African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 4, 2024 (pp. 139-145)
www.abjournals.org

ASSESSMENT OF THE EFFECT OF VEHICULAR EMISSION ON AIR QUALITY IN UYO

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Cite this article:

Precious, H. D., Olatunji, O. M., Nta, S. A. (2024), Assessment of the Effect of Vehicular Emission on Air Quality in Uyo. African Journal of Environment and Natural Science Research 7(4), 139-145. DOI: 10.52589/AJENSR-OQAEC0EU

Manuscript History

Received: 19 Sep 2024

Accepted: 17 Nov 2024

Published: 25 Nov 2024

ABSTRACT: *The presence of vehicular traffic in urban city centers due to urban expansion occasioned by rapid population growth has been of immense concern for many years, as emissions from vehicle exhausts pose a major threat to both public health and environmental quality. This trend is expected to continue as ownership of vehicles keeps increasings. In this study, attempts are made to measure the concentration of traffic related emissions, with a view to assess the intricate relationships between vehicular emissions, their effect on surrounding air quality, and their impact on public health by extension, in Uyo metropolis, using USEPA air quality index. Six sampling locations were selected for this analysis. In selecting the study locations, special preference was given to accessibility, availability of open space free from shed, meteorological consideration of upward and downward directions, and areas with minimal local influence from vehicular movement. Also, consideration was given to the sensitivity and stability of the equipment, as well as its capability to reproduce results. The concentrations of the priority pollutants (i.e., CO, H_2S, SO_2 and O) were measured with highly sensitive digital portable meters (Crowcon Gasman Monitors) in each of the selected locations, at peak traffic periods, and compared with standard air quality ratings. The results of the study showed that locations IRJ, IPJ and NRJ recorded relatively the highest measured concentrations of the pollutants (CO, H_2S and SO_2) respectively, while IPJ, NRJ and IRJ recorded the lowest measured concentrations of same pollutants respectively. Continuous accumulation of these toxic gases in the air poses greater threat or may add to an already existing health burden of the residents of those locations. Therefore, further and thorough investigation is highly recommended to study the health impact of these contaminants in the residents.*

KEYWORDS: Assessment, vehicular emission, air quality, population growth, Uyo metropolis.

Article DOI: 10.52589/AJENSR-OQAEC0EU
DOI URL: https://doi.org/10.52589/AJENSR-OQAEC0EU

INTRODUCTION

Vehicular emissions refer to the toxic chemical compounds released from the exhaust of motor vehicles due to internal combustion processes. They are some of the major problems to environmental and public health, which is expected to increase reasonably as vehicle ownership increases in the world. In recent years, the environmental problems caused by vehicular pollutants have become increasingly serious in Nigeria (Abam *et al.*, 2009). Since the 1970s, there have been many studies on the dispersion and distribution of traffic-related air pollution. The concentration of such pollutants beyond limits, as well as exposure over a certain period, is extremely dangerous and can cause severe injury or even death (Weli, 2012).

Vehicles emit a range of pollutants, including Carbon Oxides (COx), Sulfur Oxides (SOx), Nitrogen Oxides (NOx), Particulate Matter (PM_{10} and $PM_{2.5}$), and Volatile Organic Compounds. Cars, motorcycles, and many big vehicles operating in urban areas cause severe air environmental problems including Global Warming, as they emit poisonous substances like Carbon Monoxide (CO), Smog, Fumes, Dust and other Greenhouse gases into the atmosphere. These toxic chemical compounds have far reaching adverse effects on human health and environmental quality. Vehicular emission is one of the major threats to the environment, and public health that increases as vehicle ownership increases. The Intergovernmental Panel on Climate Change (IPCC, 2001) estimates that about 30% of urban air degradation come from vehicular emission. Pollution emanating from mobile transportation is on the increase, coupled with bad roads in cities and increasing the levels of air pollutants, consequently increasing health problems in human population (Modinah *et al*., 2019).

African urban centres are particularly known to have higher levels of pollution due to the reliance on road transport to move goods and people. The more populated the region, the more air pollution due to the higher number of vehicles. Most of these vehicles are old and emit more pollutants. The hallmark poor state of the roads also means people spend longer on commutes leading to even more air pollution. This is because the longer the vehicles have to stay on the roads, the more pollutants they emit. The health challenges experienced by travellers, road users, passers-by, residents and business operators in traffic flash points, having high concentration of vehicular traffic during some periods of the day are worrisome. In Nigeria, the increasing trend of importing used vehicles is contributing to air pollution and degradation of the environment despite the global efforts to reduce environmental problems caused by mobile transportation (Ajayi & Dosunmu, 2002; Atubi, 2015).

