Air Quality Assessment within Some Housing Estates in Mgbuesilaru Community in Obio- Akpor Local Government Area Rivers State

Emmanuel, C.[1], Awolo, S. N.[2], Ideriah, T. J. K.[3], Gobo, A. E[1]

[1]Institute of Geosciences and Environmental Management Rivers State University, Port Harcourt

[2]Department of Chemistry, Rivers State University, Port Harcourt

[3]Institute of Pollution Studies, Rivers State University, Port Harcourt

DOI: https://doi.org/10.51244/IJRSI.2025.12020003

Received: 08 January 2025; Accepted: 13 January 2025; Published: 26 February 2025

ABSTRACT

This research covers the assessment of the air quality of around selected residential estates in Mgbuesilaru, Port Harcourt. The assessment will be done by measuring the concentrations of particulate matter, Carbon monoxide (CO), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Methane (CH_4), Ozone (O_3) and VOCS using portable digital samplers. The lowest levels of pollutants were measured in the control station. Some sampled locations in Akpaogwu estate indicated relatively high PM_{10} and $PM_{2.5}$ values (127.4 for PM_{10} and 26.2 for $PM_{2.5}$) compared to other sampled estates. Relatively high CO levels were obtained for some sampled locations. The study also found that the pollutants were mainly from fossil fuel combustion, generator and road traffic emissions. CO, PM_{10} and $PM_{2.5}$ values were high as a result of automobile and road traffic emissions.

Keywords; Air Quality, Pollutants, Housing Estates, Mgbuesilaru, Rivers State

INTRODUCTION

The city of Port Harcourt with over 2 million people in 2011 according to WHO, is home to several industries including most of those in the oil and gas sector of the nation's economy carrying out their oil exploration activities in the city. The city of Port Harcourt has over the years witnessed a steady influx of people and business activities. According to Ede *et al.* (2006) significant amounts of pollutants are currently being released into the atmosphere in surrounding gas flare points around the city associated with petroleum extraction.

The deteriorating state of air quality in Port Harcourt is most probably due to continuous legal and illegal exploration and refining of crude oil and petrochemicals, gas flaring and open municipal waste burning from dump sites, and tyre burning among others (Ede & Edokpa, 2019; Maduka &Tobin-West, 2017; RSMENV, 2019). Another notable source of pollution has to do with the soot from illegal oil refineries which the government is trying it best to tackle. These pollutants are known to pose very serious threats to public health given the fact that these pollutants have cross- boundary effects and travel over long distances from their points of emission when atmospheric conditions are favorable for dispersion.

Nigeria is on the brink of an economic meltdown due to the persistent power outage experienced, hence purchasing and operating different capacities of generators for both private and industrial uses seem to be the most viable option for most Nigerians. Most average and low-income Nigerians opt for small capacity generators and several studies have proven that small capacity generators constitute a higher percentage of dangerous emissions especially CO compared to large capacity generators.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

A notable source of air pollution within residential estates in Mgbuesilaru is attributable to generator exhaust fumes, this is a result of the fact that almost all the apartment within the estates have one or more petrol/diesel generating plants of different capacities to supplement energy demand during periods of power outages. Previous researches conducted, found out that the small petrol generators popularly known as "I pass my neighbor" are known to constitute more harm especially when used in close proximity to living areas and bedrooms. This has in some cases led to the death of families in their sleep because the fumes constitute mostly CO (carbon monoxide) which is very deadly and its impact is even worse when the victims are asleep. The principal gases from these various sources of air pollution typically include Nitrogen oxides (NOx), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2). As in most combustion processes particulate matter (PM) is also emitted. These pollutants have significant health effects on residents. For example, a high concentration of atmospheric CO leads to asphyxiation, which affects the proper functioning of different organs, resulting in impaired concentration, slow reflexes and confusion. Wheezing and coughing are known to be common effects of nitrogen dioxide toxicity. However, dyspnea, chest pain, nose, eye, and throat irritations, headache, bronchospasm, diaphoresis, fever and pulmonary edema may also occur.

Population and industrial growth and the dependence on internal combustion engines have over time increased the concentration of gaseous and particulate emissions in cities (Rao and Rao, 2006). Studies on the causes and effects of air pollution have documented the need for emission inventories, auto emission modelling, land-use control, impact on health, economic and environmental strategies for pollution prevention and alternative fuels.

Even though there are a good number of reports on the adverse effects of air pollution on human health and the environment, no such studies have been carried out around Mgbuesilaru to substantiate these findings and also assess its air quality .This study therefore considers the assessment of air quality around some selected housing estates in Mgbuesilaru Port Harcourt to determine the levels of particulates PM_1, $PM_{2.5}$, PM_7, PM_{10}, Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Carbon monoxide (CO), Ozone (O_3), Methane (CH_4), Volatile Organic Carbons and also considers the possible sources attributable to the pollution as well as its effects on public health.

It is noteworthy to state that the complete eradication of air pollution in a complex environment such as ours is practically impossible given our reliance on fossil fuel for energy to run several industrial activities that sustain the economy of the state as well as provide goods and services that improve the livability of the indigenes. The issue of air pollution can rather be brought low to a minimum hence producing less harmful effects on public health. To curb this menace several intervention methods, adaptable and applicable to the Nigerian environment need to be employed and stringent policies effectively implemented and enforced. Care must be taken to ensure that the intervention methodologies employed to remediate the problem do not constitute more harm than good to the environment.

METHODOLOGY

The Study Area

The study area is Obio-Akpor which is a local government in the metropolis of Port Harcourt, one of the major centres of economic activities in Nigeria, and one of the major cities of the Niger Delta, located in Rivers State, with various industries and companies. The city covers 260km^2 (100 sq mi) and at the 2006 Census held a population of 464,789. Obio-Akpor is constituted mainly of the Ikwerre ethnic nationality. Obio-Akpor is bounded by Port Harcourt LGA to the south, Oyigbo and Eleme Local Government Areas to the east, Ikwerre and Etche Local Government Areas to the west. It is located between latitudes $4^0$45'N and $4^0$60'N and longitudes $6^0$50'E and $8^0$0'E.

