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ASSESSMENT OF AIR QUALITY ACROSS DIFFERENT LAND USES IN GWAGWALADA TOWN, FCT-ABUJA, NIGERIA

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ABSTRACT

This study assessed ambient air quality (NO_2, SO_2, CO, NH_3, H_2S and PM_{10}) across four different urban land uses at five points each using Handheld BW Tech GasAlert and Haze Dust Particulate Monitor in Gwagwalada town, FCT, Nigeria. The standard limit of WHO, USEPA and FME were used. CO concentration across the different land use "Abattoir (4.4), Market (0), Motor Park (3.4) and Roadside (6.4)" were within the limit of WHO, USEPA and FME (10, 9, 9 ppm/ug/m^3); NO_2 and H_2S were within the limit of WHO, USEPA and FEME (0.07, 0.02, 0.05 ppm/ug/m^3); SO_2 concentration across Abattoir (0.34), Market (0.28), Motor Park (0.26) and Roadside (0.32)" were above the limit of WHO and FME (0.01ppm/ug/m^3), but falls within the standard of USEPA (0.5ppm/ug/m^3); PM_{10} concentration at Abattoir (142.49), Market (72.54), Motor Park (162.88) and Roadside (148.54) were within the standard of FME (250 ppm/ug/m^3) and USEPA (150 ppm/ug/m^3) with the exception of PM_{10} concentration in Motor Park while the PM concentration were above the standard of WHO (50 ppm/ug/m^3) across the different land uses. NH_3 were not detected in Motor Park and Roadside, but its concentration in Abattoir (0.12) and Market area (0.1) were above the standard of WHO and USEPA (0.07) but commensurate to that of the FME. ANOVA at 0.05% level of significance shows that there is no significant difference in the concentration of pollutants across the different land uses as justified with $P \leq .963$. The air quality index rating depicts PM_{10} and NH_3 as the chief pollutant in Gwagwalada urban with the rating ranging from unhealthy for sensitive group to being hazardous to all individuals.r.

Keywords: Ambient, air, quality,Urban, pollution, USEPA, WHO, FEPA

INTRODUCTION

Poor air quality is one of the greatest environmental hazards facing many urban areas around the globe. One of the most essential environmental results of urbanization resulting in rapid changes in land use is the deterioration of air quality (Chen, Yang, Xu *et al.*, 2014; Fang, Liu, Li *et al.*, 2015). As cities grow in population and size as well as change from one land use to another, there is an increase in energy consumption, industrial emissions, and vehicular traffic, all of which can have an adverse effect on air quality (Kahyaoglu-Koracin, Basset, Mouat *et. al.*, 2009; Superczynski and Christopher, 2011) especially in developing countries such as China (Guo, Hu, Zamora *et al.*, 2014) and many growing cities in Africa (the Federal Capital territory of Nigeria Inclusive). Although industrial emission and vehicle exhaust are considered to be the foremost sources of air pollution, urban land use patterns and changes also have a close relationship with urban air quality (Xu *et al.*, 2016).

All over the world, urban air quality is influenced by various factors, such as growth of population and economic activities, increase of car ownership and usage, heavy dependence on the use of fossil resources in our society, and meteorological factors (Syafei, Fujiwara and Zhang, 2014). The source of air pollution can come from both natural and anthropogenic influences. However, in many areas, anthropogenic inputs are proportionately greater than those from natural sources because they are products of industrial, residential, vehicular and domestic waste emissions (Zhao, Da, Tang, *et. al.*, 2006). Abdullahi, Okobia and Hassan, (2012) stated that pollution in the Federal Capital City (FCT) of Nigeria is becoming overwhelming considering population, anthropogenic increase and high vehicular traffic indicating intensification of emission of carbon monoxide directly into the atmosphere. The rapid and continuous change in land use experienced in Gwagwalada Town has severely impacted on the ambient air quality of the area. This indeed is the situation as the area has witnessed unprecedented land use change over the past two decades caused by the movement of people and the expansion of human activities in the area. Zhao *et al.*, (2006) stated that urbanization and the complex nature of human activities lead to alterations of the local climate, and in particular creates a significant heat island effect.

Study Area

Gwagwalada town is about 45 km away from the Federal Capital City of Nigeria. It is the headquarters of Gwagwalada Area Council one of the six area councils headquarters of the FCT. The town lies in the downstream of River Usuma and located between latitude 8° 55' and 9° 00'N and longitudinal 7° 00' and 7° 05'E (Ishaya and Abaje, 2009a).

The climate of the area is like most climate in the tropics having a numbers of climatic elements in common, most especially the wet and dry season's characteristics. The temperature in the area ranges from 30^0 C – 37.0^0 C yearly with the highest temperature in the month of March and mean total annual rainfall of approximately 1,650mm per annum (Ishaya *et al.*, 2009b). About 60% of the annual rains fall during the months of July to September. The area is drained by River Usuma and the area is predominantly covered by tropical ferruginous soils but alluvial soils are found in the valleys of River Usuma and other streams within the study area. Gwagwalada area council has a projected population of 402,000 people in 2016 with large majority of this population residing in Gwagwalada town, Zuba and Giri. The town is located within the northern boundary of the Guinea Savanna with the vegetation showing a slight level of variability comprising shrub savanna vegetation type that are highly ravaged in recent years due intense urbanization and fuelwood harvest as observed in the fringes of the town (Ishaya *et al.*, 2009a)

