Asian Journal of Applied Chemistry Research

Volume 15, Issue 1, Page 37-47, 2024; Article no.AJACR.115275
ISSN: 2582-0273

Seasonal Variations Assessment of Air Pollutants of Communities in the Vicinity of Scrap Metal Recycling Industries in Ogijo, Shagamu South LGA, Ogun State, SW Nigeria

K. Onanuga [a*], V.N Daniel [b], A.B Mustapha [c] and O.N. Maitera [c]

[a] *Federal College of Complementary and Alternative Medicine, Abuja, Nigeria.*
[b] *Department of Science, Plateau State Polytechnic, Barkin Ladi, Nigeria.*
[c] *Department of Chemistry, Modibbo Adama University, Yola, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. Author KO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author VND managed literature searches and performed the statistical analysis. Authors ABM and ONM managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJACR/2024/v15i1281

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/115275

Original Research Article

Received: 02/02/2024
Accepted: 07/04/2024
Published: 15/04/2024

ABSTRACT

This manuscript presents a thorough investigation into the seasonal variations of air pollutants in communities surrounding scrap metal recycling industries in Ogijo, Shagamu South LGA, Ogun State, Nigeria utilizing advanced Gary Wolf Environmental Sensing and Particulate Counting devices. The study meticulously measures concentrations of carbon monoxide, nitrogen dioxide, sulfur dioxide, PM2.5, and PM10 during both dry and wet seasons across 20 strategic sampling

**Corresponding author: Email: kafilatonanuga19@gmail.com;*

locations and control. The findings reveal significant seasonal fluctuations in pollutant levels, with some concentrations exceeding Nigerian ambient air quality standards, highlighting a pressing environmental health concern. The study not only underscores the critical need for regulatory oversight and the implementation of safer metal scrapping practices but also advocates for regular environmental monitoring to mitigate the adverse impacts of such industries on local communities and the environment.

Keywords: Seasonal variations; air pollutants; scrap metal.

1. INTRODUCTION

"Air pollutants represent a complex mixture of organic and inorganic substances of varying states and sizes that can enter tissues of living organisms in a number of ways" [1]. "Pollution from the steel sector is as the result of emissions of particulate matter containing minerals (iron, iron oxide), metals (cadmium, lead, chromium, and nickel, zinc, copper and arsenic) and other pollutants (polycyclic aromatic hydrocarbons, nitrogen oxides and sulphur dioxide)" [2]. "The smoke, dust and odor nuisance from the metal recycling industries have ultimately been found to pose potential health concerns due to the chemical composition of the emissions. Metal particulate matter emissions are generated from metal recycler destruction: shredding to torch cutting (destruction process of most concern that generates fine particulate matters air pollution). Evidence that short term exposure to particulate matter air pollution is associated with morbidity and mortality is increasingly found in the literature, especially with respect to fine particulate matter of aerodynamic diameter, smaller than 2.5 μm (PM2.5)" [3,4]. "There is growing evidence that the chemical composition of particulate matter is another important consideration when studying the health impact" [5,6].

"Steel plants with electric arc furnace release dust containing heavy metals and some organic compounds" [2,7]. Steel industry is also a source of carbon dioxide (CO_2) emissions which is generated during iron and steelmaking operations, either as a result of the reaction of carbon (coke) with iron oxide in the blast furnace or from power plant producing electricity used in the production of steel. According to the International Iron and Steel Institute (IISI), integrated plants can emit between 1.6-2.4 tons of CO_2 per ton of steel produced, while electric arc furnace plants which only use iron scrap as raw material are responsible for the emission of approximate 0.7 tons of CO_2 per ton of steel produced. In recognition of the negative environmental impact, the steel industry has in recent years adopted the introduction of efficient pollution control system processes and practices which can help to reduce emissions significantly. Sulphur dioxide (SO_2) is also one of the air pollutants. SO_2 is created when fuel containing sulphur, such as coal and oil is burnt which eventually may lead to air pollution [8]. This gas can also be emitted by trains, large ships, lorries and other diesel equipment but the worst culprits are coal-burning thermal power plants and steel industry. SO2 can react with gases in atmosphere to form sulfuric acid ('acid rain').

"CO is a gas that comes from incomplete combustion. Most of the CO emissions are generated by road traffic. The manufacturing industries and the residential/tertiary sector both come in second position, contributing 26% of emissions. Urban, collective or individual heating constitute the main part of the residential/ tertiary sector contribution" [9].

"PM $_{2.5-10}$ are the finer particles, which have the greatest impact on health especially $PM_{2.5}$ which penetrates the human respiratory system more efficiently into the alveolar region" [10]. "Studies have also found that higher concentrations of fine particles ($PM_{2.5-10}$) increase overall mortality rates" [11,12]. Chang et al. [13] suggested that "re-suspended road dusts contain materials which potentially initiate allergic reactions". Studies on both rodents and humans demonstrated that, ultrafine particles have a greater effect per unit mass than larger particles [14] while another study on asthma patients performed in Germany and Finland [15] suggested that "both coarse and ultrafine particles have health effects which might be independent of each other".

