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Analysis of Ambient Pollutant Concentration from Vehicle Emission in Umuahia Abia state, Nigeria

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Abstract
This study investigated ambient air concentration of Carbon dioxide (CO_2), Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Particulate Matter ($PM_{2.5}$, PM_{10}) emanating chiefly from vehicular traffic emissions in selected traffic intersections in Umuahia metropolis of Abia state Nigeria. Sampling of air was done from January to February, 2017 in peak and off-peak periods at traffic intersections of study area which include Umuahia gate, Umudike junction, Bende road junction and control location at Dozie way junction. The choice of periods, points and pollutants was informed by findings from a pretest survey in December 2016. Results revealed that Umuahia gate recorded the highest mean concentrations of CO (33.24ppm), CO_2 (680ppm), SO_2 (0.44ppm), NO_2 (0.49ppm), $PM_{2.5}$ (27.01µg/m^3) and PM_{10} (8.79µg/m^3) at 49.7% Relative Humidity (RH), 30.5^{0C} Temp., and 1.3m/s Wind speed. Following Umuahia gate is Umudike junction and Bende road junction while Dozie way junction showed the least benign levels of these pollutants. When compared with U.S National Ambient Air Quality Standards and Nigerian National Ambient Air Quality Standards, deviations from these standards were observed. Results of daily air quality index description of the study area pointed carbon monoxide as the main constituent of air quality and classified air quality from "hazardous" through "very unhealthy" to "good".
Keywords: air pollutants, air quality index, traffic congestion, vehicular emission.

1. Introduction

Urban Traffic Congestion (UTC) is one of the major problems facing the world's major cities today especially during the rush hours of morning and evening. This phenomenon has been on a yearly increase mainly due to the noticeable spin in urbanization, motorization, ill-natured and worn out road network system especially in developing nations.

In Nigeria today, particularly in Umuahia, Abia state the recent increase in the importation and use of second-hand cars and the widespread adoption of the single piston engine (okada) motor-cycles and tricycles popularly known as "keke napep" for commercial and private purposes have given rise to the general background concentration of air pollutants**.**

The chief implication of Urban Traffic Congestion is "Atmospheric pollution" which is gradually becoming a serious menace in Nigerian cities especially in the metropolitan areas; inefficient energy combustion in the transportation system generates high levels of localized air pollution on daily bases.

Pollution due to traffic constitute up to 90- 95% of the ambient CO levels, 80-90% of NO, hydrocarbon and particulate matter in the world, posing a serious threat to human health. Vehicles traveling in major metropolitan areas are estimated to account for 80% of all carbon monoxide, 50% of hydrocarbons, 30-40% of oxides of nitrogen and almost 100% of the lead present as air pollutant**. (**Savile, 1993)**.** Ubuoh and Ogbuji (2016) noted that CO is present in exhaust pipes emission by cars, lorries and buses. In addition, Badaulf *et al*. (2009) stated that all motor vehicles emit NO_X. There is spatio-temporal variation in rate and type of air pollutant between and within peak and off peak periods of urban traffic (Utang and Peterside, 2011).

As a result, poor air quality has emerged as a major environmental concern due to lack of effective control measures. With modern activities for development, contamination of the atmosphere by gases, smoke, dusts and other suspended substances constantly takes place. Thus, making the air people breathe in, a source of hazard to their lives (Othman, 2010). The United Nations estimated that over six hundred (600) million people in urban areas worldwide were exposed to dangerous levels of traffic-generated air pollutants (Cacciola *et al*., 2002). Certain chemicals found in impacted air could cause cancer of the lungs, birth effects, brain and nerve damage, and long-term injury of the lungs and breathing passages in certain circumstances. The concentration of such chemicals beyond limits especially during the dry season and exposure over a certain period is extremely dangerous and can cause severe injury or even death (Weli, 2012). Trending epidemiological reports posit that most Nigerian people are being diagnosed of cardio vascular and respiratory diseases on daily bases. These ailments could be said to emanate from congested cities especially in Southern Nigeria where exposure rate to traffic air pollutants is high.
It has been observed through research findings that the levels and effect of these pollutants from vehicular emission on humans and the general atmosphere were more during the dry season or summer period due to increased dispersion rate of these pollutants. For example, oxides of nitrogen (NO_X) are produced more during the dry season as a result of high temperature combustion. Sivaramasundaram and Muthusubramanian (2010), Akpinar *et al*. (2008), Ilten and Selici, (2008) and Bahaltin *et al*. (2007) agreed that wind speed was the most important meteorological factor affecting the concentrations of the pollutants of interest. Higher concentrations of Suspended Particulate Matter were observed in the summer seasons. Furthermore, VOCs and NOx, in the atmosphere can form photochemical smog and high solar radiation results in severe secondary air pollution such as ground level ozone

