SEASONAL VARIATIONS ASSESSMENT OFAIR POLLUTANTS OF COMMUNITIES IN THE VICINITY OF SCRAP METAL RECYCLING INDUSTRIES IN OGIJO, SHAGAMU SOUTH LGA, OGUN STATE, SW NIGERIA

ABSTRACT

Aim: The aim of the work is to assess the seasonal variations of air pollutants of communities in the vicinity of scrap metal recycling industries in Ogijo, Shagamu South LGA, Ogun State, SwNigeia

Study Design: Gary Wolf Environmental Sensing device Model Number 2038 was used for gases and Gary Wolf Particulate Counter Model Number 454532 for particulate matter,.

Place and Duration: the air quality measurement was carried in dry and wet seasons from 5th to 7th March and 24th to 25th September, 2020 respectively within the industries and communities in the vicinity of the scrap metal recycling industries (SMRI) in Ogijo, Shagamu South Lga, Ogun State, Sw Nigeria

Methodology In-situ air measurements were conducted in 20 sampling locations and a control for three gases (Carbon monoxide, Nitrogen dioxide, Sulphur dioxide) using Gary Wolf Environmental Sensing device Model Number 2038 and two particulate matters (PM2.5 and PM10) using Gary Wolf Particulate Counter Model Number 454532 sensing device in dry and wet seasons. Air pollution has become one of the top environmental concerns in the world.

Results: The ranges of the concentrations of the air pollutants analyzed were: NO_2 from (0.05 (control) - 16.97 ppm (A5) in dry season and 0.02 (control) – 42.99 ppm (A13) in wet season); CO from 0.72 (control) - 4.40 ppm (A5) in dry season and CO 0.50 (control) – 8.7 ppm (A18) wet season; SO_2 from 0.023 (control) -0.504 ppm (A11) in dry season and0.006 (control) – 2.13 ppm (A11) in wet season); PM2.5 from 1.51(control) - 255.30 μg/m3 (A5) in dry season and 1.84 (control) - 127.06 μg/m3 (A5) in wet season) and PM10 from 2.53 (control - 135.75 μg/m3 (A5) in dry season and 2.98 (control) - 92.63 μg/m3 (A1) in wet season). All the mean concentrations of the pollutants (except CO) in wet season were significantly ($p<0.05$) different from that of

dry season.

Conclusion: The concentrations of NO_2 in both seasons, SO_2 at A11 in wet season and the PM2.5 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. The levels of air pollutants in and around the study area should be assessed regularly in order to monitor the impact of the scrapping activities on the environment

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 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 matter 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 processes, pollution control systems and practices which can help to reduce emissions significantly.

Manganese, copper, zinc, cadmium, chromium, iron, nickel, potassium, calcium, vanadium, barium, arsenic, selenium and strontium are the most commonly found metals in the pollution sources and have been studied widely. In Western Europe, North America and Western Pacific, except China, annual mean total suspended particulates (TSP) concentrations range between 20 and 80 gm^{-3}, and PM_{10} levels are between 10 and 55 gm^{-3}. High TSP and PM_{10} annual mean concentrations are found in Southeast Asia [8] ranging between 100 and 400 gm^{-3} for TSP and 100–300 gm^{-3} for PM10. High annual TSP concentrations of 300–500 gm^{-3} are observed in the large cities of China Similarly, the PM_{10} levels in Indian cities have been found to be in the range of 100–400 gm^{-3}[9].

$PM_{2.5-10}$ are the finer particles, which have the greatest impact on health [10]especially $PM_{2.5}$ which penetrates the human respiratory system more efficiently into the alveolar region. Studies have also found that higher concentrations of coarse particles (PM2.5-10) increase overall mortality rates [11]. Chang et al. [12] suggested that re-suspended road dusts contain materials which potentially initiate allergic reactions. Studies on both rodents and humans demonstrate that ultrafine particles have a greater effect per unit mass than larger particles [13] 2001) while another study on asthma patients performed in Germany and Finland [14] suggested that both one and ultrafine particles have health effects which might be independent of each other.