According to the US Environmental Protection Agency (USEPA 2006), one-quarter (1/4) of particulate matter in air is due to vehicular emission; this amount accounts for 10% of particulate matter, while 34% of Nitrogen dioxide (NO_2), and 51% of Carbon monoxide (CO) are also released yearly in the US, due to vehicular emission. In 2021, the World Health Organization (WHO) considered air pollution as the greatest environmental risk. It identified motor vehicles as one of the world's leading causes of pollution in most urban cities of the world, though China, United States, Russia, Mexico, and Japan are the world's leaders in air pollution.

As a significant source of air pollution, road transport (petrol and diesel-powered vehicles) produces air and sound emissions that are harmful to environmental and human health. Human exposure to these air pollutants as a result of traffic is known to create severe health problems

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especially in urban areas where pollution levels are on the high side, due to massive vehicular movement occasioned by large population.

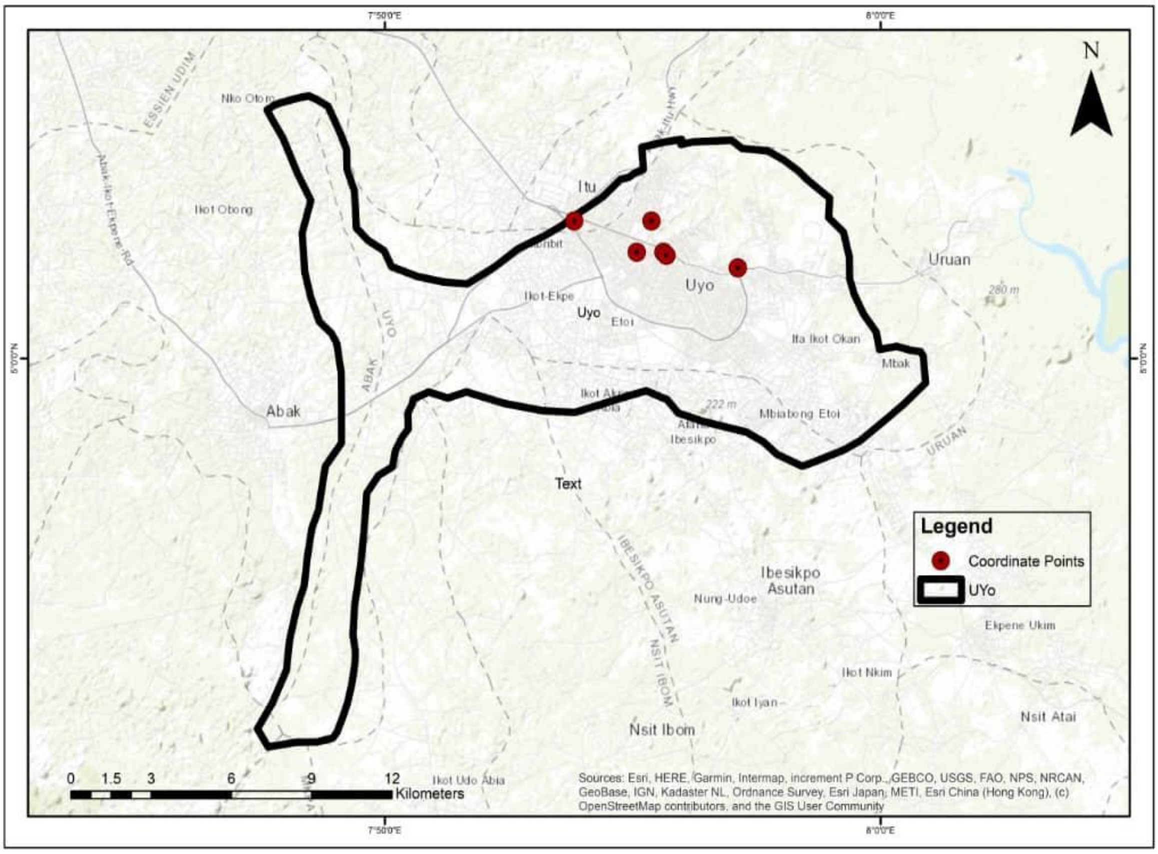
MATERIALS AND METHODS

Location of the Research

This study was carried out in Uyo metropolis. Uyo is the capital city of Akwa Ibom State, Nigeria. It is situated at 5.03° North latitude, 7.93° East longitude and 196 meters elevation above the sea level. Uyo the Capital City covers an approximate area of 188.024 km² with an estimated population of 1,057,170 (2006 National Population Census). The average annual temperature in Uyo is 26.4°C. The average rainfall here is 2509 mm.