In Obio-Akpor, rainfall is almost predictable and follows the sequence of increase towards the months of July-august before decreasing in November -February. The months of December ushers in relatively dry weather. This climatic condition is associated with sunshine and dry harmattan wind. This climatic condition persists throughout December and in the early weeks of January.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

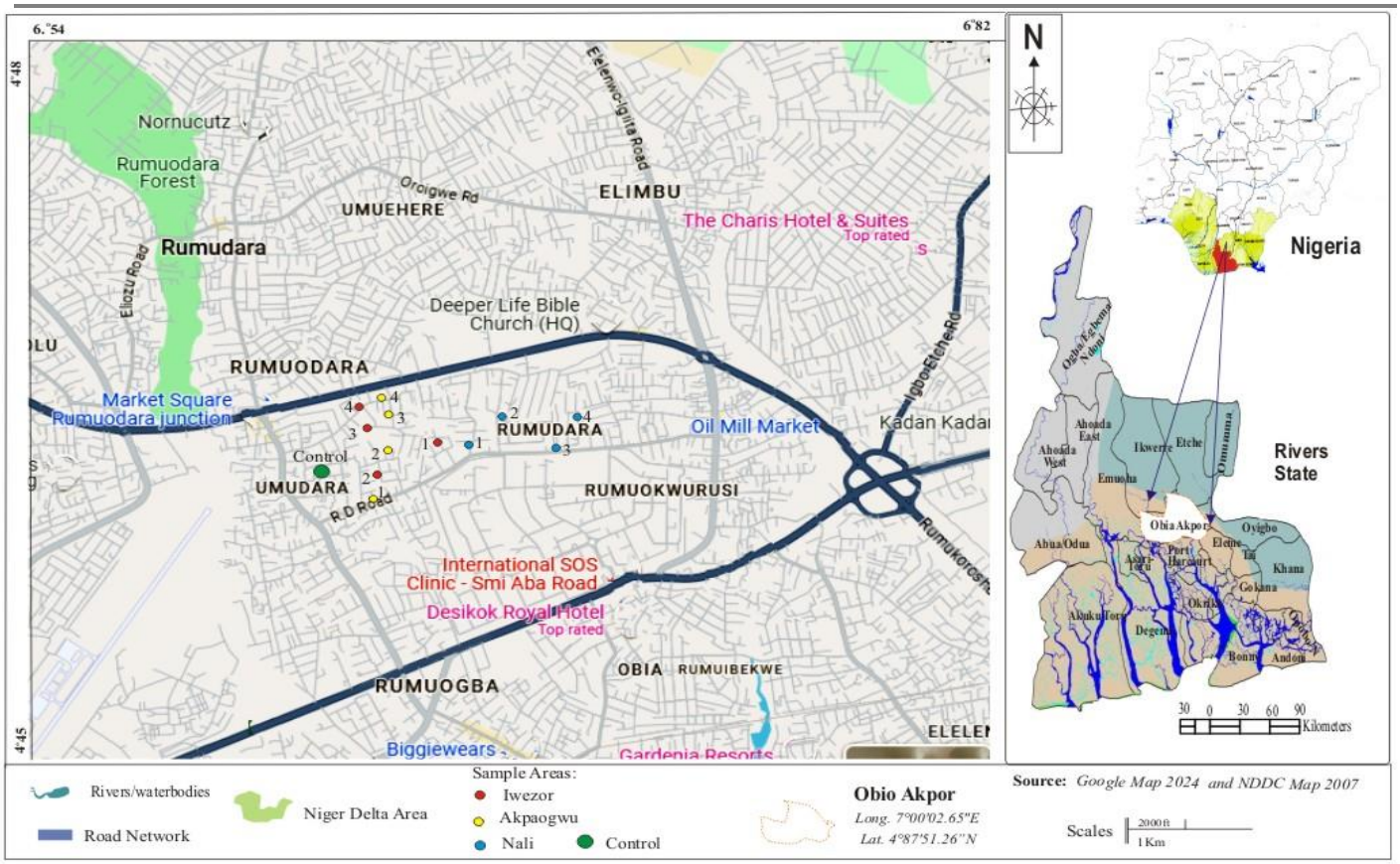

Fig 1: Map of Study Area

Materials and Sample Collection

For this research work, the air pollution measurements were carried out using direct reading, automatic in-situ portable gas monitors. The primary pollutants SO_2, CO, NO_2, O_3, CH4, VOC were measured in mg/m^3using the Aeroqual series 500 device, while PM were measured in $\mu g/m^3$ using particle counter Aerocet 1513. Meteorological values were measured using a digital anemometer.

Sampling involved open-air sampling within the estates and indoor air sampling in some selected locations. Measurements were taken after the measuring device had been properly calibrated and allowed for at least 15 minutes to provide real-time reading of parameters of interest.

RESULTS AND DISCUSSION

The results are presented in Table 1 and Figures below.

Table 1: Showing the Concentrations of Air Pollutants

SAMPLING STATION	PM ($\mu g/m^3$)				NO_2 (mg/m^3)	$S0_2$ (mg/m^3)	O_3 (mg/m^3)	CO (mg/m^3)	CH_4 (mg/m^3)	VOC (mg/m^3)
	1	2.5	7	10						
IWEZOR 1	4.4	18.0	42.9	49.4	0.174	0.00	0.11	11.76	6.4	5
IWEZOR 2	4.6	20.9	48.8	52.5	0.225	0.00	0.15	4.56	3.2	2
IWEZOR 3	4.1	18.3	43.7	51.4	0.183	0.00	0.10	6.87	3.9	3
IWEZOR 4	3.9	17.8	39.6	44.9	0.161	0.00	0.12	12.10	5.7	4
IWEZOR	4.9	19.5	49.4	58.0	0.173	0.00	0.14	11.53	3.7	4