2. MATERIALS AND METHODS

2.1 Area of Study

The study was carried out in Ogijo in Sagamu Local Government Area, Ogun State, South -

western Nigeria. The Local Government has an area of 614 km^2 and its geographical coordinates are 6° 42' 0" North, 3° 31' 0" East. The industries in the study area are mostly scrap metal recycling companies. Sagamu is a conglomeration of thirteen towns located in Ogun State along the Ibu River and Eruwuru Stream between Lagos and Ibadan, founded in the mid-19th century by members of the Remo branch of the Yoruba people in south-western Nigeria. The 13 towns that made up Sagamu are: Makun, Offin Sonyindo, Epe, Ibido, Igbepa, Ado, Oko, Ipoji, Batoro, Ijoku, Latawa and Ijagba.It is the capital of Remo Kingdom and the paramount ruler of the kingdom - Akarigbo of Remo's palace is in the town of Offin in there. Sagamu is a region underlain by major deposits of limestone, which is used in the city's major industry, cement production. "Agricultural produce of the region include cocoa and kola nuts. Sagamu is the largest kola nut collecting center in the country. The kola nut industry supports several secondary industries such as basket and rope manufacturing, which are used to store the kolanuts. Ogijo is located in Sagamu local government in Ogun State. It shares boundary between Ogun and Lagos State" [16].