In the light of the fore goings, there is the need to monitor the ambient concentrations of Carbon dioxide (CO_2), Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Particulate Matter ($PM_{2.5}$, PM_{10}) bearing in mind to answer such fundamental questions as: what is the level of pollutants of vehicular emissions in the city of Umuahia Abia state Nigeria? Do these levels exceed standard limits? Which pollutant constitutes the daily air quality index and to what class of air quality?

2. Materials and Method

2.1. Study area

Umuahia is the capital city of Abia State in southeast Geopolitical zone of Nigeria. Umuahia is geographically located on latitude $5^0 25^{'}$N and longitude $7^0 30^{'}$E . It is traversed by the rail road that runs from Port Harcourt, River state to the South, to Enugu city in Enugu state to its north. Umuahia has a population of 359,230 according to the 2006 Nigerian census. Umuahia is well known as being an agricultural market center since 1916 (www.google.com/history of Umuahia). It is also a railway collecting point for crops such as yams, cassava, corn (maize), taro, citrus fruits, and palm oil and kernels before the crumbling of railway system. Nigeria's National Root Crops Research Institute, at Umudike, is adjacent to the town. Recently the population has grown considerably more than before which has increased the rate of urban respiration. This increase springs from the creation of Abia state in 1991 and Umuahia becoming the capital of Abia state (www.nigeriagalleria.com). The map of study area is shown in figure 1.0 below.