MATERIALS AND METHODS

Area of Study

The study was carried out in Ogijo in Sagamu local Government Area, Ogun State, located within Southwestern Nigeria. The local Government has an area of 614 km2 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. The 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 it up 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. The Sagamu region is underlain by major deposits of limestone, which is used in the city's major industry, the production of cement. Agricultural products of the region include cocoa and kola nuts. Sagamu is the largest kola nut collecting center in the country. The kolanut 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. There are lots of festivals in Ogijo such as Eluku festival, Oro festival, Agemo festival etc. The Eluku festival is celebrated in every month of august, in which people who are really concern such as the Olumale, Ajano, Apena etc. goes to the shrine which is located at Ikusela village. The aim of celebrating this festival is to bring peace to Ogijo village and Ogijo occupants generally 15]

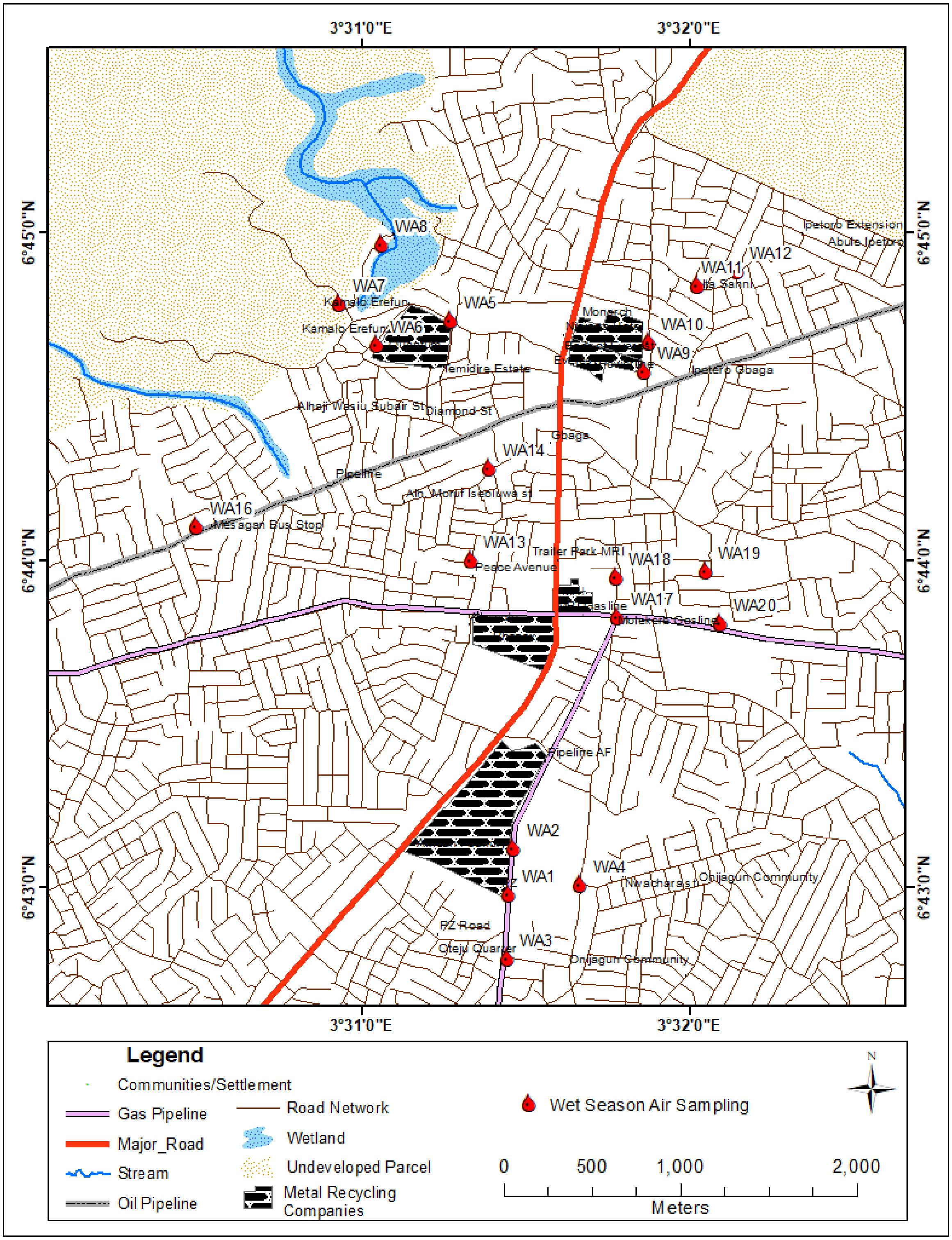

Figure 1: Map of the Study Area Showing Wet Season Air Sampling Points