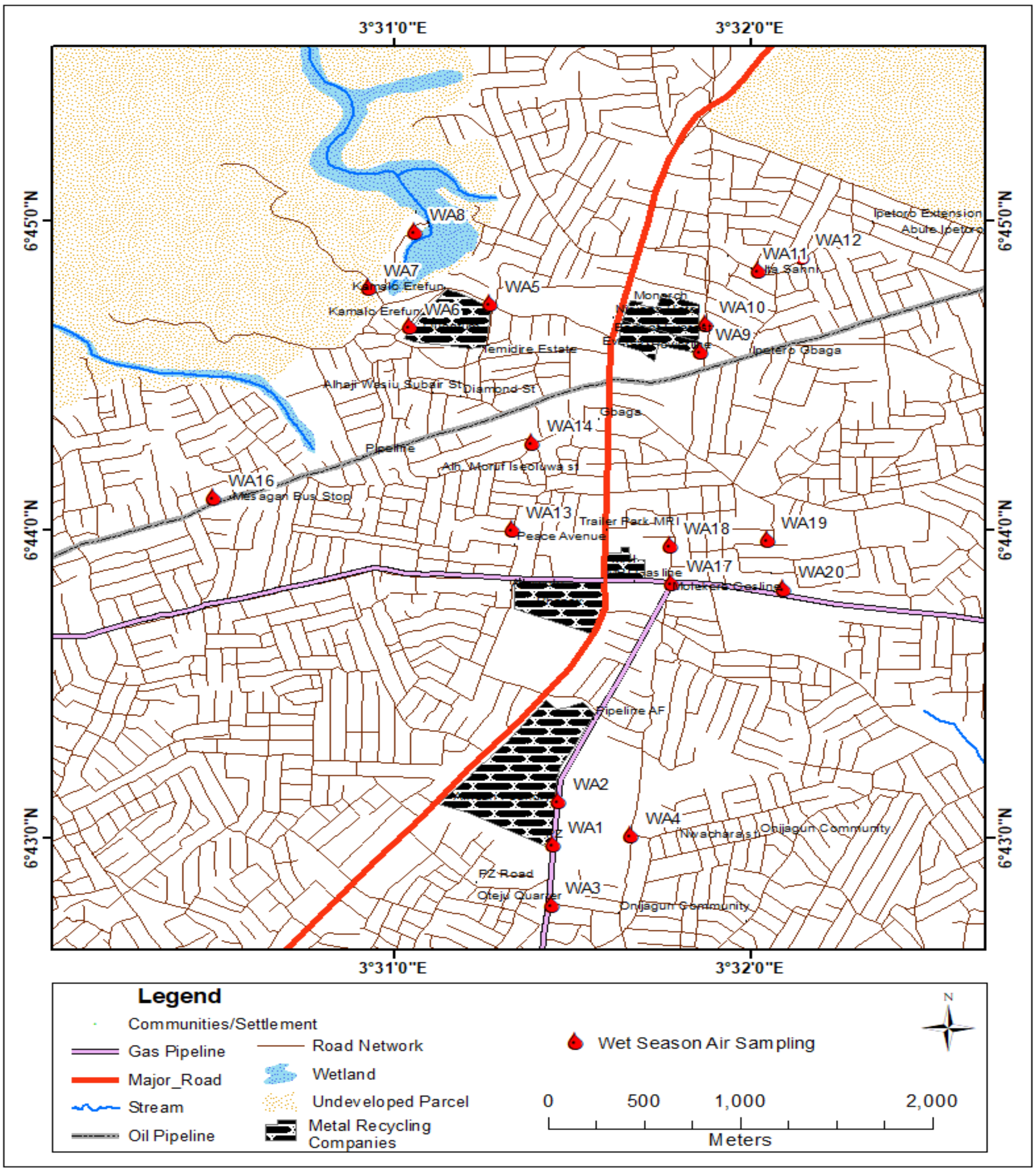

Fig. 1. Map of the study area showing wet season air sampling points

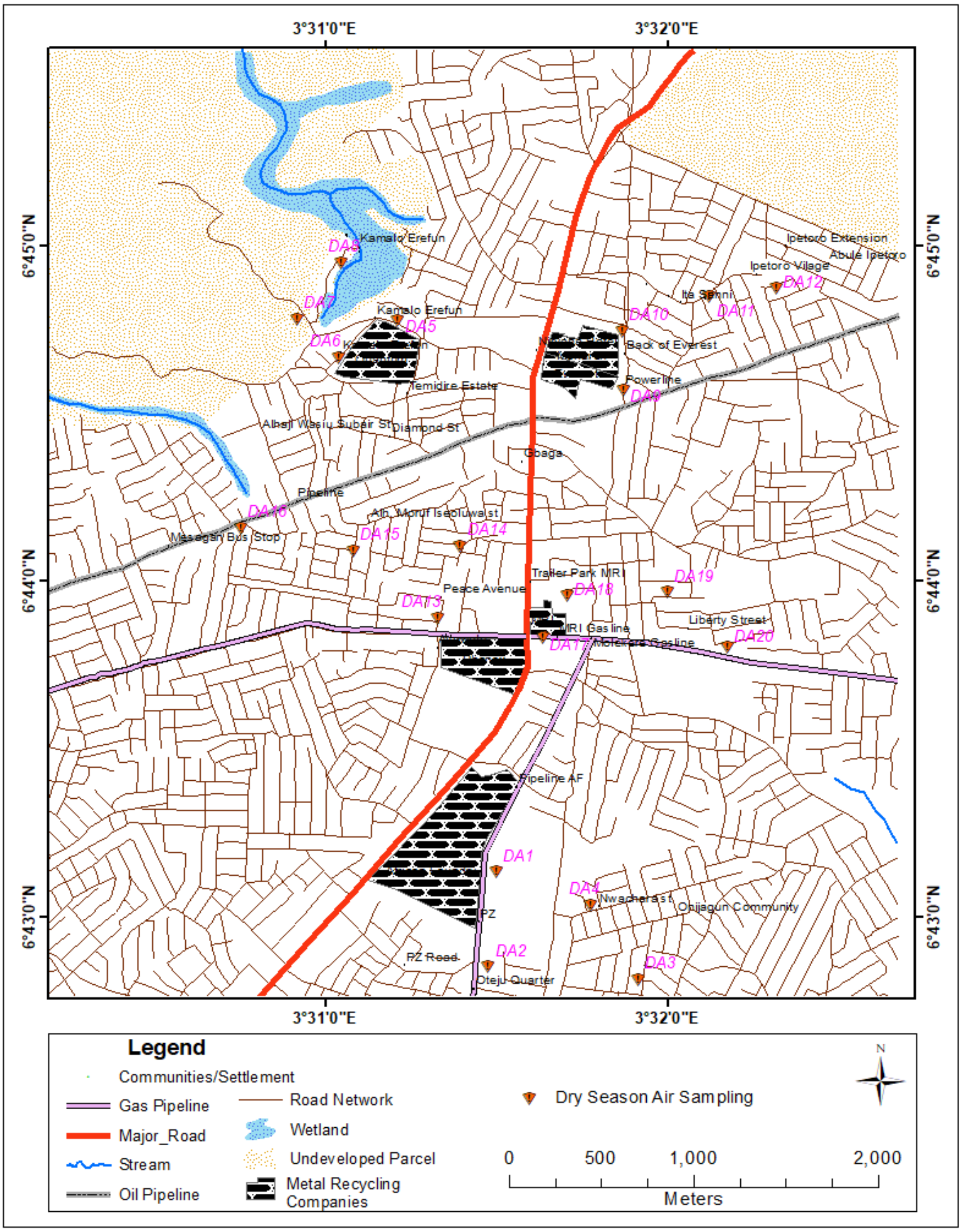

Fig. 2. Map of the study area showing dry season air sampling

2.2 Air Quality Measurement

In-situ air measurements were conducted in twenty sampling locations and control for gases (Carbon monoxide, Nitrogen dioxide, Sulphur dioxide) and particulate matters (PM2.5 and PM10) in dry and wet seasons. The twenty sampling stations were selected around the Metal recycling industries on the basis of accessibility (7). The gaseous components values were determined using Gary Wolf Environmental Sensing device Model Number 2038 while the particulate matter was determined and recorded using Gary Wolf Particulate Counter Model Number 454532 sensing device. Each determination was carried out one after the other and the concentrations of the gases components were recorded. Each gaseous component determination in the study area was carried out twice and the mean value of the gaseous component recorded.

Table 1. Air sampling location and sampling code

S/N	Sample Code	Location
1	A1	PZ Estate
2	A2	Oteju Quarter
3	A3	Onijagun
4	A4	Nwachara street
5	A5	Behind Quantum
6	A6	Ita Sanni
7	A7	Ipetero Pipeline
8	A8	Kamalo Erefun
9	A9	Power Line
10	A10	Behind Everest
11	A11	Ita Sanni
12	A12	Ipetero Village
13	A13	Peace Avenue
14	A14	Alasia Powerline
15	A15	Iseoluwa Street
16	A16	Masegan bus stop
17	A17	Molekere Gas line
18	A18	Trailer Park MRI
19	A19	MRI Axis
20	A20	Liberty Street
21	CA	Unilag Control Sample

2.3 Quality Control

A station is separated as far as possible from nearby buildings to avoid being affected by turbulence etc. Selected of station is done such that it cannot be affected by specific sources e.g chimneys, smokestacks etc.

Appropriate height were set so as to accurately comprehend the state of pollution due to the measurement target substances e.g 20 to 30 m.

Instrument's sensitivity, speed, selectivity and reliability were considered for each parameter measured results.

2.4 Statistical Analysis

The statistical analysis was performed using the analysis of variance (ANOVA), correlation and t-test to determine the differences between treatments. Mean at significant level (0.05). Standard errors of mean were estimated. All statistics were run using statistical package for social sciences (SPSS) (25.0) version.

3. RESULTS AND DISCUSSION

Concentrations of air pollutants gases; carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matters; PM_{10} and $PM_{2.5}$ were analyzed and compared with the recommended air quality guideline. The results are displayed in Fig.s 3 to 7 to show the concentrations of the pollutants.