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

INDOOR 1										
IWEZOR INDOOR 2	4.7	20.6	50.8	61.7	0.187	0.00	0.13	12.21	3.5	2
AKPAOGWU 1	9.2	26.2	54.8	61.3	0.160	0.00	0.06	13.3	3.0	3
AKPAOGWU 2	4.1	18.8	92.3	127.4	0.186	0.00	0.10	15.64	2.7	3
AKPAOGWU 3	3.5	15.3	46.5	63.5	0.191	0.00	0.21	24.16	3.7	3
AKPAOGWU 4	3.8	15.7	40.1	47.6	0.152	0.00	0.11	18.47	3.4	4
AKPAOGWU INDOOR 1	3.7	21.2	67.1	87.2	0.128	0.00	0.09	5.51	2.2	2
AKPAOGWU INDOOR 2	3.5	19.3	41.7	53.8	0.149	0.00	0.11	5.43	2.1	2
WALI 1	3.4	14.6	37.8	49.7	0.163	0.00	0.20	13.47	2.1	3
WALI 2	3.4	16.9	43.5	53.7	0.213	0.00	0.14	6.86	2.1	2
WALI 3	3.2	14.1	39.7	47.4	0.186	0.00	0.06	6.97	2.7	3
WALI 4	3.5	15.2	41.3	50.2	0.153	0.00	0.10	6.74	2.3	3
WALI INDOOR 1	3.3	15.1	44.5	59.8	0.211	0.00	0.09	8.99	2.5	2
WALI INDOOR2	2.9	15.7	50.5	67.9	0.185	0.00	0.04	8.06	2.5	2
CONTROL	3.2	13.4	35.3	46.7	0.132	0.0	0.09	4.32	4.2	3

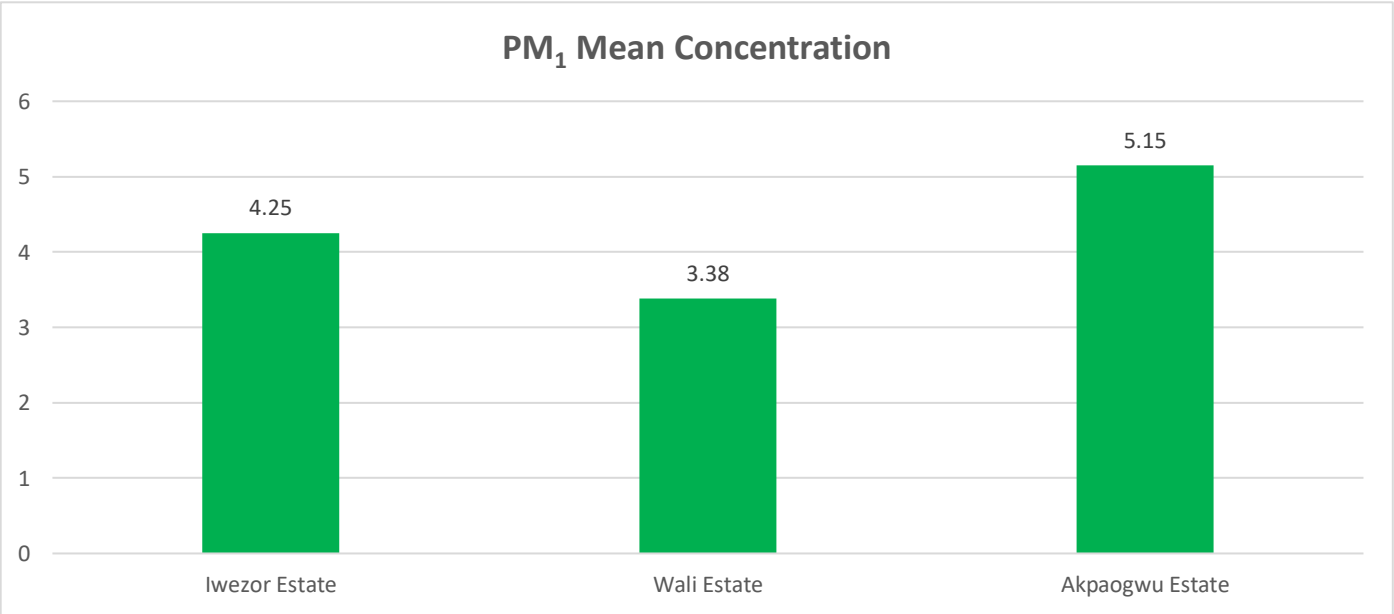

Fig. 1: PM_1 Mean Concentration for all Three Estates

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

Fig. 1 shows the mean concentration of particulate matter 1 for all three estates sampled with Akpaogwu Estate having the highest mean value of 5.15µg/m^3 followed by Iwezor and Wali estates whose values were far below WHO recommended limit of 50µg/m^3 hence its safe and pose no major health concern to residents.

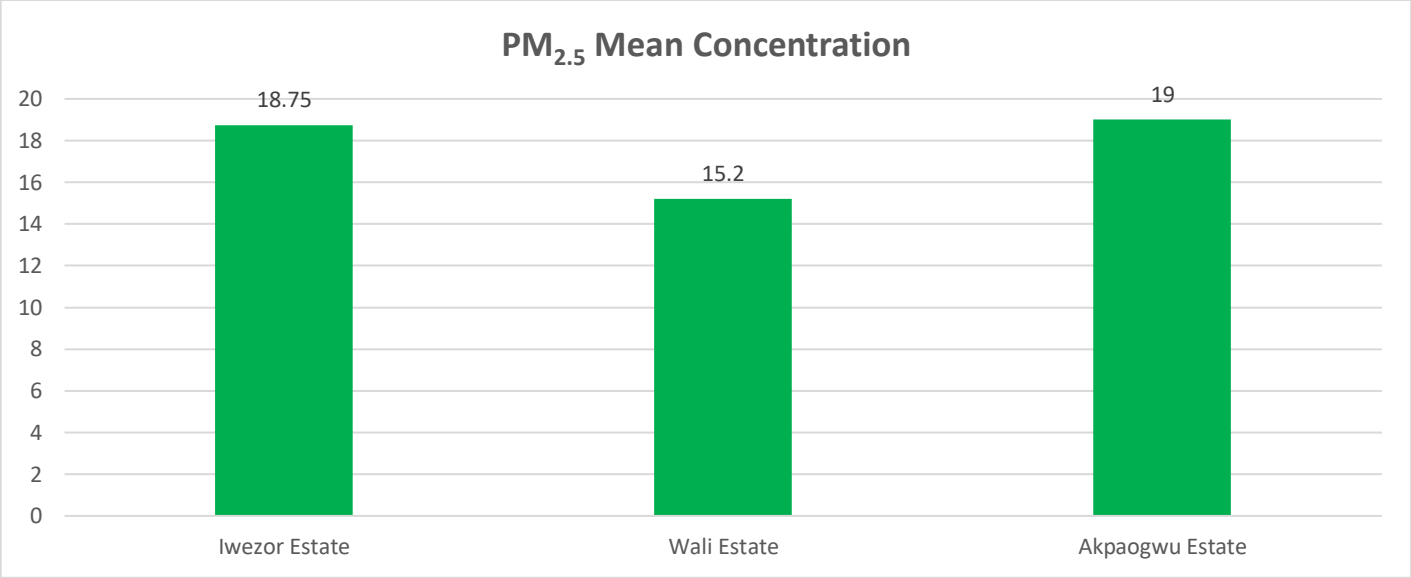

Fig. 2: $PM_{2.5}$ Mean Concentration for all Three Estates

Fig. 2 shows the mean concentration of particulate matter 2.5 for all three estates sampled with Akpaogwu estate having the highest mean value of 19µg/m^3 followed by Iwezor estate and Wali estate whose values were slightly below NESREA Air Quality standards, 2019 recommended limit of 25µg/m^3. This value does not necessarily pose any serious health concern to residents but rather calls for monitoring and pollution control in other not to exceed acceptable limits.