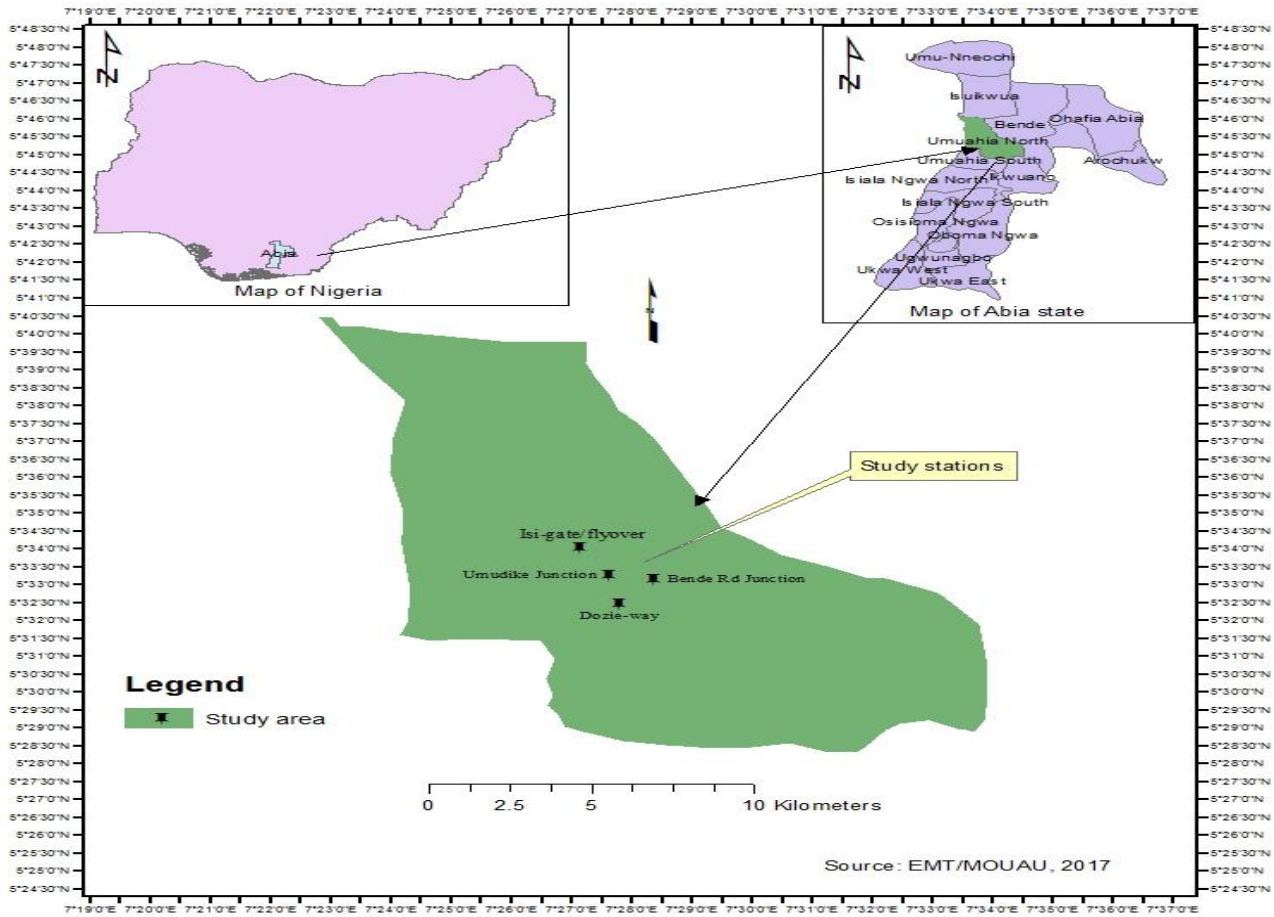

Fig. 2.1: Map of Umuahia in Abia state, 2017.

2.2. Materials

Sampling was done using sensitive Multi Gas Monitor; IBRID MX6 model for measurement of CO, CO_2, SO_2, NO_2, MET ONE instruments Model GT 521; particulate counter for measurement of PM_{10} and $PM_{2.5}$, Extech thermo-anenometer for measurement of temperature, wind speed and relative humidity, handheld portable GPS for geo-point sampling.

2.3. Sampling method

After a pre-test survey of the study area in December, 2016, three sampling intersections in the metropolis of Umuahia were identified as follows: Umudike junction by Federal Medical Centre road, Umuahia gate and Bende road traffic intersections comprised of traffic road areas in Umuahia Metropolis, Abia state Nigeria. In addition, a control study site at Dozie- way junction by Ihie Ndume road was also studied for comparison. The control study site was identified and chosen because of its outlying location where due to mode interchange and modal split, traffic intensity has petered out. This area is encircled by mainly residential layouts, such as Ehimiri, IBB phase and as well trans versed by Ehimiri seasonal stream and pockets of trees and shrubs

2.4. Pollutants of interest

The pollutants sampled include Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), and Particulate Matter ($PM_{2.5}$, PM_{10}) at ground level (1.2m above the ground) since it may represent the breathing zone of humans whether standing or sitting in relation to traffic. These were the major pollutants discovered during the pre-test survey that pervaded the study area.

2.5. Spatio-temporal coverage

Sampling was done during dry season (January – February, 2017) for 3 days of the week (i.e. Monday to Wednesday) at an hourly morning peak, off-peak (afternoon) and evening peak for each location; 7:30am to 8:30am, 12:30pm to 1:30pm and 4:30pm to 5:30pm.

Meteorological parameters such as wind speed, relative humidity and temperature were also measured concomitantly for each phase of the measurements of the gas sample to get an average reading for each of the meteorological parameter.

2.6. Determination of compliance level

The EPA National Ambient Air Quality Standard (NAAQS) and The Nigerian National Ambient Air Quality Standard (NNAAQS) were used to compare the mean concentrations of the parameters generated on the field for all the locations (including the control site) to provide information on the compliance level of air quality in the study area.

