideration as compared to the others. The other reason might also be due to low vehicular traffic since industry road is a major route for daily operation of taxis and buses.

The CO_2 levels were far below 1000 ppm the permissible limit which is the point where it shows sign of health challenges like headache, sleepiness, and stagnant, stale and stuffy air. It worthy of note that the result shows the level of human activity which has impacted the area especially during the dry season with values higher than the normal WHO standard for some of the pollutants, though the values may be high but it cannot be concluded that it will be of health since the concentration of the pollutants varies with lots of factors like wind, humidity, temperature, pressure and others. The Carbon monoxide (CO) levels were below detection limits for Trans Amadi, Old GRA, and Industry Road locations while the areas detected were; Rumuokoro; 0.009±0.00 ppm, Mile III; 0.003±0.00 ppm, and Old Township; 0.005±0.00 ppm. This report was lower than that by Gobo et al. (2012), within refinery area of Okrika community with values at 2.7 ppm during the dry season. The CO concentration in this study is quite similar to those reported by Olajire et al. (2011) in a study of air pollutants along Oba Akran road, Ikeja Lagos and were much higher to the results obtained for heavy traffic points in Ibadan and Ado Ekiti (Koku & Osuntogun, 2007). The main reason why CO is dangerous is that of its ability to combine with blood hemoglobin to form oxy-haemoglobins which prevent the passage of oxygen to different parts of the body. The mean values of the VOC were as follows; Trans Amadi; 0.197±0.02 ppm, Industry Road; 0.044±0.01 ppm, and the non-detected locations were Old GRA, Mile III and Old Township. Some typical examples of VOCs are Paints/lacquers, formaldehydes, paint strippers, pesticides, building materials/furnishings, and glues/adhesives which also have health implications to the environment when in excess amount and some of includes damage to the liver, kidney, brain, spinal cord, and other illnesses. They have health consequences since they produce resilient odour which causes the rate of its volatility to be very high and its migration to the surroundings easier and also very fast. Report from health agencies indicates that 7500ppm of VOCs for one hour is dangerous to human health. The WHO recommended a standard limit of 0.3 ppm for indoor air quality. Although the level of tolerance depends the agency or the country, therefore making it varies from place to place. Table 2 also indicated the mean H_2S which was lower than WHO standard for 24 hours in all the six areas monitored. The pollutant was not detected in Old GRA, and Rumuokoro. The results were as follows: Mile III (1.610±0.0.18 ppm), and Old Township (1.341±0.08 ppm) respectively. This mean was higher than report by Gobo et al. (2012), on stations around Port Harcourt and Okrika which could be as a result of meteorological factors, time and season of monitoring. H_2S release into the atmospheric environment is mostly through crude oil refining in the hydrotreatment unit which easily liberates sulphur in the form of hydrogen sulphide into the atmospheric environment. Hydrogen sulphide can also be introduced into the environment through motor vehicle emission, emission from diesel machines and industrial gaseous fuels. The presence of these pollutants can increase the atmospheric acidity, which could later result to acid rain via precipitation. If excess amount of the air pollutant is inhaled it can lead to serious health issues such as heart burn, cancer growths, and respiratory disorder etc. The level of the contaminant is high and could as well be of concern. The methane was not detected in Mile III, Old GRA, and Old Township accordingly. The most mean were for Industry road at 1.1680±0.01 ppm, and Trans Amadi at 0.031±0.01 ppm. The presence has about 80 times the warming power of carbon dioxide. Methane has the ability to trap heat and release same to the environment, therefore causing the warming of the atmosphere and increase in temperature. At the concentration recorded in this study it may not be deleterious to the environment but it may have direct effect on man if it is inhaled. The Port Harcourt atmosphere shows an indication of pollution to an extent though not to the sever manner for some of the pollutants while some were high enough to be of concern.