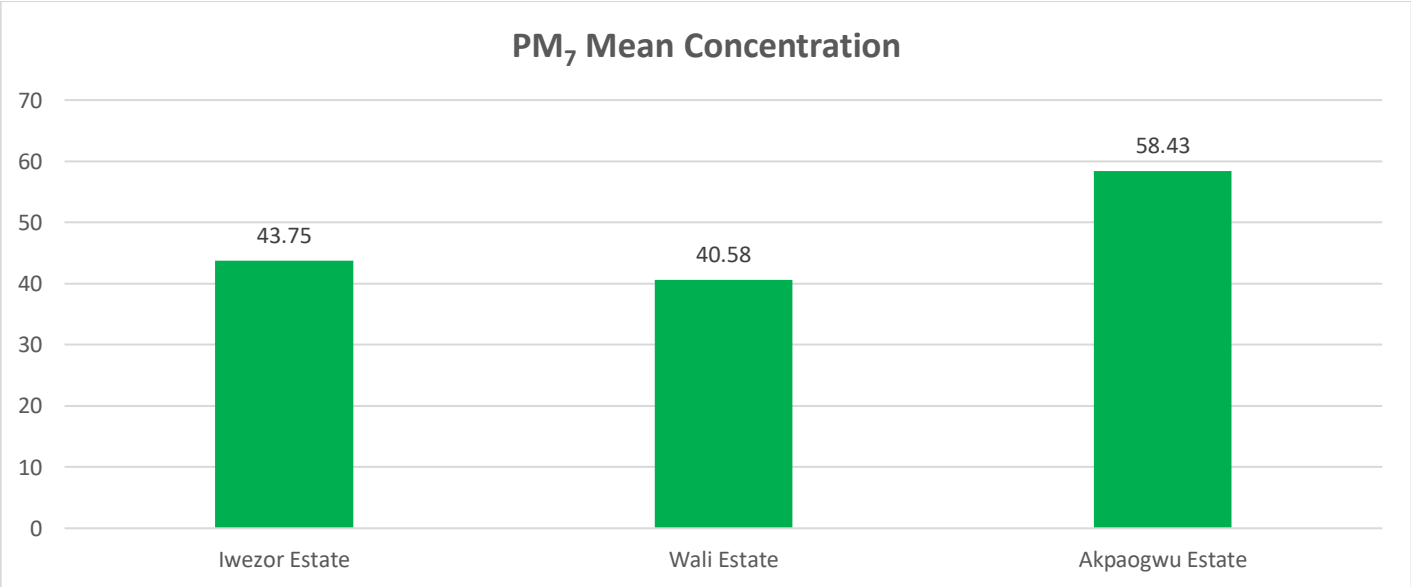

Fig. 3: PM_7 Mean Concentration for all Three Estates

Fig .3 shows the mean concentration of particulate matter 7 for all three estates sampled with Akpaogwu estate having the highest mean value of 58.45µg/m^3 followed by Iwezor estate and Wali estate. Although there is no specific permissible limit for PM_7 as particulate matter is typically categorized into 3 main sizes PM10 (coarse particle ≤10µm), PM2.5 (fine particle ≤2.5µm), PM1 (ultrafine particle ≤1µm). However, some organizations and researchers have studied PM7 as an intermediate fraction and one of such organization, California Air Resources Board (CARB) proposed 25µg/m^3 24 hour average value for PM7. Going by this all three sample locations exceed CARB recommended limit of 25µg/m^3.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