3.1 Nitrogen Dioxide

The amount of NO_2 in the air recorded during the dry season ranged from 0.02 to 16.97 ppm with location A5 having the highest NO_2 value while control recorded the least NO_2 value. In the wet season, the NO_2 values recorded ranged from 0.05 to 42.99 ppm with location A13 having the highest NO_2 value while the lowest NO_2 value was recorded in control as observed in Fig. 3. The NO_2 values recorded in this study were found to exceed the ambient air quality standard (0.04 to 0.06 ppm) set by Federal Ministry of Environment (1991). Zhao et al. [17] found that "the average PM10, NO_2, and SO_2 concentrations in the urban areas were 85.2, 49.3, and 37.4 lg/m^3, which were 1.13, 1.25, and 1.41 times the values of the suburban area during the period of March 2009 to February 2010". Also, in the study carried out by Rim-Rukey [18] recorded NO_2 values which ranged from (21.0 to 27.3 ppm) and the NO_2. Results recorded in Rim-Rukey study was found to be lower than the NO_2 values recorded in this study. In the study by Abdullahi et al. [19] showed that, the mean concentrations of NO_2 as 0.053±0.047 ppm in the dry season and 0.04 ± 0.026 ppm in the wet season. Also, in the study carried out by Olayinka [20] "to examine the environmental pollution around African Steel Foundry in Ogun State, Nigeria, the concentrations of NO_2 obtained was found to range from 2.02 to 8.50 ppm". "Road transport remains the primary source of NO_x emissions" [21]. Nitrogen dioxide could also be emitted from burning of fossil fuel and long term exposure could impair lung function and increase the risk of respiratory disorder.

3.2 Carbon Monoxide

The amount of CO in the air recorded during the dry season ranged from 0.72 to 4.40 ppm with location A5 having the highest CO value while control recorded the least CO value. In the wet season, the CO values recorded ranged from 0.5 to 8.70 ppm with location A18 having the highest

CO value while the lowest CO value was also recorded in control as observed in Fig. 4. The CO values recorded were found to be within the Nigerian ambient air quality standard (10 ppm) and WHO permissible limit (10 ppm. In the studies by Rim-Rukeh [18], Musa et al. [22], Abdullahi et al. [18] and Olayinka (2019), had their recorded CO concentrations ranges from 133.7 to 144.6 ppm, 2.64 to 16.0 ppm, 6.81±2.05 ppm in the dry season and 6.50 ±2.50 ppm in the wet season and from 3.20 to 13.33 ppm respectively and were found to be higher than the CO values recorded in this study. Adah et al., [4] found that "Rusau had extremely hazardous levels of CO, while the University Campus and Student Village Hostel had hazardous levels, Bauchi Road and Farin-Gada Roundabout had unhealthy levels of emission for sensitive groups, and Farin-Gada Junction and Student Village Hostel had moderate levels. The appreciable concentration of CO could be attributed to the regular usage of power plants and generators in the neighborhood. Carbon monoxide could also occur from emission produced by fossil fuel powered engine, including motor vehicles and non-road engines". At extremely high levels, carbon monoxide could lead to loss of consciousness, weakness, confusion, movement problem and sometimes death because it binds to haemoglobin in the blood, reducing the ability of blood to carry oxygen [23].