2.7. Description of air quality using air quality index

Daily Air Quality Index (AQI) was calculated and used to describe the air quality status of the study locations. The average concentration of the measured parameters, breakpoints of

pollutants for AQI (table 2.0) and the interpolation equation as shown below were used in computing the AQI:

$$I_P = \frac{IHI - ILO}{BPHI - BPLO} (C_P - BP_{LO}) + I_{LO} \quad (1)$$

Where: Ip = the index of pollutant, p; Cp = the rounded concentration of pollutant p; BP_{HI}= the breakpoint that is greater than or equal to Cp (upper limit); BP_{LO}= the breakpoint that is less than or equal to Cp (lower limit);

I_{HI}= the AQI value corresponding to BP_{HI}; and I_{LO}= the AQI value corresponding to BP_{LO}

Table 2.1: Breakpoints for the AQI

CATEGORY	GOOD	MODERATE	UNHEALTHY	UNHEALTHY FOR SENSITIVE GROUPS	VERY UNHEALTHY	HAZARDOUS	
AQI	0-50	51-100	101-150	151-200	201-300	301-400	401-500
POLLUTANTS	BKP	BKP	BKP	BKP	BKP	BKP	BKP
CO (ppm)	0-4.4	4.5-9.4	9.5-12.4	12.5-15.4	15.5-30.4	30.5-40.4	40-50.4
NO_2 (ppm)	0-0.053	0.054-0.1	0.101-0.36	0.361-0.64	0.65-1.24	1.25-1.64	1.65-2.04
O_3 1hr (ppm)			0.125-0.164	0.165-0.204	0.205-0.404	0.405-0.504	0.505-0.604
$PM_{2.5}$	0-15.4	15.4-40.4	40.5-65.4	65.5-150.4	150.5-250.4	250.5-350.4	350.5-500.4
PM_{10}	0-54	55-154	155-254	255-354	355-424	425-504	505-604
SO_2 (ppm)	0-0.034	0.035-0.144	0.145-0.224	0.225-0.304	0.305-0.604	0.605-0.804	0.805-1.004

Source: Fernando (2012). BKP = Breakpoint

3. Results and Discussion

3.1. Results

Table 3.1: Sampling Locations and Geographic Positions

Location	Coordinates	Elevation
Umuahia Gate	N 05^0 32. 046' E 007^0 29.654'	176m
Umudike Junction	N 05^0 31. 448' E 007^0 29. 608'	150m
Bende Road	N 05^0 31. 897' E 007^0 29. 867'	152m
Dozie way Junction	N 05^0 30. 596' E 007^0 31. 050'	129m

Source: Field Survey, 2017

Table 3.2: Mean Result of Air Quality Concentrations and Meteorological Parameters of Traffic Intersections of Study in Dry Season.

TIME	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO_2 (ppm)	RH (%)	TEMP. (^oC)	WIND SPEED (m/s)
				UMUAHIA GATE					
Morning peak	34.31	0.53	0.50	29.50	8.87	681	55	26	1.8
Noon offpeak	25.67	0.20	0.38	22.01	6.43	658	44	34.5	0.3
Evening peak	39.75	0.58	0.58	29.52	11.06	702	50	31	1.9
Mean	**33.24**	**0.44**	**0.49**	**27.01**	**8.79**	**680**	**49.7**	**30.5**	**1.3**

TIME	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO_2 (ppm)	RH (%)	TEMP. (^oC)	WIND SPEED (m/s)
				UMUDIKE JUNCTION					
Morning peak.	23.92	0.36	0.18	24.50	6.71	683	57	27	2.4
Noon offpeak	15.33	0.12	0.08	17.46	2.36	600	45	35	0.5
Evening peak	28.20	0.43	0.32	25.64	6.34	684	48	29	2.1
Mean	**22.48**	**0.30**	**0.19**	**22.53**	**5.14**	**655**	**50**	**30.3**	**1.7**

TIME	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO_2 (ppm)	RH (%)	TEMP. (^oC)	WIND SPEED (m/s)
				BENDE ROAD JUNCTION					
Morning peak	19.98	0.16	0.08	16.41	2.65	639	53	27	3.2
Noon offpeak	11.31	0.06	0.18	9.32	2.18	484	43	33	1.0
Evening peak	18.67	0.18	0.10	18.88	2.70	629	48	29.5	2.6
Mean	**16.65**	**0.13**	**0.12**	**14.87**	**2.51**	**584**	**48**	**29.8**	**2.3**