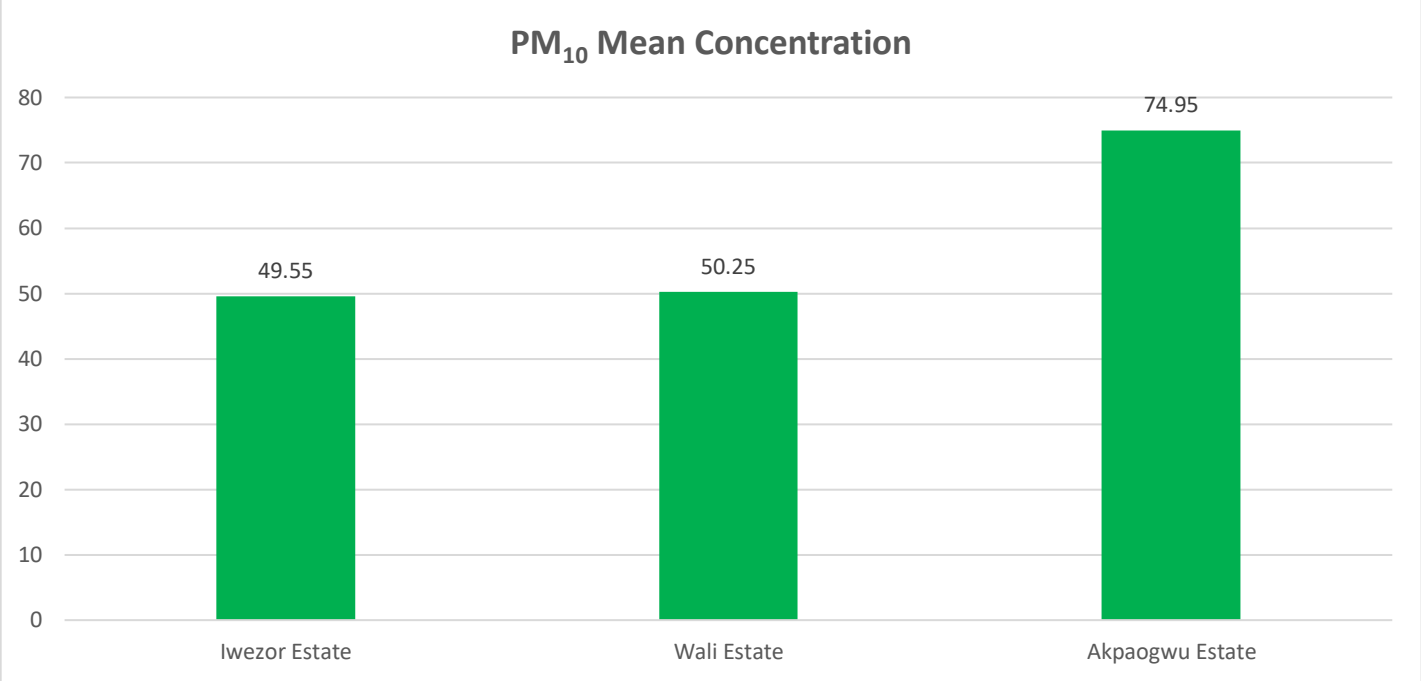

Fig. 4: PM_{10} Mean Concentration for all Three Estates.

Fig. 4 shows the mean concentration of particulate matter 10 for all three estates sampled with Akpaogwu estate having the highest mean value of 74.95µg/m^3 followed by Iwezor estate and Wali estate whose values were slightly below NESREA Air Quality standards, 2019 recommended limit of 100µg/m^3. This value does not necessarily pose any serious health concern to residents but rather calls for monitoring and pollution control in other not to exceed permissible limits.

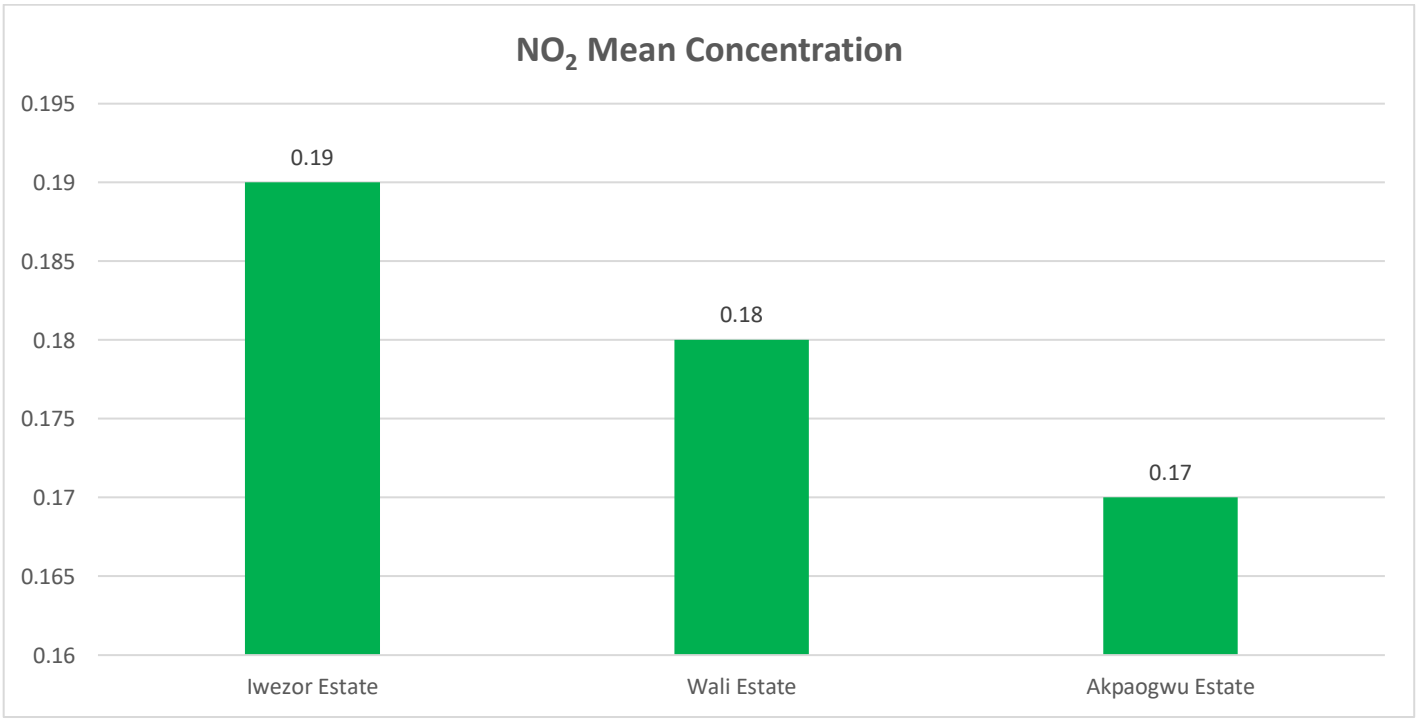

Fig 5: NO_2 Mean Concentration for all Three Estates

Fig. 5 shows the mean concentration of nitrogen dioxide ($N0_2$) for all three estates sampled with Iwezor estate having the highest mean value of 0.19mg/m^3 followed by Wali estate and Akpaogwu estate whose values were slightly above NESREA Air Quality standards, 2019 recommended limit of 0.1mg/m^3. This value does not necessarily pose any serious health concern to residents but rather calls for monitoring and pollution control in other not to exceed permissible limits.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