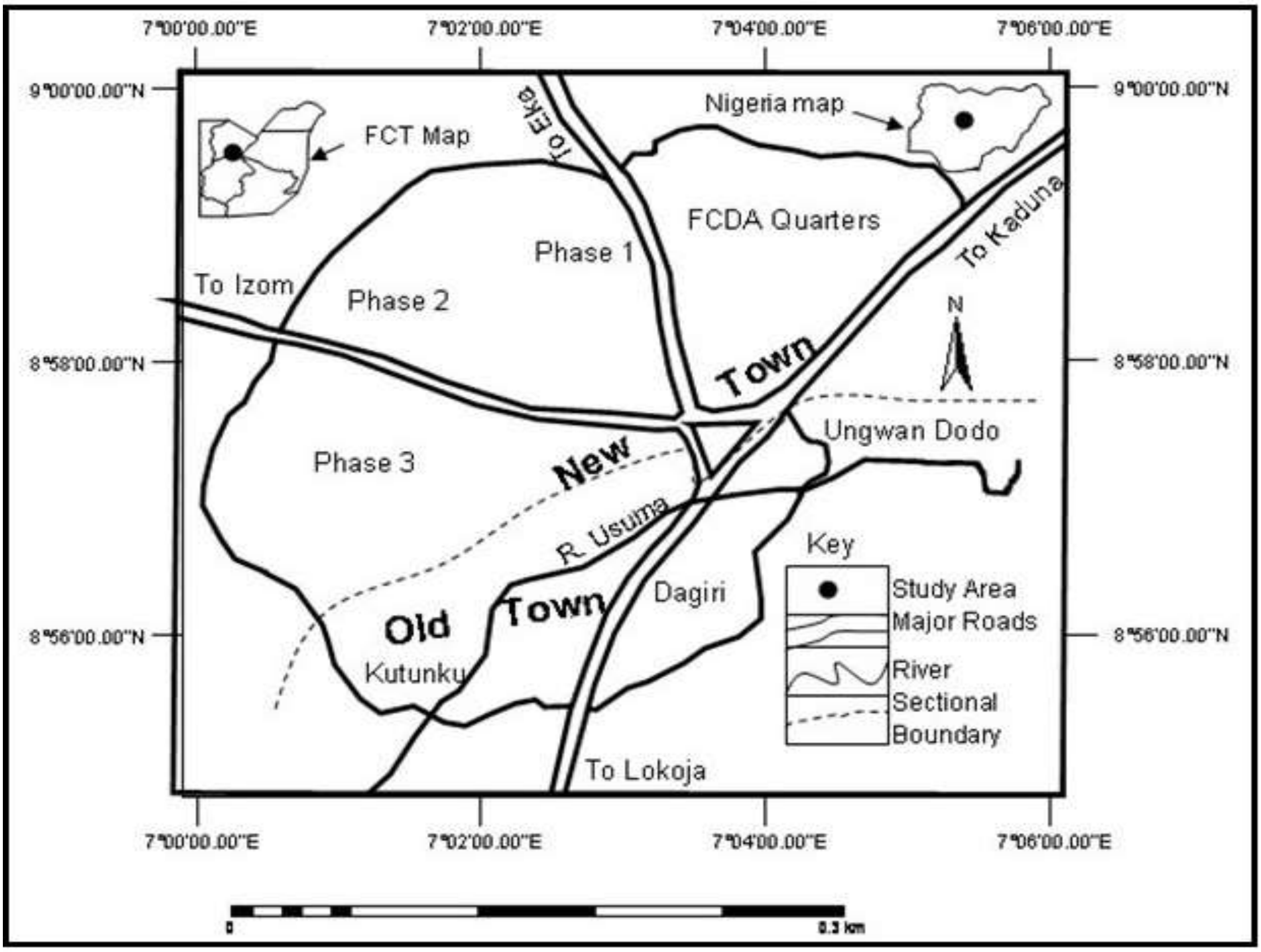

Figure 1: Map of Gwagwalada Town.

METHODOLOGY

Causal–comparative research design was used to investigate the dynamics in air quality across different urban land uses in Gwagwalada town of the FCT of Nigeria. The design was used to ascribe the changes in ambient air quality to changes in urban land uses and diverse human activities therein. This study relies solely data on diurnal variation in air pollutants (NO_2, SO_2, CO, NH_3, H_2S and PM_{10}) across urban land uses (abattoir, motor parks, market, and roadside) and different land use data on pollution indices. The air pollutants were measured at five (5) sampling points in each identified urban land uses via the use of BW Technologies gas alert during the day.

Sampling technique and Procedure of data collection

Prior to this study, a reconnaissance survey was carried out between 25th to 27th of January 2018 and information collated from the survey was used to delineate sampling points for ambient air quality measurement in each of the land use. Random sampling techniques was used to randomly sampled Five (5) sampling points (designated as SP1, SP2, SP3, SP4 and SP5) from the different specified urban land-uses: abattoir, motor parks, market, and roadside; implying that in each land use, five (5) air quality samples were measured, given a total of twenty (20) air quality samples. The geographic points of each sampling units was duly referenced. The researcher with the aid of two research assistants carried out the field data gathering. This process lasted from the 5th to 10th of February 2018. An established google earth image of the sampling points guarded the conduct of the field data gathering. The concentrations of gaseous pollutants in the ambient air for each land use were measured using various handheld air quality measuring equipment (table 1). The equipment were switched on at each sampling time and allowed to suck air for a minimum of 2 minutes after which the ambient concentration of the pollutants being measured were displayed on the screen for recording. The ambient air pollutant measurements were taken at a minimum of 1.5m height at noontime. This handheld equipment were calibrated by the manufacturer in October 2017 and used before the expiration of the calibration, which is 1 year (Calibration certificates attached in appendices).