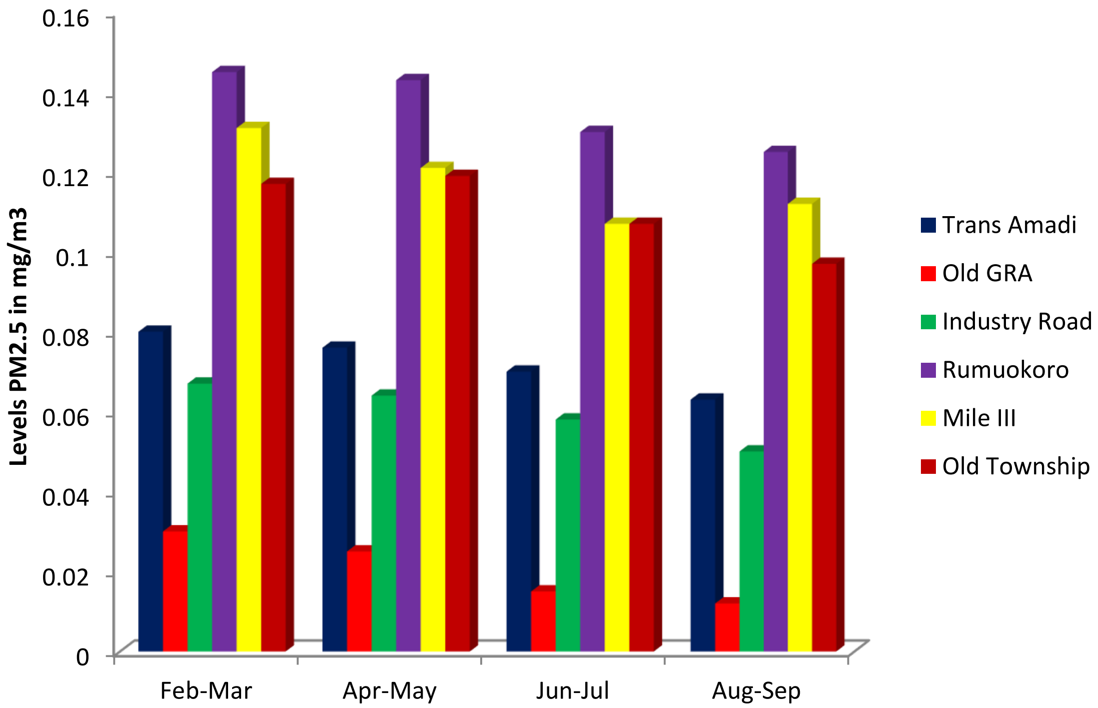

Figure 1: Differences in levels of PM2.5 across different months in air samples of Port Harcourt metropolis. Figure 1 present the sample level of PM2.5 for Port Harcourt environmental, which differed on many factors. The overal order was Rumuokoro>Mile III>Old township>Trans Amadi>Industry Road>Old GRA respectively. The levels of pollutants in Rumuokoro and Mile III are anticipated due to vehicle movement around both locations. The monthly variation were thus: February-March>April-May>June-July>August- september. The monthly variation is normal due to climate and weather around the specified periods.