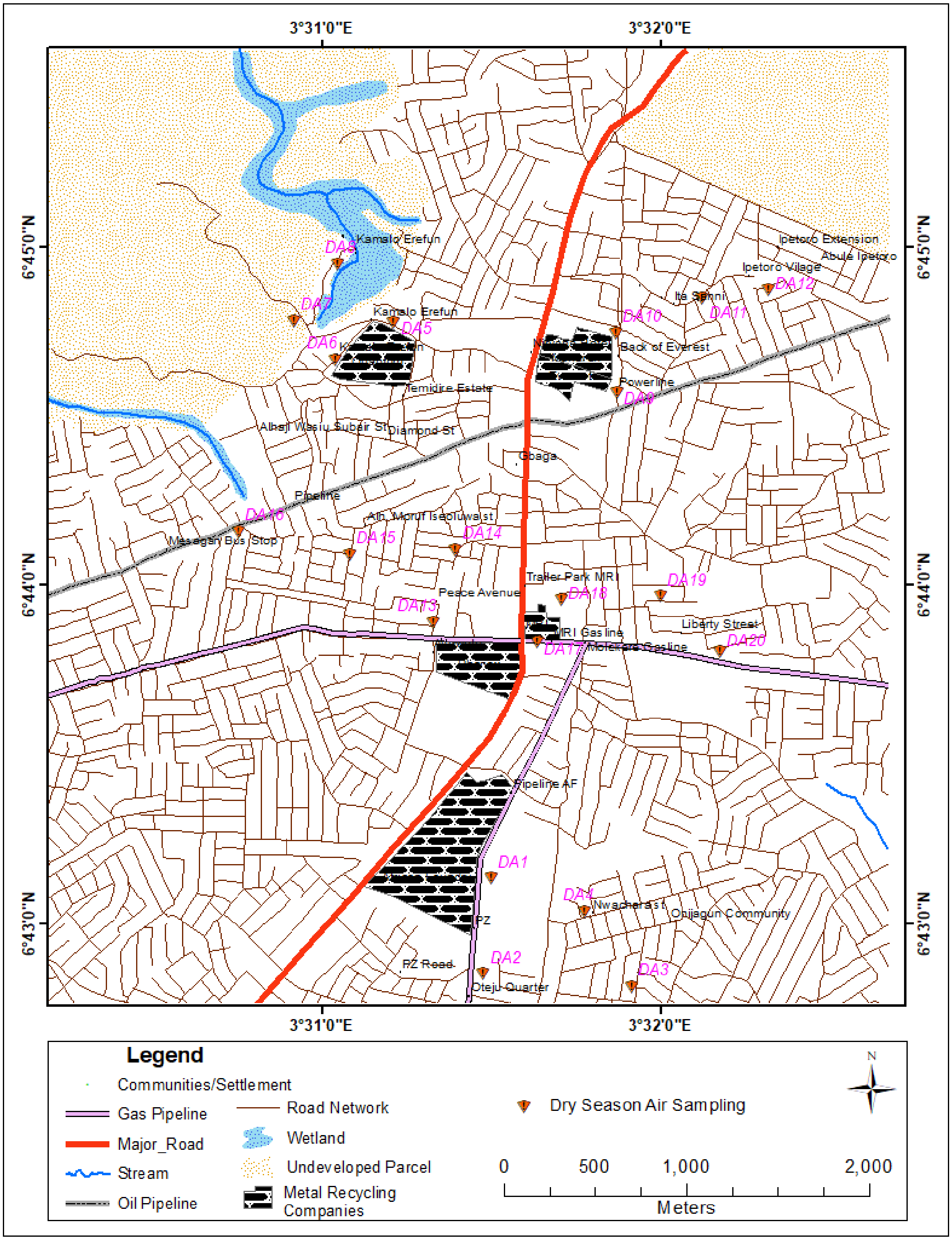

Figure 2: Map of the Study Area Showing Dry Season Air Sampling

Figure 3: A Metal Recycling Industry at the Study Location

Air Quality Measurement

In-situ air measurements were conducted in all the sampling locations for gases (Carbon monoxide, Nitrogen dioxide, Sulphur dioxide) and particulate matters (PM2.5 and PM10) in dry and wet seasons. 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

Quality Control

Distilled water was used during digestion, extraction and preparation of solutions. All glasswares were cleaned by soaking in 10% nitric acid overnight and rinsed with deionized water before use. Blank samples were also analyzed to account for any possible contamination by reagents, deionized water, digestion chemicals and digestion vessels. Replicate analyses of samples were carried out to determine the reproducibility of results.

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.

RESULTS AND DISCUSSION

Concentration of air pollutants gases carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), PM_{10} and $PM_{2.5}$ were analyzed and compared with the recommended air quality guideline. The results have then displayed from Figures 3 to 7 to show the concentrations of the pollutants.