Figure 1: Map of the Study Uyo, Showing the Study locations

Air Monitoring and Analytical Procedures



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Air monitoring was carried out twice, that is, morning peak hours (7:00–9:00 a.m.) and evening peak hours (4:00–6:00 p.m.) in Uyo. Concentrations of selected air pollutants (CO, H_2S, SO_2 and O_2) were measured at six (6) selected locations (NRJ, IPJ, IRJ, ITRJ, ABRJ and ARJ).

Highly sensitive digital portable meters (Crowcon Gasman Monitors) were used to measure each of the pollutants, detailing their ranges and alarm levels. The measuring instrument was put on, zeroed and held steadily for at least five (5) minutes before readings of pollutant concentrations were taken. Readings were taken at least five meters (5 m) away from the center of the road in each sampling location. Consideration was given to the sensitivity and stability of the equipment, as well as its capability to reproduce results. In selecting the study locations, special preference was given to accessibility, availability of open space free from shed, meteorological consideration of upward and downward directions, and areas with minimal local influence from vehicular movement.

Air Quality Index (AQI)

Air Quality Index (AQI) was used for describing ambient air quality. The indices for each of the pollutants was derived using the mathematical formula:

$AQI_{pollutant}$ = (Pollutant data reading/Standard) x 100………………………………… (1)

It is a rating scale for outdoor air. The lower the AQI value, the better the air quality and vice versa.

RESULTS AND DISCUSSION

The results of the average concentration of the gaseous pollutants indicate that CO was in the range of 12.80 to 29.00 ppm. The emission of the pollutant was highest (29.00 ppm) at IRJ, and lowest (12.80 ppm) at IPJ. The six study locations were within the permissible limit of USEPA 35 ppm.

H_2S ranged between 0.10 to 12.80 ppm. The highest (12.80 ppm) concentration of the pollutant was recorded in IPJ, while the lowest (0.10 ppm) was recorded in NRJ. The permissible level of H_2S is not stated in this study because it is not reported in the USEPA ambient air quality standards. Incomplete combustion of sulfur-containing fuel (especially diesel) or lubricating oil, leads to the release of high amount of H_2S.

SO_2 was found in the range of 0.13 to 0.53 ppm. It was highest (0.53 ppm) in NRJ and lowest (0.13 ppm) in IRJ. The six (6) sampling locations were within the permissible limit of USEP 0.425 ppm, except for NRJ (0.53 ppm) that is slightly above the permissible level of USEPA 0.425 ppm.

O_2 volume was found between 20.80 and 28.80 ppm. It was highest (28.80 ppm) in ITRJ.

The high concentrations (29.00 ppm, 12.80 ppm and 0.53 ppm) of CO, H_2S and SO_2 in IRJ, IPJ and NRJ, as shown in Table 4.5 may be largely due to vehicular traffic congestion or high traffic volume in those locations at rush hours/peak traffic hours. Conversely, NRJ, and IRJ recorded the lowest concentrations of CO, H_2S and SO_2 respectively, and that could be largely due to relatively low traffic volume in those locations.

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At low concentrations of CO, fatigue in healthy people and chest pain in people with heart disease is imminent. But at higher concentrations, impaired vision and coordination, headaches, dizziness, confusion, and nausea could occur. CO concentrations are generally high in areas with heavy traffic congestion; the emissions are substantially greater in cold weather because cars need more fuel to start at cold temperatures and some emission control devices such as oxygen sensors and catalytic converters operate less efficiently when they are cold (Utang & Peterside, 2011).

Exposure to high amount of H_2S may cause irritation to the eyes and respiratory system. It can also cause apnea, coma, convulsions, dizziness, headache, weakness, irritability, insomnia and stomach upset. The level of exposure depends on dosage and duration of stay in the polluted location. High concentrations of SO_2 can cause inflammation and irritation of the respiratory system, especially during heavy physical activity. The resulting symptoms can include pain when taking a deep breath, coughing, throat irritation, and breathing difficulties (WHO, 2005).