Table 1: Equipment used for ambient air pollutant measurement

S/No	Gaseous Pollutant	Equipment	Model Number	Serial Number
1	CO (ppm)	BW Technologies Microclip X3	MCXL-XWHM-Y-NA	KA415-1092223
2	SO_2 (ppm)	BW Technologies gas alert	GAXT-S-DL	J614-SO36593
3	NO_2 (ppm)	BW Technologies gas alert	GAXT-D-DL	J615-DO4050
4	PM (mg/m^3)	HAZE Dust Particulate Monitor	-	HP-5800D

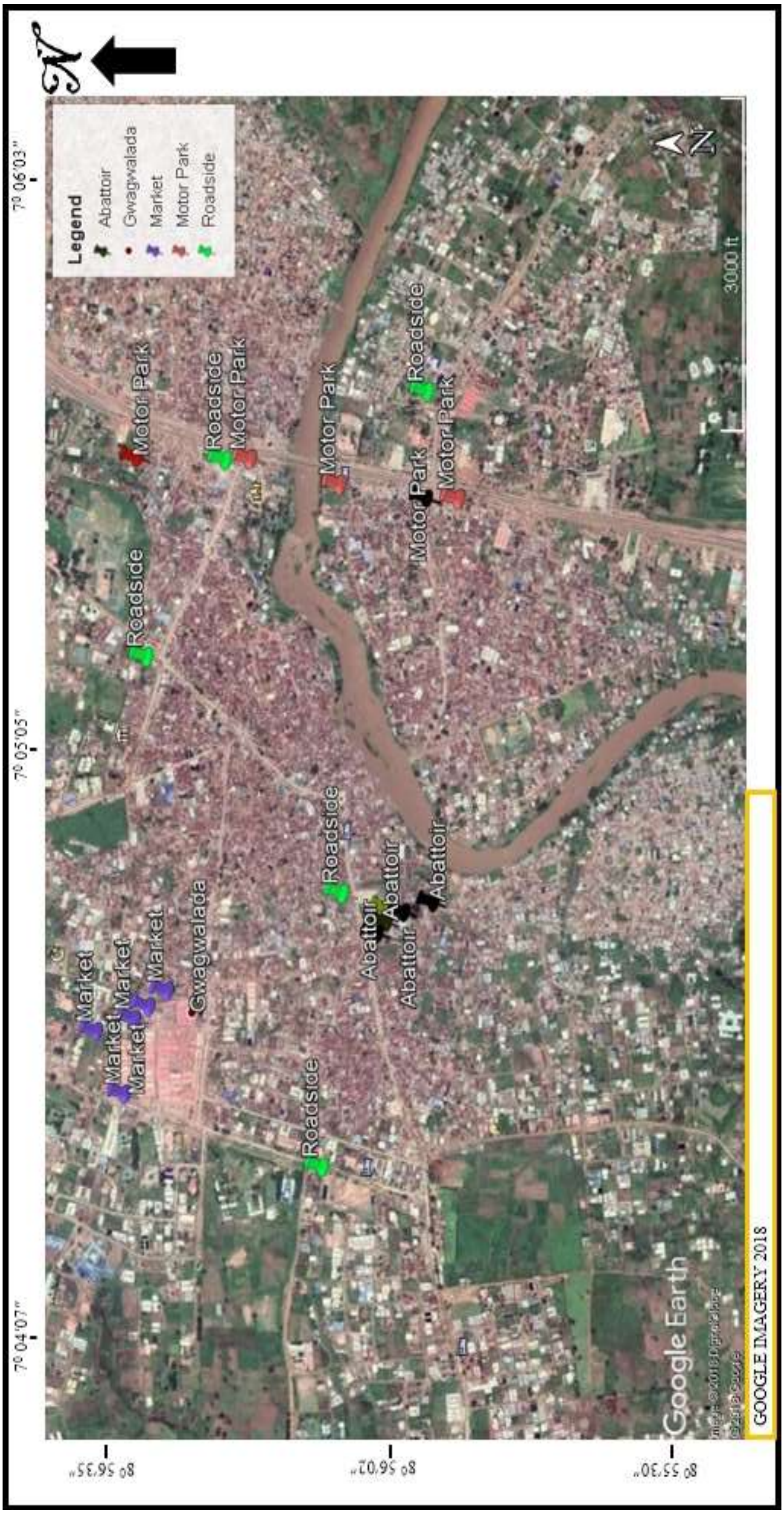

Figure 2: Map of Sampling Point Source: Digitized from Google Earth (2018)

Method of data analysis
The spatial variations in atmospheric pollutants concentration was evaluated by analyzing the actively sampled pollution data from the different urban land uses. Both descriptive and inferential statistical tools were used to give meaningful explanations to the data obtained from the processes explained above. The descriptive statistics involves graphs, while the inferential statistics involved the use of Analysis of Variance for comparing group mean of pollutant between the different land use types. The collated data of pollutant were further subjected to the Air Quality Index Rating.

Assessment of pollution index
The Air Quality Index (AQI) is an index for reporting daily air quality. It tells how clean or unhealthy the air is, and what associated health effects might be a concern. The AQI focuses on health effects one may experience within a few hours or days after breathing unhealthy air. This AQI is divided into six categories indicating increasing levels of health concern. An AQI value over 300 represents hazardous air quality and below 50 the air quality is said to be good.
The results from the AQI computation are further subjected to the air quality-rating table to determine the condition of the air as presented in table 2.