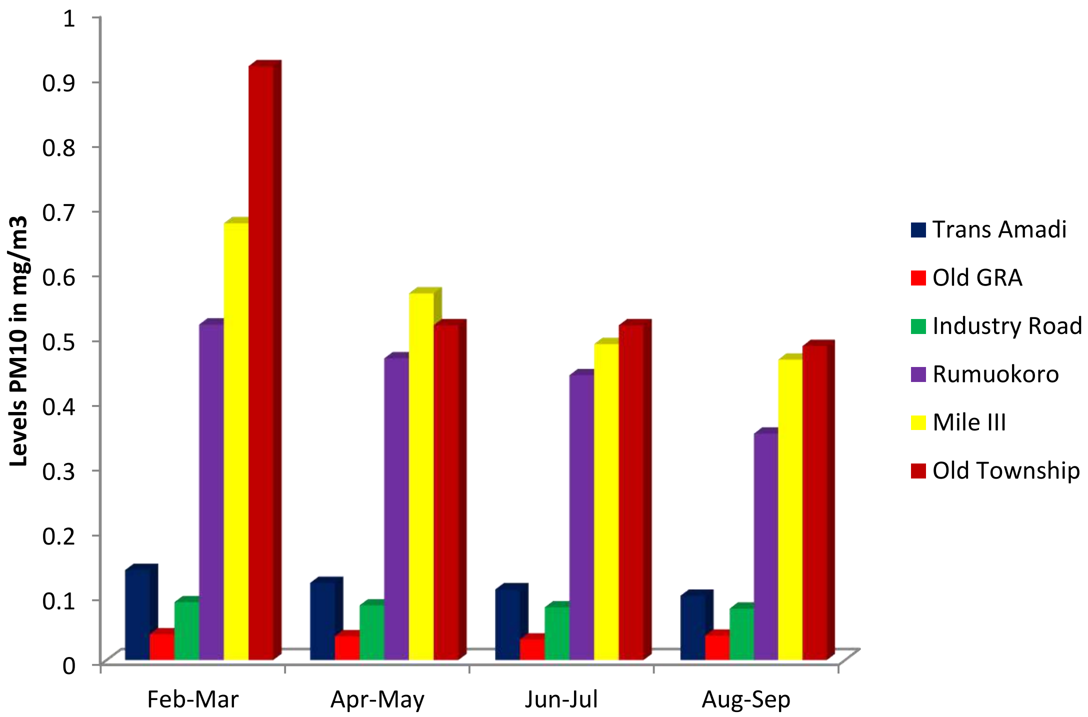

Figure 2: Differences in levels of PM_{10} across different months in air samples of Port Harcourt metropolis. Figure 2 represent the levels of PM_{10} across thje Port Harcourt study areas of the current research work. The montly order were February-March>April-May>June-July>August-September. The most PM_{10} pollutants were observed in Old township, followed by Mile III, Rumuokoro and Trans Amadi while the least were for Industry Road and Old GRA. The values for Old GRA were expected since it is a residential area and also serve as a source of control.

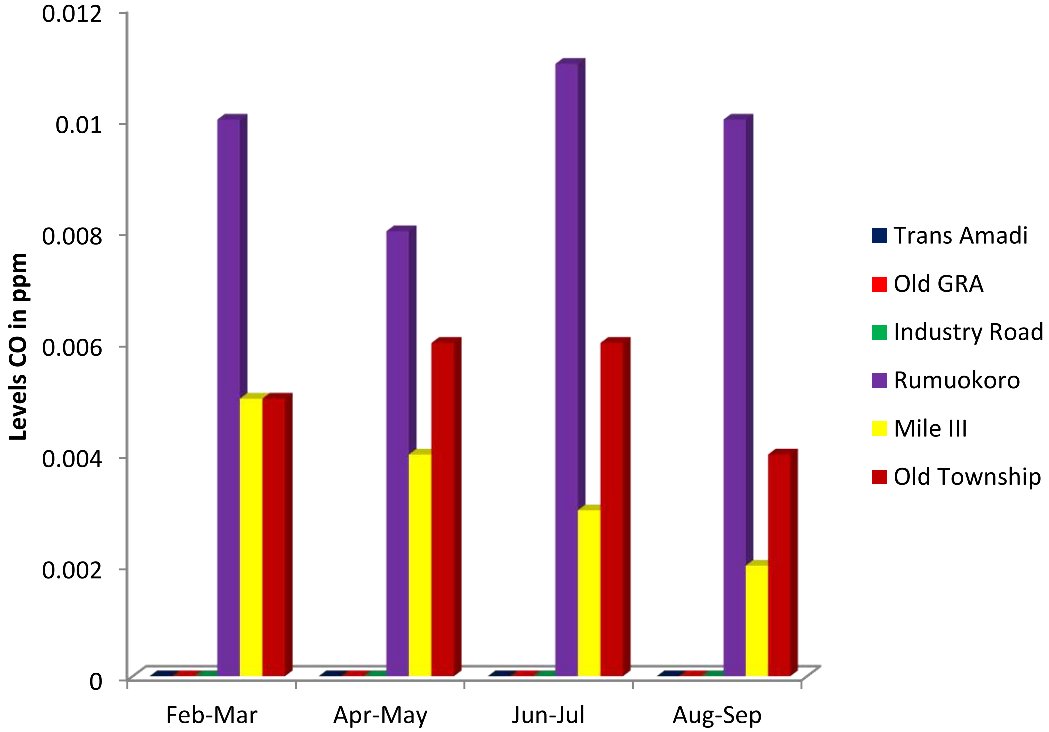

Figure 3: Differences in levels of CO across different months in air samples of Port Harcourt

Figure 3 present CO presence in Port Harcourt ambient air. The order was Rumuokoro more than Old Township which is greater than Mile III. The most pollutant was found in June/July period, followed by February/March while the least were August to September and April to May.