Fig. 3. A Metal Recycling Industry at the Study Area

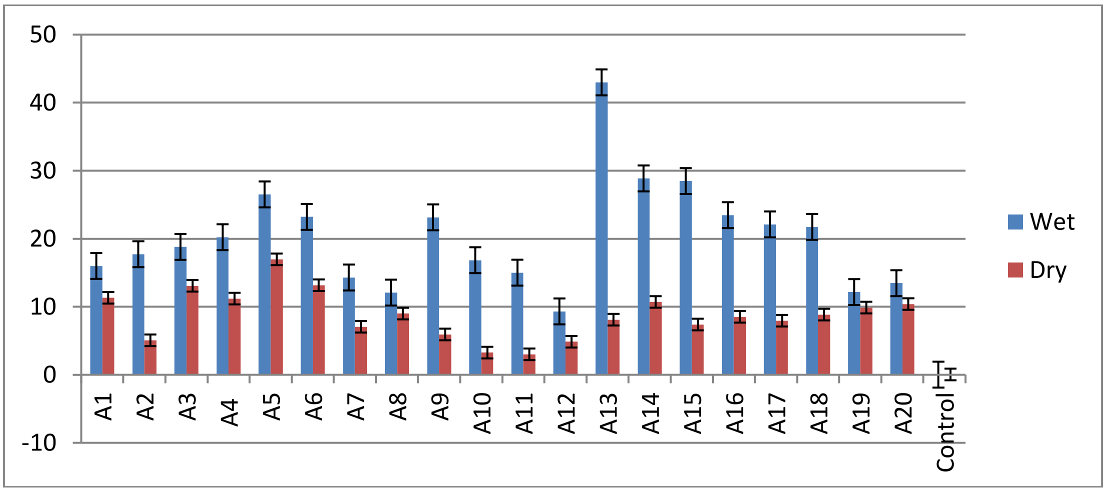

Fig. 4. Mean Concentration of NO_2 Air Sample in Dry and Wet Season

3.3 Sulphur Dioxide

The amount of SO_2 in the air recorded during the dry season ranged from 0.023 to 0.504 ppm with location A11 having the highest SO_2 value while the control recorded the least SO_2 value. In the wet season, the SO_2 values recorded ranged from 0.006 to 0.213 ppm with location A11 having the highest SO_2 value while the lowest SO_2 value was recorded in the control as observed in Fig. 5. The SO_2 values recorded were found to be within the Nigerian ambient air quality standard (0.1 ppm) set by Federal Ministry of Environment (1991) except in location A11 in dry and wet season. The high value of SO2 in A11 could be becauseA11 is located between two recycling industries and other meteorological factors. Rim-Rukeh [18] recorded SO_2 values of 27.7 to 37.1 ppm, Weli and Adekunle [24] recorded 0.67 ppm and Ubouh and Nwawuike [25] recorded a high SO_2 values and Olayinka [26] with 1.63 to 3.96 ppm were found to be greater than the SO_2 values recorded in this study and the Nigerian ambient air quality standard. In the study by Kosan et al. [27] evaluating “air pollution by PM_{10} and SO_2 levels in Erzun province, Turkey showed that the mean concentrations of SO_2 as 0.056±0.045 ppm in the dry season and 0.041 ±0.045 ppm in the wet season”. “Sulphur dioxide (SO_2) reacts with the moisture content in the nose, nasal cavity and throat and, in this way, it destroys the nerves in the respiratory system and harms human health” [28].