TIME	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO_2 (ppm)	RH (%)	TEMP. (^oC)	WIND SPEED (m/s)
DOZIE WAY JUNCTION (CONTROL)									
Morning peak	3.30	0.01	0.01	10.17	1.67	162	55	26	3.8
Noon offpeak	1.30	0.00	0.006	6.50	1.01	58	46	34	3.0
Evening peak	5.30	0.02	0.02	12.85	1.90	165	53	29	3.1
Mean	**3.30**	**0.01**	**0.012**	**9.84**	**1.53**	**128**	**51**	**29.7**	**3.3**

Table 3.2 above shows the mean air quality concentrations and meteorological parameters obtained from the field at different locations and time periods during dry season. Umuahia gate location apparently recorded the highest levels of CO, SO_2, NO_2, $PM_{2.5}$, PM_{10}, and CO_2, in morning peak, afternoon off peak and evening peak respectively, followed by Umudike junction, Bende road junction and Dozie way junction. The concentration of the above gases around Umuahia gate area peaked highest in the evening hours up to 39.75 ppm, 0.58 ppm, 0.58 ppm, 29.52 $\mu g/m^3$, 11.06 $\mu g/m^3$, 702 ppm at RH (50%), Temp. (31 ^oC), Wind speed (1.9 m/s) and then intermediate in the morning hours: 34.31 ppm, 0.53 ppm, 0.50 ppm, 29.50 $\mu g/m^3$, 8.87 $\mu g/m^3$, 681 ppm at RH (55%), Temp. (26 ^oC), Wind speed (1.8 m/s) but lowest in the afternoon off peak: 25.67 ppm, 0.20 ppm, 0.38 ppm, 22.01 $\mu g/m^3$, 6.43 $\mu g/m^3$, 658 ppm at RH (44%), Temp. (34.5 ^oC), Wind speed (0.3 m/s). The mean air quality concentration and meteorological for the day around Umuahia gate was CO (33.48ppm), SO_2 (0.44ppm), NO_2 (0.49ppm), $PM_{2.5}$ (27.01$\mu g/m^3$), PM_{10} (8.79$\mu g/m^3$), CO_2 (680ppm), RH(49.7%), Temp(30.5^{oc}), Wind speed (1.3m/s). More so, the same trend as observed in Umuahia gate followed suit around Umudike junction area where levels of CO (28.20ppm), SO_2 (0.43ppm), NO_2 (0.32ppm), $PM_{2.5}$ (25.64$\mu g/m^3$), PM_{10}(6.34$\mu g/m^3$), CO_2(684ppm), RH(48%), Temp(29^{oc}), Wind speed (2.1m/s) recorded highest in the evening rush hours. The mean air quality concentration and meteorological situation for the day around Umudike Junction (CO;22.48ppm, SO_2;0.30ppm, NO_2;0.19ppm, $PM_{2.5}$;22.53$\mu g/m^3$, PM_{10};5.14$\mu g/m^3$, CO_2;655ppm, RH;50%, Temp;30.3^{oc}, Wind speed;1.7m/s) was lower than it is the case in Umuahia gate when compared. Again, the result of the study further revealed highest concentrations of CO (18.67ppm), SO_2 (0.18ppm), NO_2 (0.10ppm), $PM_{2.5}$ (18.88$\mu g/m^3$), PM_{10}(62.70$\mu g/m^3$), CO_2(629ppm), RH(48%), Temp(29.5^{oc}), Wind speed (2.6m/s) also occurring during the evening peak around Bende road junction and 24hour air quality mean and meteorological (CO;16.65ppm, SO_2;0.13ppm, NO_2;0.12ppm, $PM_{2.5}$;14.87$\mu g/m^3$, PM_{10};2.51$\mu g/m^3$, CO_2;584ppm, RH;48%, Temp;29.8^{oc}, Wind speed;2.3m/s) even lower than that of Umudike junction and much lower than Umuahia gate. The 24hr mean air quality concentrations at Dozie way junction(control) is the lowest and seemed the safest when compared to other locations.