Table 1: Measured Concentration Levels at Different Locations and Peak Traffic Periods, in Parts Per Million (ppm)

Location	Time	CO	H_2S	SO_2	O_2
Nwaniba Road (NRJ)	Morning Evening	17.80 21.60	0.20 0.00	0.92 0.14	20.80 20.80
Ibom Plaza (IPJ)	Morning Evening	11.00 14.60	11.00 14.60	0.22 0.12	20.88 20.80
Ikpa Road (IRJ)	Morning Evening	16.80 41.20	0.00 0.00	0.14 0.12	20.84 20.80
Itam Road (ITRJ)	Morning Evening	10.40 16.40	0.00 0.00	0.20 0.26	20.80 20.80
Abak Road (ABRJ)	Morning Evening	21.40 15.60	0.00 0.00	0.24 0.26	20.80 20.80
Aka Road (ARJ)	Morning Evening	26.00 20.00	0.00 0.00	0.24 0.16	20.80 28.90
USEPA Standard (2006)		**35**	**-**	**0.425**	-

Table 2: Mean of Measured Concentrations of Pollutants in the Study Locations

Location	CO	H_2S	SO_2	O_2
NRJ	19.70	0.10	0.53	20.80
IPJ	12.80	12.80	0.17	20.84
IRJ	29.00	0.00	0.13	20.82
ITRJ	13.40	0.00	0.23	28.80
ABRJ	18.50	0.00	0.25	20.80
ARJ	23.00	0.00	0.20	20.85

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Also, the average air quality in all the locations, and the associated health implications were analytically determined by comparison with USEPA Air Quality rating for priority pollutants.

For CO, the average air quality was found to be good in IPJ and ITRJ, and moderate in ABRJ, NRJ, ARJ and IRJ.

For SO_2, the air quality was good in IRJ, IPJ and ARJ; moderate in ITRJ and ABRJ; and unhealthy for sensitive groups in NRJ.

The associated health implications for the different categories of AQI levels (Good, Moderate and Unhealthy for sensitive groups) as found in this study are: air quality is considered satisfactory, and air pollutant poses little or no risk in those locations and time; color code is green. Air quality is acceptable; however, for some pollutants, there may be a moderate health concern for a very small number of people; color code is yellow. Members of sensitive groups may experience health effects. The general public is not likely to be affected; color code is orange.

Table 3: Summary of Air Quality Index for the Chosen Pollutants

Location	**CO**	**SO_2**
NRJ	56	125
IPJ	37	40
IRJ	83	31
ITRJ	38	54
ABRJ	53	59
ARJ	66	47
USEPA Standard (2006)	**35**	**0.425**

CONCLUSION

This study assessed the effect of vehicular traffic related emission on air quality in Uyo metropolis. The study found that the selected study locations in Uyo are exposed to varying levels of traffic related gaseous pollutions. The analysis of the results obtained in this research underscores the existence of a strong relationship between vehicular emission, its effect on surrounding air quality, and its associated public health implications.

The study has also shown that the locations IRJ, IPJ and NRJ recorded relatively the highest average measured concentrations of the pollutants (CO, H_2S and SO_2) respectively. While NRJ, NRJ and IRJ recorded the lowest average measured concentrations of same pollutants respectively. These peak concentrations of CO, H_2S and SO_2 in IRJ, IPJ and NRJ may be largely due to vehicular traffic congestion or high traffic volume, as there were no local

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industries sited in those locations at the time of this study. Idling high volume of vehicles operate at low speeds, and they emit more exhaust pollutants compared to those moving at higher speeds. And if not mitigated, this trend could cause devastating environmental and public health concerns.

The measured concentrations of CO and SO_2 were compared with USEPA Air Quality Standard for priority pollutants, and were found within permissible limits (35 ppm and 0.425 ppm) in all locations except for NRJ where SO_2 (0.53 ppm) was slightly above USEPA permissible limit (0.425 ppm).

The results from Air Quality Index analysis in the various locations show that for CO, air quality ranked between good and moderate, while for SO_2, Air Quality Index ranked between good and unhealthy for sensitive groups. This suggests that SO_2 poses greater environmental and public health threat than CO in the study area. The results also show that the Air Quality Standard for ambient air and Air Quality Ratings for priority pollutants, as reported by USEPA (2006 and 2016) respectively, are very useful tools for the determination of surrounding air quality and its associated public health implications.

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