Table 2: Air Quality Rating Table

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Source: USEPA, 2014

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 AQI has also been developed into electronic mode called AQI calculator. However, the AQI is compared with standards for pollutants in the environment as provided by both global and regional organization. These standards are used to check the emission status of activities in the world today. Compilations of these standards are presented in table 3.
The pollutant's index is its concentration expressed as a percentage of the relevant air standard. In the present study, AQI was calculated by the equation given by the US. EPA (2017) as follows:

$$\text{Index} = \frac{\text{Pollution Concentration}}{\text{Pollution Standard Level}}\ x\ 100$$

In estimating the pollution index (PI), the PI of the respective pollutants at different land uses were calculated, and the result subjected to the World Health Organization standard for pollutant concentration.Each category corresponds to a different level of health concern:

- **Good -** the AQI value for in a given community is between 0 and 50. Air quality is satisfactory and poses little or no health risk.
- **Moderate - t**he AQI is between 51 and 100. Air quality is acceptable; however, pollution in this range may pose a moderate health concern for a very small number of individuals. People who are unusually sensitive to ozone or particle pollution may experience respiratory symptoms.
- **Unhealthy for Sensitive Groups - w**hen AQI values are between 101 and 150, members of sensitive groups may experience health effects, but the general public is unlikely to be affected.
- **Unhealthy - e**veryone may begin to experience health effects when AQI values are between 151 and 200. Members of sensitive groups may experience more serious health effects.
- **Very Unhealthy -** AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects.
- **Hazardous** - AQI values over 300 trigger health warnings of emergency conditions. The entire population is even more likely to be affected by serious health effects.

Table 3: Compilation of Ambient Air Quality Standards

Pollutants	Time of Average	Nigeria standard	USEPA standard	WHO Guideline	European Commission Standard
Particulates PM 5 PM10	Daily average of daily values 1 hour.	250 ug/m^3 *600 ug/m^3	150ug/m^3	50ug/m^3	25ug/m^3
Sulphur oxides (Sulphur dioxide)	Daily average of hourly values 1 hour	0.01 ppm (26 ug/m^3) 0.1 ppm (26 ug/m^3	0.5ppm 0.075ppm	20ug/m^3	125ug/m^3 350ug/m^3
Non-methane Hydrocarbon	Daily average of 3-hourly values	160 ug/m^3	-	-	-

Carbon monoxide	Daily average of hourly values 8-hourly average	10 ppm (11.4 ug/m^3) 20 ppm (22.8 ug/m^3)	9ppm	9ppm	10ppm
Ammonia	Daily average of hourly values 8-hourly average	0.28 ppm	0.07ppm	0.07ppm	-
Hydrogen Sulfide	Daily average of hourly values 8-hourly average		0.1ppm	0.1pm	10ppm
Nitrogen oxides (Nitrogen dioxide)	Daily average of hourly values (range)	0.04 ppm-0.06 ppm (75.0 ug/m^3-113 ug/m^3)	0.053ppm	0.02ug/m^3	40ug/m^3
Photochemical oxidant	Hourly values	0.06 ppm			

Source: Researcher's Fieldwork, 2017

RESULTS

Ambient concentration of SO_2, NO_2, CO, NH_3, H_2S, and PM across the different Land-use

Ambient concentrations of Sulphur Dioxide, Nitrogen Dioxide, Carbon Monoxide, Ammonia, Hydrogen sulfide, and Particulate Matter were recorded from five locations across individual urban land uses. The results for ambient concentrations of the pollutants are presented in graphical format.

Carbon Monoxide

The average concentrations of carbon monoxide across the different urban land use are presented in figure 3. The concentration is found to be within the recommended limit across all sampling points as shown in figure 3. However, the concentration of CO varies across the different urban areas. This is an indication that the activities resulting from different urban areas varies in the rate of atmospheric gas pollution in the study area.

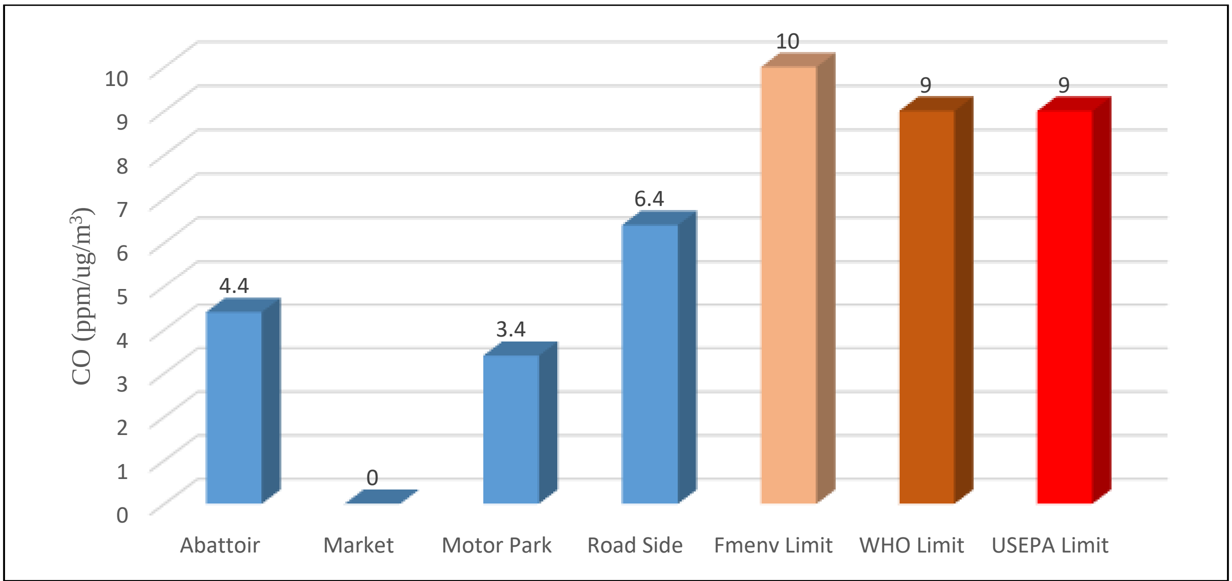

Figure 3: Average concentration of carbon monoxide in different urban area Source: Fieldwork, 2018.