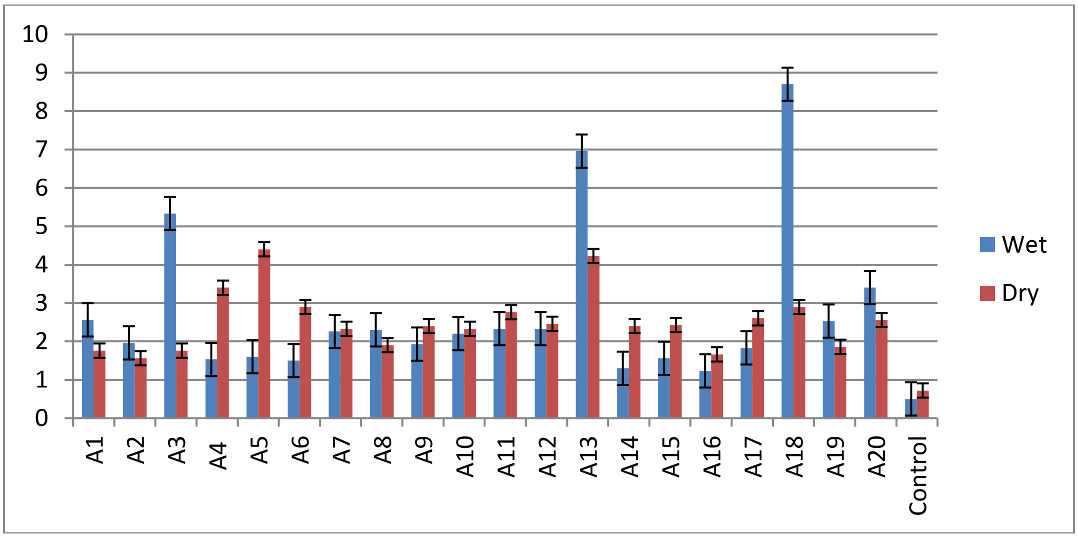

Fig. 5. Mean concentration of CO Air Sample in dry and wet season

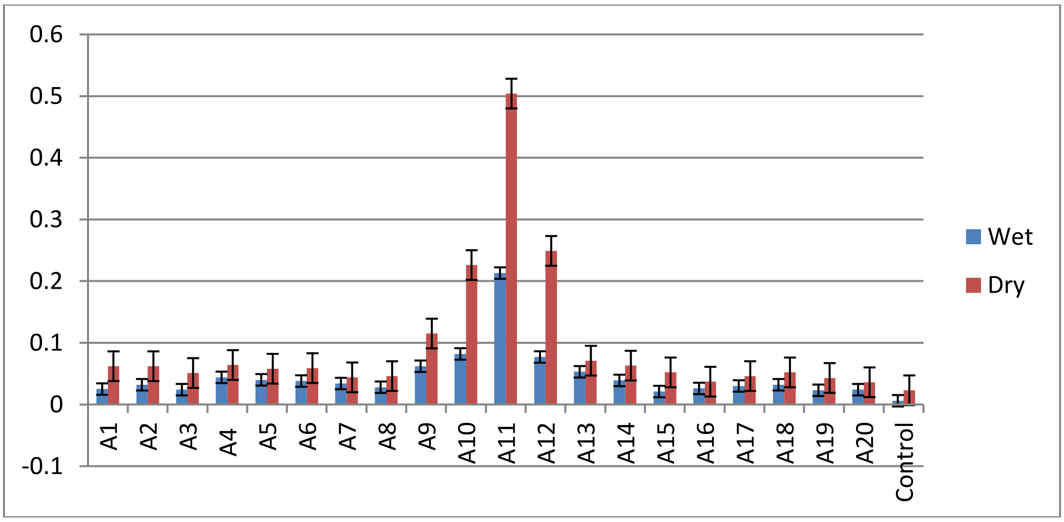

Fig. 6. Mean concentration of SO_2 Air sample in dry and wet season

3.4 PM2.5

The detected particulates could be from dust re-suspension, vehicular emissions, and some industrial and domestic activities involving combustion. The particulate matter varied between sampling locations. The amount of $PM_{2.5}$ in the air recorded during the dry season ranged from 1.51 to 255.30 µg/m3 with location A5 having the highest $PM_{2.5}$ value while control recorded the least $PM_{2.5}$ value. In the wet season, the PM2.5 values recorded ranged from 1.84 to 127.06 µg/m3 with location A6 having the highest $PM_{2.5}$ value while the lowest $PM_{2.5}$ value was recorded in location A12 as observed in Fig. 6. The mass concentrations of $PM_{2.5}$ were higher in dry season than wet season. PM2,5 concentrations were within the Nigerian ambient air quality except for locations A5 and A13 in dry season, where the $PM_{2.5}$ values reported marginally above the Nigerian ambient air quality standard (250 µg/m3)), The $PM_{2.5}$ values recorded in the study of Tianpeng et al. [29] "in investigation the seasonal variation and health risk assessment of atmospheric PM2.5-bound polycyclic aromatic hydrocarbons in a classic agglomeration industrial city, Central China were found to be within the limits of that standard". Also, Cyrille et al. [30] recorded "lower values of $PM_{2.5}$, than in this work in the measurement of fine particles concentrations and estimation of air quality index over northeast Doula, Cameroun". "According to the Global Burden of Disease (GBD), $PM_{2.5}$ is estimated to be the sixth largest risk factor for premature deaths on the global scale" [31]. "$PM_{2.5}$ caused 2.9 million premature deaths in 2017 or about 9 percent of total deaths in the world" [32].

3.5 PM_{10}

The amount of PM_{10} in the air recorded during the dry season ranged from 2.53 to 135.75 µg/m3 with location DA5 having the highest PM_{10} value while location A10 recorded the least PM_{10} value. In the wet season, the PM_{10} values recorded ranged from 2.98 to 92.63 with location A1 having the highest PM_{10} value while the lowest PM_{10} value was recorded in location A11 as observed in Fig. 7. The PM_{10} values recorded in this study were found to be within the Nigerian ambient air quality standard (250 µg/m3). In the studies of Ogbemudia [33], Ubouh and Nwawuike [25] and Rim-Rukeh [18], the recorded a high PM_{10} values were moderate (128.50±28.50 µg/m3), high and very high (773 to 801 µg/m3) respectively. Exposure to fine particles could cause eye, nose, throat, lung irritation, coughing, asthma and shortness of breath. Results recorded showed that the air quality is poor with most of the PM values exceeding WHO [34] limits. Higher values of PM were observed in the dry and wet season with highest records around A5.

The statistical comparison of the wet and dry season's means concentrations is displayed in Table 2. There were significant differences (($p<0.05$)) in the values of the monitored parameters across the monitoring periods during the dry and wet seasons hence values of air quality parameters in the study area are affected by seasonality. The air quality in the area is poor and the results obtained from this study justify the need for epidemiological study to ascertain the health effect this poor air quality has on the affected population and also the need for government to improve existing air quality policy.

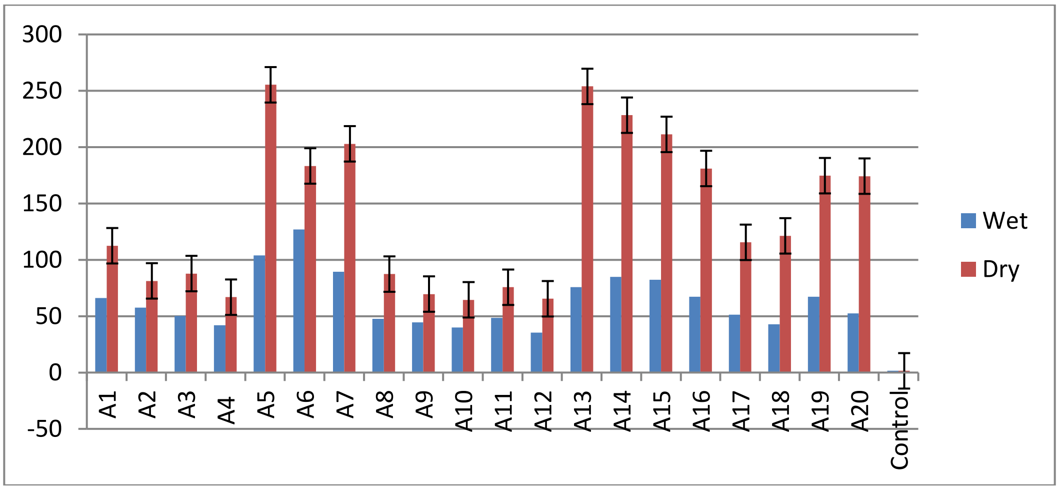

Fig. 7. Mean concentration of PM2.5 Air sample in dry and wet season

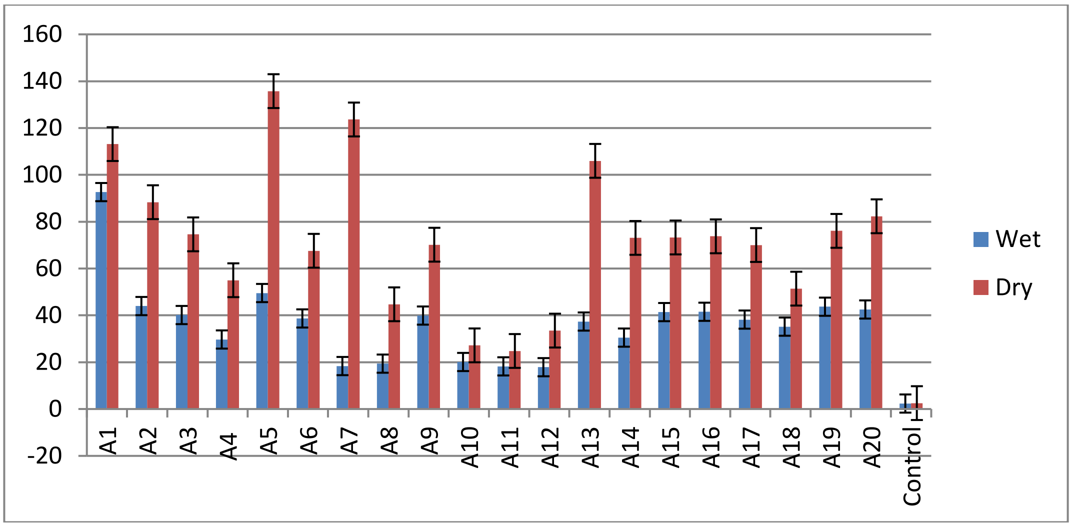

Fig. 8. Mean concentration of PM10 Air Sample in dry and wet season

Table 2. Statistical significance ($p < 0.05$) of the seasonal Variations of Physicochemical properties for Air Samples in wet and dry season