3.2 Meteorological Values

Table 3 Estimated meteorological parameters of current study

Parameter	February-March	April – May	June – July	August – September
RH (%)	71.98	72.09	76.08	87.60
WS (m/s)	4.980	4.500	4.100	3.670
WD(^{o})	NE 45^o	NE 51^o	NW 38^o	SE 41^o
Temp. (^{o}C)	38.00	34.00	30.00	28.00
Pressure (Pa)	1005	1008	1007	1009
Altitude	11.00	11.00	11.00	11.00
Noise (decibel)	82.00	80.00	78.00	76.00

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

Table 3 present the meteorological parameters of Port Harcourt metropolis of this current study. The range values were as follows: relative humidity was from 71.98 to 87.60%, wind speed was 4.980 m/s to 3.670 m/s, Temperature was 38.00 to 28.00°C, pressure was from 1005 hPa to 1009 hPa, the height was 11.0m, and the highest noise level was 82.00 dB.

3.3 Correlation of the air pollutants from the different locations

The difference and similarity between the various pollutants across the different locations is displayed in table 4.

Table4: Mean relationships of air pollutants in air samples of Port Harcourt study area

Parameter	Trans Amadi	Old GRA	Industry Road	Rumuokoro	Mile III	Old Township
PM2.5 (mg/m^3)	0.072 ± 0.00^b	0.021 ± 0.01^a	0.060 ± 0.00^b	0.138 ± 0.01^c	0.118 ± 0.02^c	0.109 ± 0.01^c
PM10(mg/m^3)	0.117 ± 0.01^b	0.030 ± 0.00^a	0.084 ± 0.00^b	0.445 ± 0.02^c	0.549 ± 0.07^c	0.682 ± 0.01^d
CO_2 (ppm)	678.8 ± 7.94^d	752.8 ± 11.3^e	622.0 ± 9.87^c	473.6 ± 4.23^a	537.1 ± 5.30^b	540.1 ± 7.30^b
CO (ppm)	-	-	-	0.009 ± 0.0^a	0.003 ± 0.00^a	0.005 ± 0.00^a
NO_2 (ppm)	-	-	-	-	-	-
VOC (ppm)	0.197 ± 0.02^b	-	0.044 ± 0.01^a	0.021 ± 0.00^a	-	-
H_2S (ppm)	0.108 ± 0.01^a	-	0.090 ± 0.01^a	-	1.610 ± 0.18^b	1.341 ± 0.08^b
NH_3 (ppm)	-	-	-	-	-	-
CH_4 (ppm)	0.031 ± 0.01^a	-	1.1680 ± 0.01^b	0.011 ± 0.01^a	-	-
SO_2 (ppm)	--	-	-	-	-	-
O_3 (ppm)	-	--	-	-	-	-

Table 4 presents the differences and similarity of some of the mean ambient air quality parameters of Port Harcourt locations in this current study. The correlation reveals that the mean concentration of PM2.5, PM10, CO_2 in Trans Amadi and Industry Road had clear significance difference with mean concentrations of samples of Rumuokoro Mile III, Old Township and Old GRA respectively ($p<0.05$) while CO shows that mean of Rumuokoro and Old Township had strong significant difference with the mean of Trans Amadi, Old GRA and other locations of the Port Harcourt study area ($p>0.05$). The result further revealed that the mean of VOC, H_2S, and CH_4 air pollutants had varying degree of significant difference in the concentration across the different locations of the Port Harcourt area ($p>0.05$).

3.4 Air Quality Index

The air quality index estimation of the study is presented in table 5 and is among the various areas of Port Harcourt under investigation.