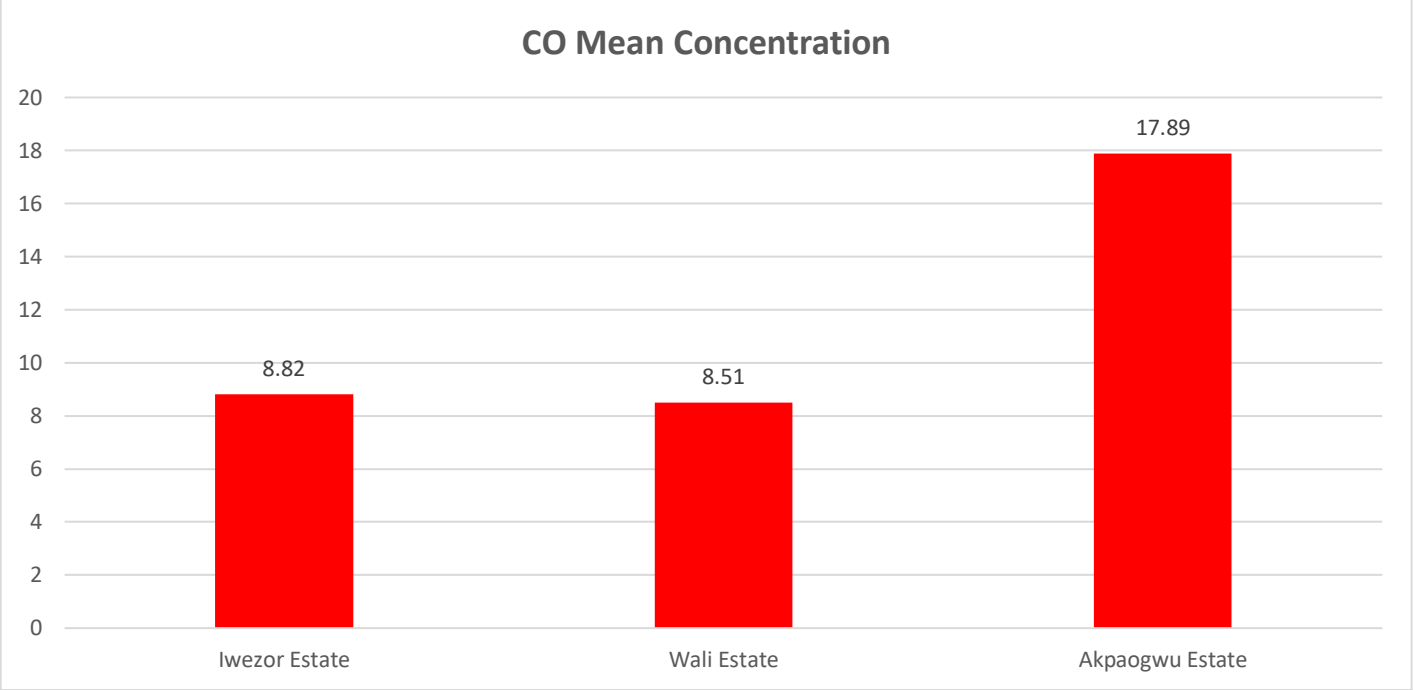

Fig. 6: CO Mean Concentrationfor all Three Estates

Fig. 6 shows the mean concentration of Carbon monoxide (CO) for all three estates sampled with Akpaogwu estate having the highest mean value of 17.89mg/m^3 followed by Iwezor estate and Wali estate whose values were above NESREA Air Quality standards, 2019 recommended limit of 5mg/m^3. This high value may pose a significant health concern to residents especially those of the susceptible groups like pregnant women, the elderly and those with prevailing cardiovascular health issues.

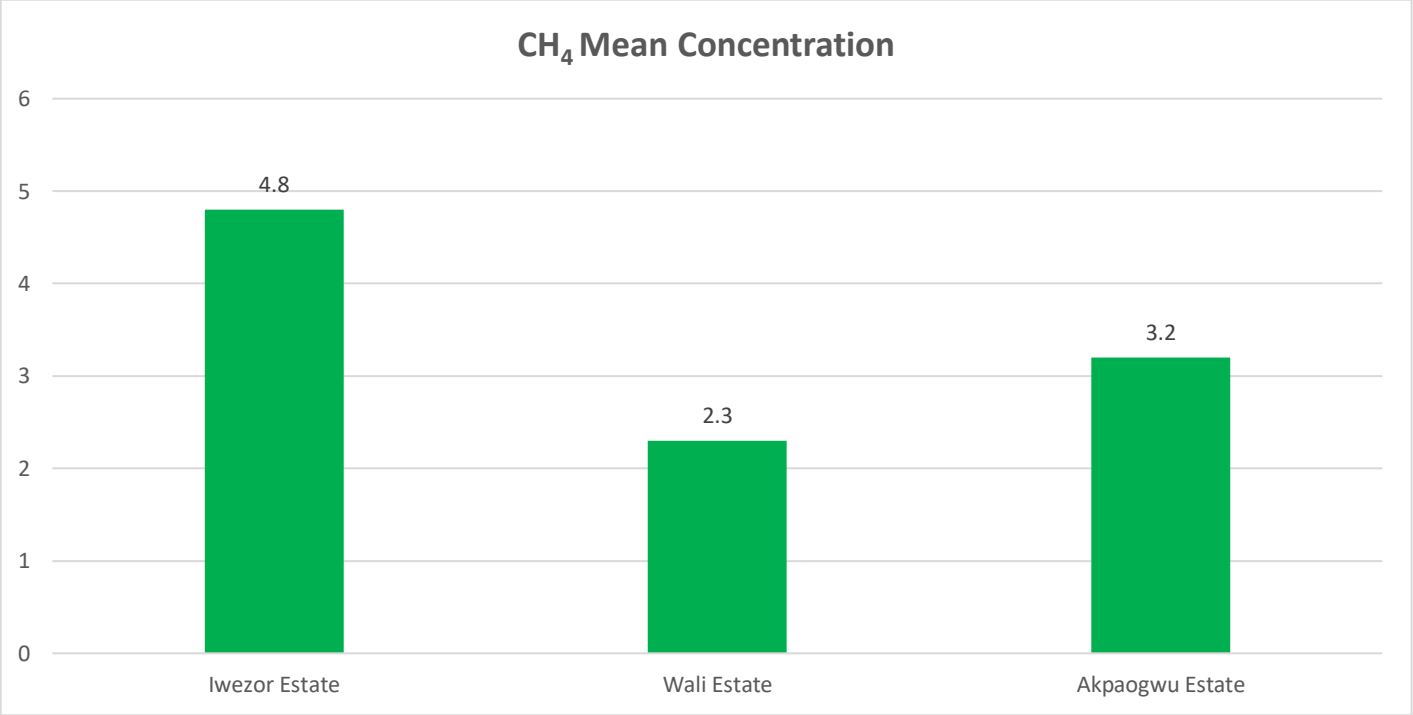

Fig. 7: CH_4 Mean Concentrationfor all Three Estates

Fig. 7 shows the mean concentration of methane (CH4) for all three estates sampled with Iwezor estate having the highest mean value of 4.8mg/m^3 followed by Akpaogwu estate and Wali estate whose values were far below National Institute of Occupational Safety and Health (NIOSH) recommended limit of 1400mg/m^3. This value does not necessarily pose any serious health concern to residents and is hence safe.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