Elements	Season	Mean	Standard deviation	t-value	P-value	Remark
NO2	Dry Season	8.374	4.06	-8.995	0.000	Significant
	Wet Season	19.36	8.80			
CO	Dry Season	2.45	1.06	-0.757	0.451	Not Significant
	Wet Season	2.66	1.99			
SO_2	Dry Season	0.09	0.11	3.242	0.002	Significant
	Wet Season	0.05	0.04			
$PM_{2.5}$	Dry Season	133.94	72.83	7.471	0.000	Significant
	Wet Season	60.84	26.96			
PM_{10}	Dry Season	69.91	33.35	7.275	0.000	Significant
	Wet Season	35.30	17.72			

4. CONCLUSION

The amount of NO_2, CO, SO_2, $PM_{2.5}$ and PM_{10} values during the dry season ranged from 0.05 (control) - 16.97 ppm (A5), 0.72 (control) - 4.40 ppm (A5), 0.023 (control) -0.504 (A11) 1.51(control) - 255.30 µg/m3 (A5) and 2.53 (control) - 135.75 µg/m3 (A5) respectively, with only NO_2 concentration exceeding the Nigerian limit. The amount of NO_2, CO, SO_2, $PM_{2.5}$ and PM_{10} values during the wet season ranged from 0.02 (control) – 42.99 ppm (A13), 10.50 (control) – 8.7 ppm (A18), 0.006 (control) – 2.13 ppm (A11), 1.84 (control) - 127.06 µg/m3 (A6) and 2.98 (control) - 92.63 µg/m3 (A1) respectively. The concentrations of NO_2 in both seasons, SO_2 at A11 in both seasons and the $PM_{2.5}$ values at A5 and A13 in dry season were above Nigerian ambient air quality standard of Federal Ministry of Environment (1991). The regulatory agency and the relevant government agencies should advocate for safe metal scrapping activities in the study area or outright relocation of the industries. Suitable remediation methods should be adopted for the reduction of the levels of the pollutants. The levels of air pollutants in and around the study area should be assessed regularly in order to monitor the impact of the scrap recycling activities on the environment.

ACKNOWLEDGEMENT

The authors express their gratitude to Dr. Shakirudeen Odunuga and Ajayi Olalekan Samson of Laboratory for Remote Sensing and GIS, Department of Geography, University of Lagos for air analysis on the field. The authors also wish to express their profound gratitude to Adeyanju Binuyo, Senator L. Mustapha, Hon. D. Okubadejo, Alhaji M. Tahir, brothers and sisters for their financial support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Thakar BK, Mishra PC. Dust Collection Potential and Air Pollution Tolerance Index of Tree Vegetation around Vedanta Aluminum Limited, Jharsuguda. The Bioscan. 2010;3:603-612.
2. Adeyeye MA, Akeredolu F. Sonibare A, Fakinle JA, Odekanle BS, Oloko-Oba ELIM. Emission Inventory of Air Pollutants in a Metal Recycling Facility. American Journal of Environmental Protection. 2017; 5(1):9-12.
   DOI:10.12691/env-5-1-2
3. Pope CA, Dockery DW. Health effects of fine particulate air pollution: lines that conect. J Air Waste Manag Assoc. 2006;56:709–42.
4. Adah AJ, Daniel T, Akpaso DU. Estimation of indoor air pollutants and health implications due to biomass burning in rural Household Kitchens in Jos, Plateau State, Nigeria. Environ. Sci. Proc. 2023; 27:29.
   Available:https://doi.org/10.3390/ecas2023-16345
5. Franklin M, Koutrakis P, Schwartz P. The role of particle composition on the association between PM2.5 and mortality. Epidemiology. 2008;19:680–9.
6. De Hartog JJ, Lanki T, Timonen KL, Hoek G, Janssen NA, Ibald-Mulli A. Associations between PM2.5 and heart rate variability are modified by particle composition and beta-blocker use in patients with coronary heart disease. Environ Health Perspect. 2009;117:105–11.
7. Olatunji AS, Kolawole TO, Oloruntola M, Günter C. Evaluation of pollution of soils and particulate matter around metal recycling Factories in Southwestern Nigeria. Journal of Health & Pollution. 2018:8(17):20-30.
8. Sivertsen B. Presenting Air Quality Data. NILU-F 6/2002, National Training Course on Air Quality Monitoring and Management, Norwegian Institute for Air Research, Kjeller, Norway; 2002.
9. Sharma M, Pandey R, Maheshwari M, Sengupta B, Misra A, Shukla BP. Air Quality index and its interpretation for City of Delhi. Int J Energy Clean Environ. 2013;3(4):67–75.
10. Cifuentes LA, Vega, J, Kopfer K, Lava LB. Effect of the One Fraction Of Particulate Matter Versus The Coarse Mass and other Pollutants on Daily Mortality in Santiago, Chile. J Air Waste Manage Assoc. 2000;50:1287–1298.
11. Castillejos M, Borja-Aburto VH, Dockery DW, Gold DR, Loomis D. Airborne Coarse Particles and Mortality. Inhal Toxicol. 2000; 12:61–72.
12. Kamar K, Pratap V, Kumar Choudhary A, Prasad R, Shukla A, Singh RP, Singh AK Assessment of Atmospheric Aerosol over Varanasi. Physical and Chemical Properties and Meteorological Implication. Journal of Atmospheric and Solar – Terrestrial Physics. 2020;209(1)
13. Chang J, Liu, M, Li XH, Lin X, Wang LL, Gao L. Primary Research onHealth Risk Assessment of Heavy Metals in Road Dust of Shanghai. Zhongguo Huanjing Kexue/China Environ. Sci. 2009;29:548–554.
14. Oberdorster G. Pulmonary Effects of Inhaled Ultrafine Particles. Int Arch Occup Environ Health. 2001;74:1–8.
15. Wichmann HE, Peters A. Epidemiological evidence of the effects of ultrane particle exposure. Philos Trans R Soc Lond A. 2000;358:2751–2769.
16. (http://wikiedit.org/Nigeria/Ogijo/2421820/retrieved June, 2021).
17. Zhao WC, Cheng JP, Yu ZY, Tang QL, Cheng F, Yin YW, Wang WH. Levels, Seasonal variations, and health risks assessment of ambientair pollutants in the residential areas. Int. J. Environ. Sci. Technol 2013;10:487–494.
   DOI: 10.1007/s13762-013-0178-3
18. Rim- Rukey A. An assessment of the contribution of municipal solid dump waste sites fire to atmospheric pollution. Journal of Pollution. 2014;3:53 – 60.
19. Abdullahi AO, Maitera ON, Maina HM, Yelwa JM. Determination of Some Pollutant Gases in Ambient Air of the Vicinity of a Kaolin Milling Plant in Alkaleri, Bauchi State, Nigeria. International Journal of Advanced Research in Chemical Science (IJARCS). 2017;4:12.
20. Olayinka OO, Adedeji OE, Balogun O. Air and Heavy Metals Pollution around a Steal Foundry in Ogijo, Ogun State, Nigeria. Journal of Science Research. 2015;14:9-16.