Table 3.3: Comparison of Mean Air Quality Concentration during Dry Season to NAAQS/NNAAQS

Time	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO_2 (ppm)
Morning	20.38	0.27	0.19	20.15	5.0	541
Afternoon	13.4	0.10	0.16	13.82	3.0	450
Evening	22.98	0.30	0.26	22.00	5.5	545
NAAQS:	35(1hr)	0.075^C(1hr)	0.1^C(1hr)	35(24hr)	150(24hr)	N/A
	9(8hr)	0.5(3hr)	0.053^C(A)	15(A)		
NNAAQS:	10(1hr)	0.01(1hr)	0.04(1hr)	250	250	N/A
	20(8hr)	0.1(24hr)	0.06(24hr)			

A: annual; hr: hour; N/A: Not Available; X^C: converted; NAAQS: National Ambient Air Quality Standard; NNAAQS: Nigerian National Ambient Air Quality Standards approved by FMENV

From table 3.3, the mean value of CO ranged between 13.4 -22.98 ppm with evening peak (22.98 ppm) having the highest concentration followed by morning peak (20.38 ppm) and then afternoon off peak (13.4 ppm). The peak periods are all within the 35 ppm (1hr average time) while both peak and off peak periods are all above 9 ppm (8 hr average time) for NAAQS. For NNAAQS, both the peaks and off peak are all above the 10 ppm (1hr average time), the peaks are both above the 20 ppm (8hr) while the off peak is within the limit.

SO_2 ranged between 0.1 -0.3 ppm with evening peak ahead of all followed by morning and then afternoon off peak which are all within the NAAQS 0.5 ppm (3hr) limit but above 0.075ppm (1hr) limit. Afternoon off peak was right at the margin of 0.1ppm (24hr) limit for NNAAQS and above the 0.01ppm (1hr) limit while the morning-evening peaks are all above the limits. Furthermore, NO_2 peaked between 0.16 ppm -0.26 ppm with evening peak(0.26 ppm) having the highest value followed by morning peak(0.19 ppm) and then afternoon off peak (0.16 ppm) which are all highly above NAAQS and NNAAQS permissible limits for ambient air quality in all the averaging time (1hr & annual).

Again, mean values of $PM_{2.5}$ for morning, afternoon off peak and evening peak fell within the concentration bracket of 13.82 -22.0 $\mu g/m^3$which are all within the 24hr average time (35.0 $\mu g/m^3$) limit for NAAQS but above the 15.0$\mu g/m^3$ (annual). On the other hand, PM_{10} which ranged from 3.0 -5.5 $\mu g/m^3$were all within 150 $\mu g/m^3$ (24 hr) average time limit for NAAQS and 250 $\mu g/m^3$ for NNAAQS. CO_2 peaked between 450 – 545ppm which is very much up above the WHO maximum limit of 100 ppm.

Table 3.4: Daily Air Quality Index Report during Dry Season.

Day	Location	CO	SO_2	NO_2	$PM_{2.5}$	PM_{10}	CO_2	AQI For The Day	Pollutant That Constitute The Air Quality	Color Code	Category
Day 1	Umudike junction	293.4	215.9	129.2	65.4	4.84	N/A	293.4	CO	Purple	Very Unhealthy
Day 2	Umudike Junction	226	202.6	106.5	66.3	5.86	N/A	226	CO	Purple	Very Unhealthy
Day 3	Umudike Junction	222	172.7	120	62.6	3.57	N/A	222	CO	Purple	Very Unhealthy
Day 1	Umuahia Gate	329	242	164	70.6	8.53	N/A	329	CO	Maroon	Hazardous
Day 2	Umuahia Gate	304	239	187.1	73.4	8.57	N/A	304	CO	Maroon	Hazardous
Day 3	Umuahia Gate	352	252.3	170	77.2	7.39	N/A	352	CO	Maroon	Harzadous
Day 1	Bende road	221.1	93.7	85	48.53	2.38	N/A	221.1	CO	Purple	Very Unhealthy
Day 2	Bende road	199.9	82.9	82	48.72	2.37	N/A	199.9	CO	Red	Unhealthy
Day 3	Bende road	204.3	112.2	68	47.65	2.25	N/A	204.3	CO	Purple	Very Unhealthy
Day 1	Dozie way Jnc.	59	19.1	20.8	44.8	1.08	N/A	59	CO	Yellow	Moderate
Day 2	Dozie way Jnc.	29.5	14.71	9.4	33.11	2.59	N/A	29.5	CO	Green	Good
Day 3	Dozie way Jnc.	22.7	9.8	7.9	17.89	1.09	N/A	22.7	CO	Green	Good