The highest average concnetration of atmospheric CO was recorded along roadside with a mean value of 6.4 ±2.3ppm. The rate of CO concentration along roadsides in urban areas are triggered by vehicular/motorcycle emmision. CO concentration was also recorded in Abattoir and motor park areas with mean values of 4.4 ±4.1ppm and 3.4 ±3.5ppm respectively. Daily human activities within abatoir and motor parks are found to be point source of CO emission. While CO emission in abattoir can be attributed to burning/roasting of animal parts, the potential source of CO in motor parks could be due to exhaust from motor engines. In contrast, CO concentration was not detected in market area. This results is at par with the discovery of Ola, Salami and Ihom (3013), on the levels of toxic gases; carbon monoxide, hydrogen sulphide and particulate matter to index pollution in Jos Metropolis, Nigeria; where gross atmospheric pollution along the main streets of Jos where found due to vehicular traffic..

Nitrogen dioxide

The average concentration of nitrogen dioxide across the different urban land-use is presented in figure 4.

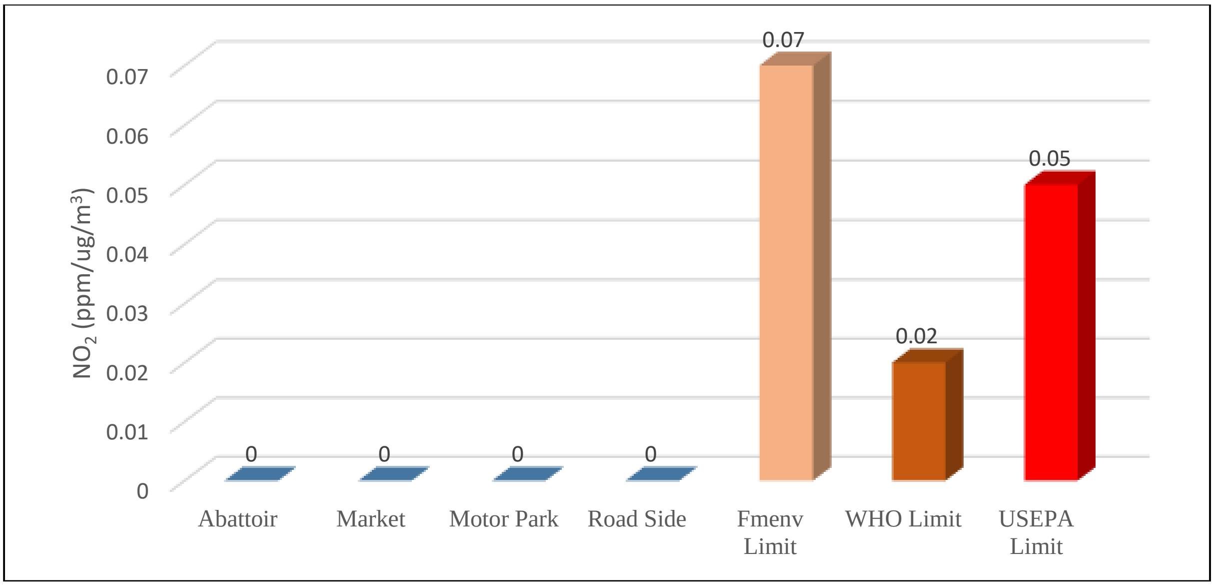

Figure 4: Average concentration of nitrogen dioxide in different urban area Source: Fieldwork, 2018.

The ambient concentration of NO_2 across the different urban land-use area were not detected. Nitrogen dioxide as part of the group of gaseous air pollutants produced as a result of road traffic and other fossil fuel combustion processes such as hydrocarbons is a contributor to the formation and modification of other air pollutants, such as ozone, particulate matter, and acid rain. However, the result of this study implies that in general, human-urban related activities in gwagwalada amounts to little or no atmospheric air pollutant of NO_2. The study is in uniform to the findings of Njee, Meliefste, Malebo, and Hoek (2016), where NO_2 was found to be considerable within the recommenmded standard across urban background in Dar es Salaam city of Tanzania.

Sulphur dioxide

The average concentration of Sulphur dioxide across the different urban land-use varies considerably as presented in figure 5.

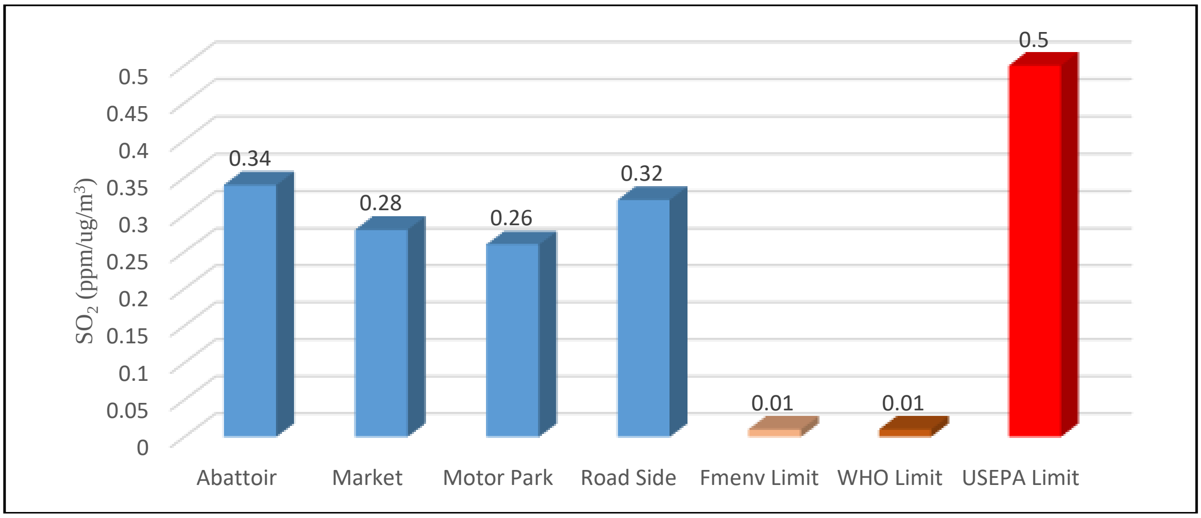

Figure 5: Average concentration of sulphur dioxide in different urban area Source: Fieldwork, 2018.