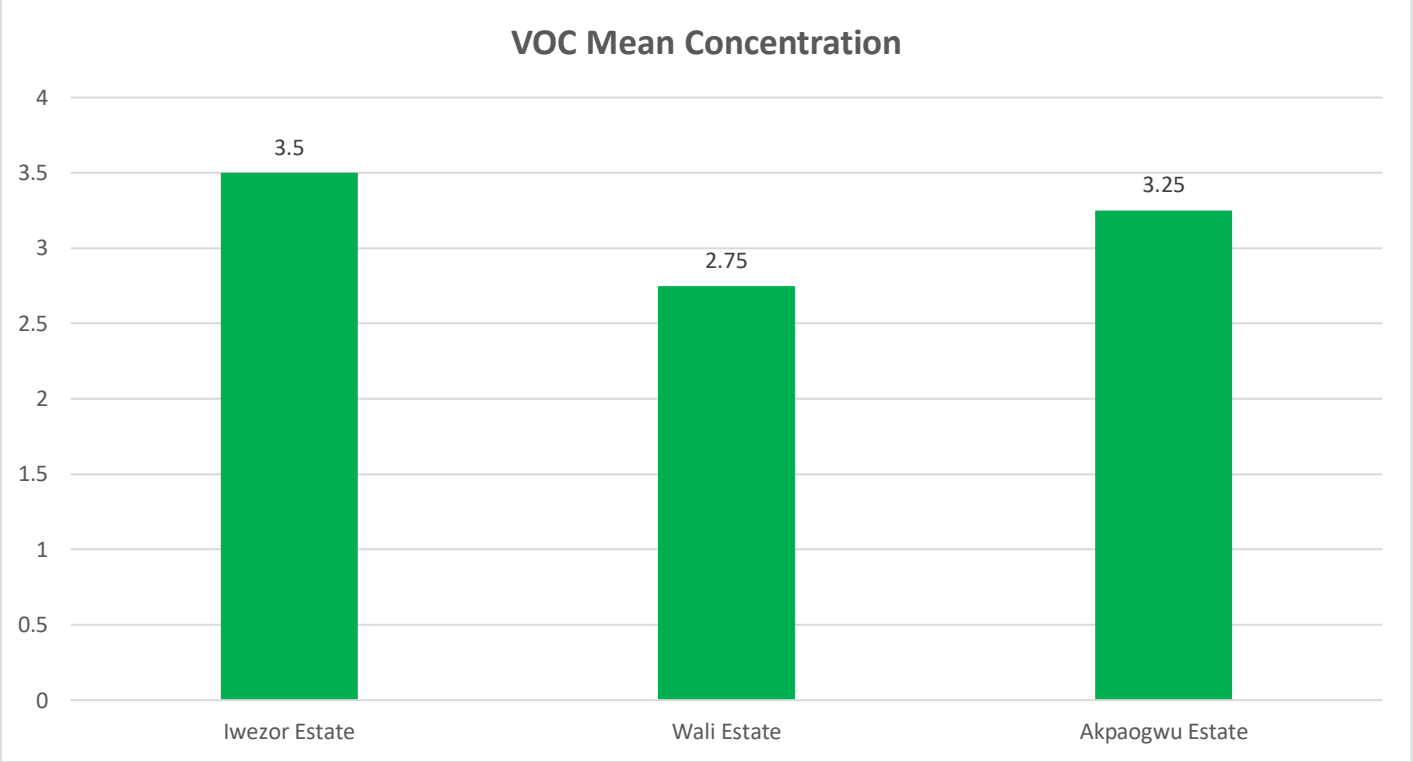

Fig. 8: VOC Mean Concentration for all Three Estates

Fig. 8 shows the mean concentration of Volatile Organic Carbons (VOC) for all three estates sampled with Iwezor estate having the highest mean value of 3.5mg/m^3 followed by Akpaogwu estate and Wali estate whose values were far below National Institute of Occupational Safety and Health (NIOSH) recommended limit of 250mg/m^3 and occupational safety and health administration (OSHA) recommended limit of 1800mg/m^3. This value does not necessarily pose any serious health concern to residents and is hence safe.

Table 2: AQI for the Study Area

Sampling Station	AQI	AQI Standard	Degree of Contamination	Levels of Health Concern	Colour Code
Iwezor estate Akpaogwu estate Wali Estate	43 67 40	0-50 51-100 0-50	Clean air Moderate air contamination Clean air	.Good Moderate Good	

Generally, the study showed that the air quality of the sampled estates in Mgbuesilaru is clean as seen in Iwezor and Wali estates with the exception of Akpaogwu estate which had slight air contamination and the air quality obtained for the 3 estates is very different from what is obtainable in other locations in Port Harcourt like the Eleme Petrochemicals and Oyigbo axis known to be highly polluted from previous studies (Ede & Edokpa 2019). The clean state of air could be likely attributed to the high presence of trees in the Shell RA residence that bothers all three estates sampled.

The control station had the best state of air and this is likely attributable to its lower population density and high presence of trees and undeveloped plots within the estates and also due to it being distant from the East-West road compared to other estates sampled. On the other hand, Akpaogwu estate had the worst state of air measured in the study with AQI of 66 when compared to other estates sampled. This can be explained by the high population density of the area, the volume of cars and their exhaust fumes, close proximity to the East

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

West road. This supports studies that found population density and industrial ecology as implicative factors of air pollution (Weli, 2014).

Particulate matter values obtained for $PM_{2.5}$ and PM_{10} in some sampled locations exceeded NESREA Air Quality Standards recommendation of 100µg/m^3 for PM_{10} and 25µg/m^3 for PM $_{2.5.}$ This is seen in Akpaogwu sample location 1 which had a value of 26.2 µg/m^3 for PM 2.5 and Akpaogwu location 2 which had a value 127.4 for PM10. This is a significant health risk as smaller particles are known to easily enter the lower region of the lungs (Miller *et al*, 2018). The implications of smaller particulate sizes such as PM $_{2.5}$ have been studied (mark *et al*, 2018). PM $_{2.5}$ value measured at Akpaogwu sample location 1 exceeded the WHO air quality standard and recommended limit of 25µg/m^3 (24hour mean) for PM $_{2.5}$ and most PM_{10} values computed in all locations slightly exceeded the WHO air quality standard recommended limit of 50µg/m^3 (24 hours mean) for PM_{10} and this is likely attributable to its high population density, vehicular and generator emissions and close-proximity to the East-West road. This is a likely health concern for health- sensitive groups.