The above result shows that Carbon monoxide (CO) constitutes the daily Air Quality Index for all the locations; Umudike junction, Umuahia gate, Bende road and Dozie way junction.
The air quality in Umudike junction for the days 1, 2 & 3 was very unhealthy with daily AQI values of 293.4, 226 and 222. This is a very serious situation that could be deleterious to health, meaning everyone may experience more serious health effects.
Umuahia gate had a very threatening air quality categorized as hazardous in all the sampled days with daily AQI values of 329, 304 and 352. This calls for health warning alert of emergency conditions as the entire population is more likely to be affected.
Bende road had a very unhealthy air quality in day 1&3, but an unhealthy air quality in day 2 with daily AQI values of 221.1, 204.3 and 199.9. The implication of an unhealthy air is that everyone may begin to experience health effects. Sensitive people may experience more serious health effects.
The air quality around dozie way junction which is the control location was moderate in day 1 but good in day 2&3. Good air quality is considered satisfactory and air pollution poses little or no risk. Also, moderate air quality is acceptable; however, for some pollutants, there may be a moderate health concern for a very small number of individuals. For example, people who are unusually sensitive to ozone may experience respiratory symptoms if ozone levels fall into this range.

3.2. Discussion

The general situation in the study area has shown that the air quality presents a likely unhealthy breathing zone for the population of the study area. The concentrations of CO, NO_2, SO_2, CO_2, $PM_{2.5}$, and PM_{10} were relatively highest during evening peak hours followed by morning peak hours and then afternoon off peak at all the locations of study which supports the findings of Utang and Peterside, (2011) that there is spatio-temporal variation in rate and type of air pollutant between and within peak and off peak periods of urban traffic. Umuahia gate harbored high concentrations of CO, NO_2, SO_2, and CO_2 more than Umudike junction, Bende road junction and Dozie way junction as revealed in the result. CO, for instance peaked high concentration in Umuahia gate more than around Umudike junction, Bende road and control. This could be as a result of concentration of high rise buildings and intensive economic activities that characterize this location and also due to the inundation of parking facilities and poor traffic grid system leading to long waiting time of vehicles and engine idleness and subsequently resulting in accumulation of these gases from exhaust pipes into the breathing zone. Umuahia gate is a convergent location for business activities that occur majorly during evening hours. The convergence is mainly due to the fact that it serves as traffic attraction and distribution point. .Umuahia has five entry and exit routes all of which have connection with Umuahia gate and so there was usual high vehicle crowdedness due to little or no traffic control. According to Subrata, (2012) CO is a product of incomplete combustion of carbonaceous fuels in stationary and mobile sources. The noticeable increase in the level of CO in air around the study area could be tied to vehicle traffic emissions from incomplete combustion of fuels in old and unmaintained automobile engines which are widely used for passenger and freight purposes. This is in support of the views of Ubuoh and Ogbuji, (2016). Ubuoh and Ogbuji (2016) further noted that CO can compete with the haemoglobin in the blood which can lead to death.

SO_2 gas also peaked high concentrations following the same trend as CO with respect to location. The increased level of SO_2 mainly around Umuahia gate may be due to the

interplay of emissions of sulphur through incomplete combustion of sulphur containing fuels and wind transported sulphur. This may spell danger to the people living and working around this area as they may have serious health defects like respiratory problem and other cardiovascular problems Wai and Steven (2007) reported that SO_2 for instance irritates airways and eyes and is known to cause longer-term heart diseases, other cardiovascular ailments, and bronchitis. It also readily causes shortness of breath and coughing amongst asthma sufferers.