Available:http://wikiedit.org/Nigeria/Ogijo/2421820/
Accessed on: June, 2021)

21. Pénard-Morand C, Annesi-Maesano I. Air Pollution: From Sources of Emissions to Health Effects. Breathe. 2004;1(2):109 - 119.
22. Musa HD, Onoja OO, Santeli BN. Air Quality Assessment of Solid Watse Dumps in Residential Neigborhood of Makurdi. Environmental Technology and Science, Journal; 2021.
Available:http://repositoy.futminna.edu.ng.8080/jspul/handle/123456789/15149
23. Kinoshita H, Turkanh VS, Nagvi S, Bedairr RR, Tsatsakis A. Carbon monoxide Poisoning. Toxicol. Rep. 2020;7: 189-173.
24. Weli VE, Adekunle O. Meteorological conditions in the Vicinity of Landfill Site and its implication to Atmospheric Pollution Stagnation in Rumuolumeni Port Harcourt, Nigeria. Journal of Natural Science Research. 2014;4:51-64
25. Ubouh, EA, Nwanwuike N. Evaluation of On-Site and Off-Site Ambient Air Quality at Nekede Waste Dumpsite. International Journal of Environment and Pollution. 2016;4(1):23-43.
26. Olayinka AI. Levels of organochlorine pesticides (OCPs) residue in selected Cocoa Farms in Ilawe—Ekiti, Ekiti State, Nigeria. Open J Anal Chem Res. 2019; 1(3):52–58.
DOI: 10.12966/ojacr.11.02.2013
27. Kosan Z, Kavuncuoglu D, Calikolu O, Yerli EB. Evaluation of Air Pollution By PM_{10} and SO2 Levels In Erzun Province, Turkey, Descriptive Study Journal of Surgery and Medicine. 2018;2(3):58-95.
28. Ude IU, Anjorin FO, Egila JN. Assessment of Carbon (II) Oxide and Sulphur (IV) Oxide Emissions at Some Selected Traffic Areas in Jos Metropolis, North Central Nigeria. International Journal of Advanced and Innovative. 2016;5(12):6–14
29. Tianpeng H, Jiaquan Z, Xinli X, Changlin Z, Li Z, Hongxia L, Ting L, Jingru Z, Ruizhen Y, Junji C. Seasonal variation and health risk assessment of Atmospheric PM2.5-Bound Polycyclic Aromatic Hydrocarbons in A Classic Agglomeration Industrial City, Central China. Air Quality, Atmosphere & Health.
Available:https://doi.org/10.1007/s11869-018-0575-3
30. Cyrille AM, Yamnick CN, David M. Measurement of the fine particle concentration and the estimation of air quality index over Northeast Douala, Cameroon. Environmental Monitoring and Assessment. 2023;195(965).
31. Henrik O. Air pollution and health – Indicators, trends and impacts. Dissertation for the Degree of Doctor of Philosophy in Applied Environmental Science at Stockholm University; 2019
32. Akpokodje J, Croitoru L, Jiyoun CC, Andrew K. The cost of air pollution In Lagos. Pollution Management and environmental Health. World Bank; 2019.
33. Ogbemudia FO, Anwana ED, Ita, RE. and 1Bassey, IN. Air Quality Assessment Along A Landfill Site In Uyo. NJB. 2020;33(2).
34. WHO. Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide. Global update 2005 Summary of risk assessment WHO/SDE/PHE/OEH/06.02 © World Health Organization 2006; 2005.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/115275