CO levels were relatively higher than NESREA recommended limit of 5µg/m^3 (24 hours mean) in most sampled locations as a result of vehicular and generator emissions. Sampled locations Akpaogwu (1, 2, 3, 4) recorded high CO values (13.13, 15.64, 24.16, 18.47) respectively which far exceeds NESREA recommended limit of 5µg/m^3 and this can be a major health concern especially for health sensitive groups in apartments with their generating sets close to living areas which can cause respiratory illnesses from high CO inhalation and in severe cases death during sleep as a result of CO poisoning.

All VOC values were far below the permissible limits of 300mg/m^3. The high indoor values for CO in some sampled locations are likely attributable to generator emissions located in close- proximity to living areas and poor ventilation as seen in some apartments within the sampled estates.

The zero values obtained for SO_2 in the sampled locations are likely attributable to the non-sulphuric nature of the Nigerian crude which gave it the alias “sweet crude”.

The mean concentration of particulate matter 1 for all three estates sampled indicated Akpaogwu Estate had the highest mean value of 5.15µg/m^3 followed by Iwezor and Wali estate whose values were far below the WHO recommended limit of 50µg/m^3, hence its safe and pose no major health concern to residents.

The mean concentration of particulate matter 2.5 for all three estates sampled showed Akpaogwu estate had the highest mean value of 19µg/m^3 followed by Iwezor estate and Wali estate whose values were slightly below NESREA (2019) recommended limit of 25µg/m^3. This value does not necessarily pose any serious health concern to residents but rather calls for monitoring and pollution control in other not to exceed permissible limits.

The mean concentration of particulate matter 7 for all three estates sampled showed Akpaogwu estate had the highest mean value of 58.45µg/m^3 followed by Iwezor estate and Wali estate. Although there is no specific permissible limit for PM_7 as particulate matter is typically categorized into 3 main sizes PM10 (coarse particle ≤ 10µm), PM2.5 (fine particle ≤ 2.5µm), PM1 (ultrafine particle ≤ 1µm). However, some organizations and researchers have studied PM7 as an intermediate fraction and one such organization, California Air Resources Board (CARB) proposed 25µg/m^3 24-hour average value for PM7. Going by this all three sample locations exceed CARB recommended limit of 25µg/m^3.

The mean concentration of particulate matter 10 for all three estates sampled Showed Akpaogwu estate had the highest mean value of 74.95µg/m^3 followed by Iwezor estate and Wali estate whose values were slightly below the NESREA (2019) recommended limit of 100µg/m^3. This value does not necessarily pose any serious health concern to residents but rather calls for monitoring and pollution control in other not to exceed permissible limits.

The mean concentration of nitrogen dioxide (NO_2) for all three estates sampled showed Iwezor estate had the highest mean value of 0.19mg/m^3 followed by Wali estate and Akpaogwu estate whose values were slightly above the NESREA (2019) recommended limit of 0.1mg/m^3. This value does not necessarily pose any serious

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue II February 2025

health concern to residents but rather calls for monitoring and pollution control in other not to exceed permissible limits.

The mean concentration of Carbon monoxide (CO) for all three estates sampled showed Akpaogwu estate had the highest mean value of 17.89mg/m^3 followed by Iwezor estate and Wali estate whose values were above NESREA (2019) recommended limit of 5mg/m^3. This high value may pose a significant health concern to residents especially those of the susceptible groups like pregnant women, the elderly and those with prevailing cardiovascular health issues.

The mean concentration of methane (CH4) for all three estates sampled showed Iwezor estate had the highest mean value of 4.8mg/m^3 followed by Akpaogwu estate and Wali estate whose values were far below the National Institute of Occupational Safety and Health (NIOSH) recommended limit of 1400mg/m^3. This value does not necessarily pose any serious health concern to residents and is hence safe.

The mean concentration of Volatile Organic Carbons (VOC) for all three estates sampled showed Iwezor estate had the highest mean value of 3.5mg/m^3 followed by Akpaogwu estate and Wali estate which values where far below the National Institute of Occupational Safety and Health (NIOSH) recommended limit of 250mg/m^3 and occupational safety and health administration (OSHA) recommended limit of 1800mg/m^3. This value does not necessarily pose any serious health concern to residents and is hence safe.

CONCLUSION

The study found AQI of the study area to be generally good. Of all the sampled locations, Akpaogwu estate had the highest AQI of 66 while the other locations recorded less than 50 AQI (≤50AQI).

The study showed that residents of Mgbuesilaru are likely to be at low risk of air pollution morbidities. Regular air quality monitoring as the city gets more populated and urbanized will ensure that vulnerable groups are protected and exposure to ambient air with minimal air pollution risk. Also tree planting should be incorporated in building plans and designs for expansion and developments within the estates.

REFERENCES

1. Ede, P. N., & Edokpa, D. O. (2019). Satellite Determination of Particulate Load over Port Harcourt during Black Soot Incidents. Journal of Atmospheric Pollution, 5, 55-61.
2. Ede, P.N., Seiba, I.H. and Igwe, F. U. (2006) Combustion Efficiency Determined for Selected Flare Points in the Niger Delta Area. African Journal of Environmental Pollution and Health, 5, 19-25.
3. Maduka, O. and Tobin-West, C. (2017) Is Living in a Gas-Flaring Host Community Associated with Being Hypertensive? Evidence from the Niger Delta Region of Nigeria. BMJ Global Health, 2.
4. Miller, L., & Xu, X. (2018). Ambient PM2.5 Human Health Effects-findings in China and Research Directions. Atmosphere, 9, 424.
5. NESREA (National Environmental Standards and Regulations Enforcement Agency) (2019). Air Quality Control Regulations.
6. Rao, M. N. & Rao H. V. N. (2006). Air Pollution-Tate McGraw Hill Publishing Company Limited, New Delhi 6-12.
7. RSMENV. (Rivers State Ministry of Environment) (2019). .A Study of Airborne Particulate "Black Soot" in Port Harcourt and Its Environs. Port Harcourt: Government of Rivers State
8. Weli, V. E. (2014). Atmospheric Concentration of Particulate Pollutants and its Implication for Respiratory Health Hazard Management in Port Harcourt Metropolis, Nigeria. Civil and Environmental Research, 6, 11-17.