The highest average concnetration of atmospheric SO_2 was recorded in abattoir area with a mean value of 0.34 ±0.13ppm. The concentration amounts to the incessant activities of the facility such as the burning of animal manure and remains as well as heaps of animal dirt. SO_2 concentration was also recorded in market and motor park areas with mean values of 0.28 ±0.13ppm and 0.26 ±0.16ppm respectively. Daily human activities in market and motor parks such as smog emission from vehicles and ancilliary activities of all sort taking place in market are point source of SO_2 emission. Considerable amount of SO_2 was also detected in roadside with a mean value of 0.32 ±0.4ppm. This result is in consonance with the findings of Mohammed, Uzairu and Ujoh *et al.*, (2013), where SO_2 was detected in some selected traffic areas of Kaduna metropolis. The concentrations were far beyond the FMEnv and WHO permissible limits but fall within the USEPA standards for criteria pollutants published in 2010.

Particulate Matter

Particulate matter concentration is the most recognizable atmospheric air pollutant. Aside the use of monitoring devices, particulate matter can easily be seen with the eyes, however, accurate estimate of its quantity may not be achieved. Using the handheld monitoring device as stated in the methodology, the average concentration of PM_{10} across the different urban areas are presented in figure 6.

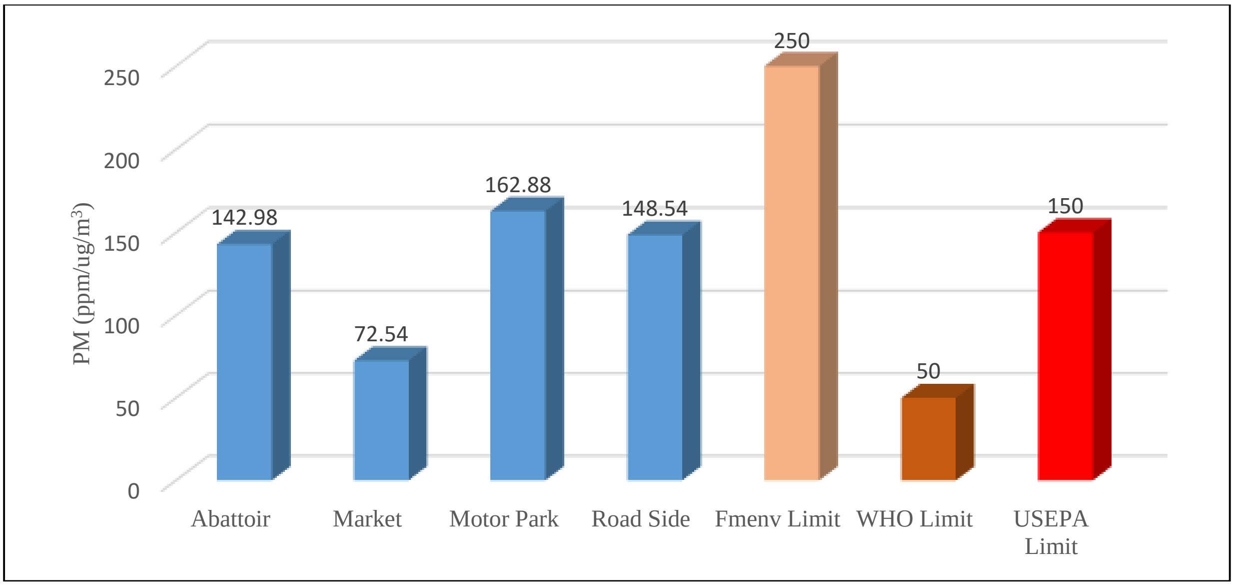

Figure 6: Average concentration of particulate matter in different urban area Source: Fieldwork, 2018.

The average PM_{10} concentration of 142.98 ±57.6ug/m3 was detected around abattoir concession. The PM_{10} was in consonance with the Federal Ministry of Environment (Nigeria) and the USEPA critical limit. However, it did not commensurate with the WHO standard. In market confinement, average PM detected was 72.54 ±4.9ug/m3, which falls slightly above the WHO standard for atmospheric PM concentration, but commensurate with that of the Federal Ministy of Environment (Nigeria) and the USEPA critical limit. For motor park and roadside, the atmospheric compositions of PM_{10} were found to be 162.88 ±76.3ug/m3 and 148.58 ±52.6ug/m3 respectively, which is far above the WHO standard. While the PM_{10} concentration at the roadside was found to be within the standard of Federal Ministy of Environment (Nigeria) and the USEPA for PM_{10} emission, it was not so for PM_{10} emission around Motor park area which was only in consonance to the standard as recommended by the USEPA. In comparing the outcome of the PM_{10} concentration in the current study area to similar study in china, Zheng, Zhou, Singh, Wu, Ye, and Wu (2017), carried out a spatiotemporal distribution of air pollutants and their relationship with land-use patterns in Hangzhou City. With similar relationship to the findings of this study, PM_{10} concentrastion was found to be within 86 - 108µg/m^3 across different urban areas inHangzhou City. Furthermore, the result is at par to the findings ofEnotoriuwa, Nwachukwu and Ugbebor (2016) in Obigbo area of River State, where the concentration of PM_{10} across urban land-use types was found higher above WHO critical limit but commensurate to the standard of the Federal Ministy of Environment (Nigeria) and the USEPA.