Furthermore, the results revealed NO_2 to be in high concentrations in the same order as earlier mentioned gases about the study area. The high levels of NO_2 observed around the study area may be implicated majorly by high temperature combustion of fuels in vehicle use around the near road micro environment where temperature peaks between 26 -35^{o}c resulting in emissions of increased levels of this gas into the atmosphere. This is supported by the opinion of Baldauf *et al*., (2009) that all motor vehicles emit NOx, the majority of on-road emissions occur from diesel vehicles. NOx poses detrimental health effects ranging from short term respiratory irritation to long term lethal chronic respiratory diseases. Wai and Steven, (2007) noted that NOx causes severe respiratory problems, especially in children. NOx when combined with water forms nitric acid and other toxic nitrates which could form acid rain. NO_2 is a main component in the formation of ozone at ground level. The gas irritates the lungs and has been known to lower the immune system.

Particulate matter (2.5&10) appeared to be very low in concentration in the entire study area. This could be due to the fact that there are no quarry industries/non-asphalted roads situated around the study area. Finally, CO_2 which is a greenhouse gas and a major player in global warming accounting for half of the annual increase in average global temperature and also the predominant greenhouse gas emitted by motor vehicles also recorded ranking levels majorly around Umuahia gate and Umudike junction . The increase could be due to the complete combustion of fossil fuel or hydrocarbon in automobile gasoline or diesel engines. It could also be associated with the increased aggregates of respiring humans around the area.

However, the concentrations of the gases at Dozie way junction relatively seemed to be at their natural background concentration when compared to Umuahia gate, Umudike junction and Bende road respectively. This may be justified by the presence of long verges of vegetation and shrubs around the area. The layout of the area is well planned and serene in nature with a Ehimiri stream running across the street providing a tranquil and cool environment. In addition, due to modal split and mode interchange, traffic flow towards Dozie way peters out which collectively may have reduced the concentrations of the gases to a negligible state. Again, meteorological parameters especially wind speed appeared to show influence on air quality concentration obtained at every location in the study area in the sense that locations with low wind speed accumulated largest concentration of pollutants .For example, Umuahia gate which recorded the highest concentrations of the gases expressed the least wind speed while Dozie way with the lowest air quality data recorded the highest wind speed. This is in agreement with the findings of Sivaramasundaram and Muthusubramanian, (2010), Akpinar *et.al*, (2008), Ilten and Selici, (2008), Bahaltin *et.al*, (2007) that wind speed is the most important meteorological parameter that aids in dilution of pollutants.

4. Conclusion

Based on the results of this study, air quality varied relatively in space and time thus the term spatio-temporal. Umuahia gate had the most challenging air quality proven by the relative increased levels of Carbon monoxide, Sulphur dioxide, Nitrogen dioxide, and Carbon dioxide due to traffic emissions suspected to be from aged automobiles and long waiting time followed by Umudike junction, Bende road junction and then Dozie way junction (control). The pollutant levels were in excess of the set limits except for particulates. The daily air quality of the study area is not safe especially Umuahia gate which recorded hazardous state for all the sampling days. This is likely to be dangerous to passerby, commuters and very many other features of the study area may start developing unhealthy symptoms in future since most of these pollutants have cumulative or indirect impact.

5. Recommendation

In the light of the findings of this study, the following are recommended to reduce the excessive deterioration of air quality and potential health effects around the study area due to traffic emission

i. Pedestrians, commuters and other people working, living or routing around these zones are strongly advised to relocate to a serene environment such as Dozie way, avoid taking that route especially during peak hours or spend not much time around that region as that can be very dangerous to their health. In that way, the rate of vehicular activity around these areas would have been reduced since motorists would seek alternative routes.

ii. Awareness creation efforts on the health impact of vehicular emission through key stakeholders (policy and decision makers, journalists, industrialists) as well as the inclusion of environmental education in school curricula can be encouraged. This will go a long way in discouraging people to locate businesses and residences along areas of high traffic intensity.

iii. Legislation on the age of vehicles imported into the country can go a long way in mitigating vehicular emission. The older a vehicle the more the tendency to emit more pollutants. The Vehicle Inspection Officers (VIOs) and the Road Safety Corps should ban Unserviceable vehicles from plying the roads. This on the overall is expected to ensure a healthful Umuahia, Abia state and Nigeria at large.

iv. The study area particularly Umuahia gate and Umudike junction should be well planned and spaced out in terms of building, economic and road facilities.

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