Table 5 Air quality index of selected pollutants in ambient air of Port Harcourt study locations (Method I)

Parameters	Trans Amadi	Old GRA	Industry Road	Rumuokoro	Mile III	Old Township
PM2.5	E (Very poor)	D (Good)	E (Very poor)	E (Very poor)	E (Very poor)	E (Very poor)
PM10	E (Very poor)	B (good)	E (Very poor)	E (Very poor)	E (Very poor)	E (Very poor)
CO	-	-	-	C (Moderate)	A (Very good)	A (Very good)
H_2S	B (Good)	-	B (Good)	-	E (Very poor)	E (Very poor)

Table 5 displayed the air quality index for Port Harcourt locations with wide variation on the quality level due to concentrations difference. Presence of PM2.5 made the air quality to be very poor for the locations except for Old GRA which showed good air quality. PM10 presence conferred on the air good quality for Old GRA and very poor for all other locations across Port Harcourt and its environment. CO air quality index I was from moderate to very good for all the stations. Concentration of H_2S indicated that the air quality of Trans Amadi and Industry Road was good; Mile III and Old Township were very poor.

3.5 Source Apportionment

The possible origin of the pollutants in the ambient air of the current study locations as predicted using principal component analysis (PCA) is displayed in table 6.

Table 6. Principal Component loadings of air pollutants in samples of Port Harcourt metropolis

Parameters	PC1	PC2	PC3	Communality
PM2.5	0.93	0.06	0.15	0.891
PM10	0.84	0.15	0.25	0.791
CO	0.21	0.74	0.07	0.597
VOC	0.85	0.21	-0.05	0.747
CO_2	0.04	0.44	0.65	0.619
H_sS	0.17	0.69	0.12	0.453
CH_4	-0.12	0.61	0.15	0.380
Temp.	0.11	0.52	-0.12	0.283
RH	0.84	-0.11	0.10	0.701
Eigen value	4.43	1.56	1.42	
% Variance	46.65	15.26	14.46	
% Cumulative	46.65	61.91	76.37	

Temp. = temperature, RH = Relative humidity

Table 6 present the Principal Component Analysis (PCA) result for possible sources of air pollutants in samples of Port Harcourt and its locations. PCA was used to study the monthly and weekly temporal assessment of air quality in the study station. Component score coefficient matrix was used to calculate the components scores for each study area for the study period (table 6). The scores of the components were merged using variance contribution rate (percentage of variance for each component). The result reveals that three principal components were extracted which accounted for a cumulative percentage variance of 76.37% which means that 76.37% of the variations in the observed variables were accounted for by the three Principal components. Principal component 1, 2 and 3 accounted for 46.65%, 15.26% and 14.46% respectively. For principal component 1, PM2.5 (0.93), PM10 (0.84), VOC (0.85) and relative humidity (0.84) had the highest loading. The PC1 possible source constitutes the traffic pollution gases and those of photochemical reactions. This means that these parameters are subjected to more variation than others as PC1 covers the higher percentage of variance in the data. This can be attributed to the location of the monitoring station which lies on a side of main highway and near traffic light intersection. In addition to the variation in traffic volume and the effect of weather condition on the emitted gases. Principal component 2 had highest loading for CO (0.74), H_2S (0.69), and temperature (0.54) and principal component 3 was CO_2 (0.65) respectively. This PC2 represents the decomposition of organic materials and unburned vehicle fuel especially at their stopping in the nearby traffic light intersection. PC3 shows the parameters of least seasonal variation. This study quantifies the possible sources of ambient air pollutants at selected locations within the Port Harcourt city and its environment and it clearly shows varying pollutants sources with PC1 having more contribution as compared to the other two components. The estimation reveals varying sources of the pollutants into the environment which include traffic, seasonal parameters influence, waste incineration and vehicular/generator emissions etc.

4.0 CONCLUSION

The pollutant levels observed in this present research work is seen to be moderate to severe in concentration as the values were below the hourly air quality monitoring standard of the World Health organisation (WHO) and United State Environmental Protection Agency (USEPA).

The following order Rumuokoro>Mile III>old Township>Trans Amadi>Industry Road>Old GRA, while PM_{10} was Old Township>Rumuokoro>Trans Amadi>Old GRA. This present research has help provide base information on pollutants distribution within the areas. The order of pollutant concentration amongst the parameters are; H_2S> VOC>CO. The particulate matter is in the order of PM_{10}>PM>$_{2.5}$. The pollutants levels were dependent on traffic emissions, photochemical smog, weather effect, decomposition of organic matters, un-burnt gases heavy waste incineration at open dumps. It is therefore necessary to suggested that there should be continuous air pollution monitoring and environmentally friendly activities should be carried out on a daily basis.

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