Ammonia

Gaseous ammonia (NH_3) is a major component of total reactive nitrogen and the most abundant alkaline gas in the atmosphere. Major source of atmospheric NH_3 emissions is related to agriculture, including animal husbandry and NH_3-based fertilizer applications, as well as industrial processes, vehicular emissions and volatilization from soils and oceans Behera, Sharma, Aneja and Balasubramanian, (2013).The concentration of NH_3 pollutant across the different urban land-use types is presented in figure 7.

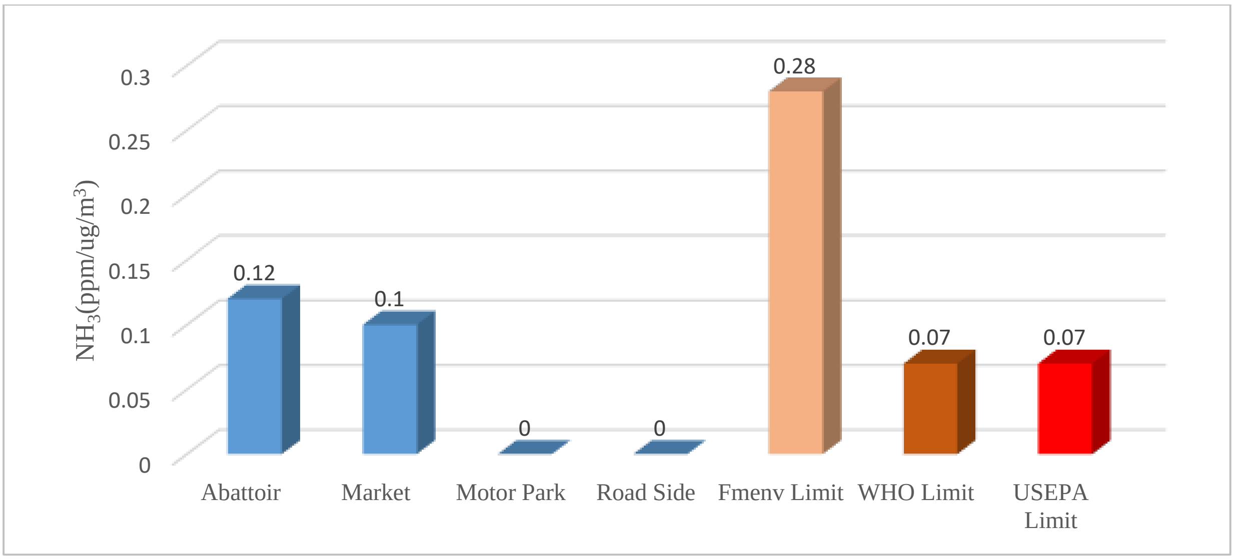

Figure 7 Average concentration of particulate matter in different urban area Source: Fieldwork, 2018.

The average concentration of atmospheric NH_3 was only detected in abbotoir and market areas respectively, with a unit value of 0.12 ±0.09 and 0.1 ±0.12. This values are far above the standard for NH_3 atmospheric concentration as recommended by WHO and USEPA, howver, it is within the critical limit of the Federal Ministy of Environment (Nigeria). No atmospheric NH_3 pollutant was detected within the franchise of motor parks and roadside in gwagwalada urban center. This result shows that the possible emission of NH_3 into the atmosphere in urban areas of Gwagwalada town is attributed to the activities carried out in abattoir and market areas respective. Animal waste associated with the ranching and butchering of animals in abattoir is a major source of NH_3 pollutant concentration in the atmosphere around abattoir facility, while several activities in specific areas around the market accounts for the possible emission of NH_3 pollutant into the atmospheres within the market domain. The result is similar to the outcome of the study of Gobo, Ideriah, Francis, and Stanley (2012), where NH_3 was detected around the urban areas of Okrika townin rivers state.

Hydrogen sulfide

Hydrogen sulfide (H_2S) pollutants occur as colourless gas under conditions of deficient oxygen, in the presence of organic material and sulfate. Most of the atmospheric hydrogen sulfide has natural origins. However, only a minor fraction of the total global emissions of this compound are of anthropogenic origin (WHO, 2000). Below is the concentration of H_2S as detected across the study area (see figure 8).

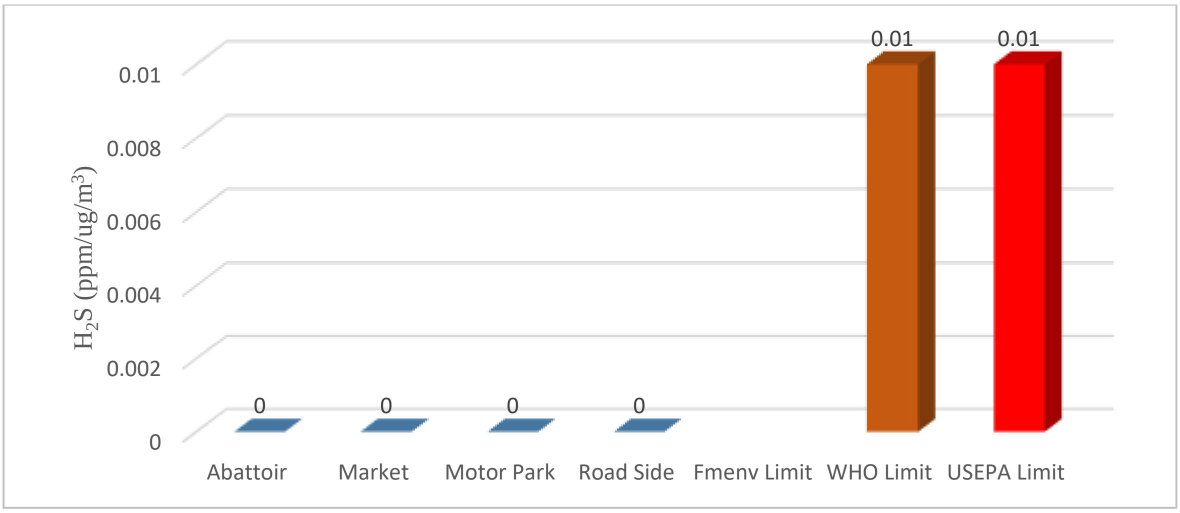

Figure 8: Average concentration of particulate matter in different urban area Source: Fieldwork, 2018.

The ambient concentration of H_2S across the different urban land-use area were not detected. The result commensurate to the fact that only a fraction of the armospheric pollutant of H_2S are of anthropogenic origin, and are present in the atmosphere mostly in geothermally active areas (ATSDR, 2006).

Air Quality Index for the sampled points across the Urban Land-use aea

Using the United States Environmental Protection Agency (2017) equation for calculating Air Quality Index (AQI), the average concentration of the six measured pollutants (CO, NO_2, SO_2 PM, NH_3 and H_2S) were converted into the air quality index to know the condition of atmospheric air pollution at the different urban land-use areas. The Air Quality Index and rating for the six pollutants is presented in Table 4 and 5.

Table 1: Air Quality Index for the study area

	Pollutant											
Location	CO	AQI	NO_2	AQI	SO_2	AQI	PM	AQI	NH_3	AQI	H_2S	*AQI*
Abattoir	4.4	48	0.0	0	0.34	1.7	142.98	285	0.12	171	0	0
Market	0	0	0.0	0	0.28	1.4	72.54	145	0.1	142	0	0
Motor Park	3.4	37	0.0	0	0.26	1.3	162.8	325	0.0	0	0	0
Roadside	6.4	71	0.0	0	0.32	1.6	148.54	297	0.0	0	0	0

Table 5: Air Quality Index Interpretation Key

Good	Moderate	Unhealthy for sensitive group	Unhealthy	Very unhealthy	Hazardous
0-50	51-100	101-150	151-200	201-300	301-500

Air quality index rating as presented in table 4 was calculated based on the World Health Organization standard for the concentrations of atmospheric pollutant. The air quality index rating depicts that the atmospheric concentration of carbon monoxide is good across Abattoir, Market, and Motor-park concessions of Gwagwalada urban area, while it is moderate around roadside area. The rate of CO concentration across Abattoir, Market, and Motor-park is satisfactory and will pose little or no health risk. However, people with high sensitivity who spent their daily life around roadsides may experience cases of respiratory disorder. This may be severe under conditions of 24hours exposure and in cases of high traffic gridlock.

In subjecting the atmospheric concentration of NO_2, $H_2S$and SO_2 to the air quality index rating, it was observed that the concentrations of both pollutants (NO_2, $H_2S$and SO_2) are within the rating of good. Therefore, the rate of NO_2 and SO_2 concentration in a mesoscale within Gwagwalada urban area will pose no health risk.

The air quality index for PM concentration across the sampled areas ranges from being unhealthy to sensitives groups to being hazardous to human health. The PM concentration within the confinement of abattoir facility is very unhealthy for human health, while PM concentration around the market area will only pose health challenges to sensitives groups. In Motor-park area, AQI for PM concentration is hazardous and very unhealthy along roadside in Gwagwalada urban area.

Result of the AQI depicts poor air quality in the study area, with considerable atmospheric air pollutants far above standard for human health. Major pollutant of concern includes CO, NH_3 and PM to a considerable effect on human health's. Remarkable effects of these pollutants on human wellbeing will occur to people residing with closed proximity to Abattoir and Market area as well as those whose businesses are around major routes around the study area as spotted by the AQI. This is synonymous with the research of Enotoriuwa *et al.*, (2016), where CO, NH_3 and PM were found to be above the standard of WHO across different urban background (Market, Hospital residential units and roads) in Obigbo urban area of River State. Similarly, findings of the current study are aligned with the study of Ola, Salami and Ihom (2013). In their study, the levels of toxic gases (CO, H_2S and PM) as compared to AQI in Jos Metropolis (busy roads in Jos, Nigeria including; Ahmadu Bello way, Bauchi road, Tomato market, and some junctions/ terminals; University of Jos gate, Farin Gada and Gada biu) was rated moderate and unhealthy across the sampled points, while H_2S was rated good alongside PM.

CONCLUSION

With emphasis to the summary of findings, this research shows that some trace amount of CO, SO_2, NH_3, and PM pollutants were detected on a mesoscale level at the different urban units. However, the atmospheric concentration of CO, NO_2, SO_2, NH_3, H_2S and PM_{10} pollutant do not significantly differs across urban land-use units in Gwagwalada.

The air quality index of USEPA rates pollutants such as NO_2, SO_2, and H_2S as good in all locations. The condition of the local air quality according to the air quality rating across the different urban land-use shows critical ratings for PM mostly at Motor Park and Roadside respectively. The rating was also critical for NH_3 at Abattoir and Market area. For CO pollutants, it was related as rated as good for Abattoir, Market and Motor Park areas and Unhealthy for sensitive group around Roadside.

RECOMMENDATIONS

Based on the findings and conclusion of this research, the following recommendations are considered appropriate:

i. The road network at the hinterland of Gwagwalada town should not only be expanded to allow free movement of vehicles most importantly during traffic peak periods, but effort should be made to rehabilitate the road to forestall cases of traffic gridlock.
ii. Adequate and efficient infrastructures should be provided alongside modern techniques to run daily operational activities in Abattoir. This will eliminate the current improper practice (roasting of animal skin and burning of animal waste) leading to high rate of NH_3 and PM emission with a microscale effect on the atmosphere.
iii. Research in Pollutant emission model should be embarked upon in urban areas of Gwagwalada to predict the future emission rates and concerns that will follow.
iv. There is need for development and implementation of clean air act for Abuja.

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