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_2value was recorded in control as observed in Figure 3.

The NO_2 values recorded in this study were found to far exceed the Nigerian ambient air quality standard (0.04 to 0.06 ppm) set by Federal Ministry of Environment (1991). Zhao et al., [16] found that the average PM10, NO_2, and SO_2 concentrations in the urban area 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 [17] 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. [18] 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 [19] 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 [20]. 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.

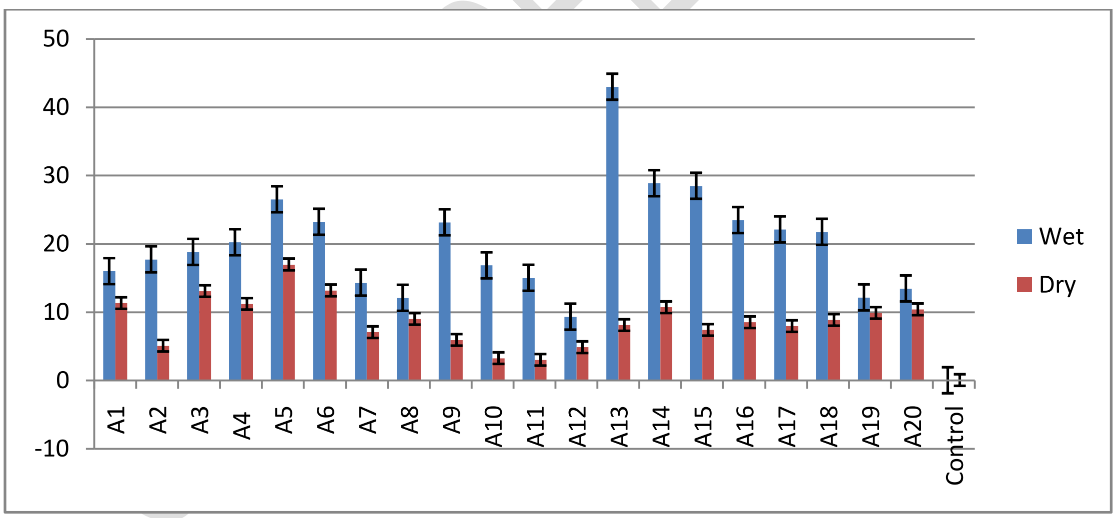

Figure 4: Mean Concentration of NO_2 Air Sample in Dry and Wet Season

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 Figure 4. The CO values recorded were found to be within the Nigerian ambient air quality standard (10 ppm) set by Federal Ministry of Environment (1991) and WHO permissible limit (10 ppm) set for carbon monoxide. In the studies by Rim-Rukeh [17], Musa et al. [21], 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 [22].

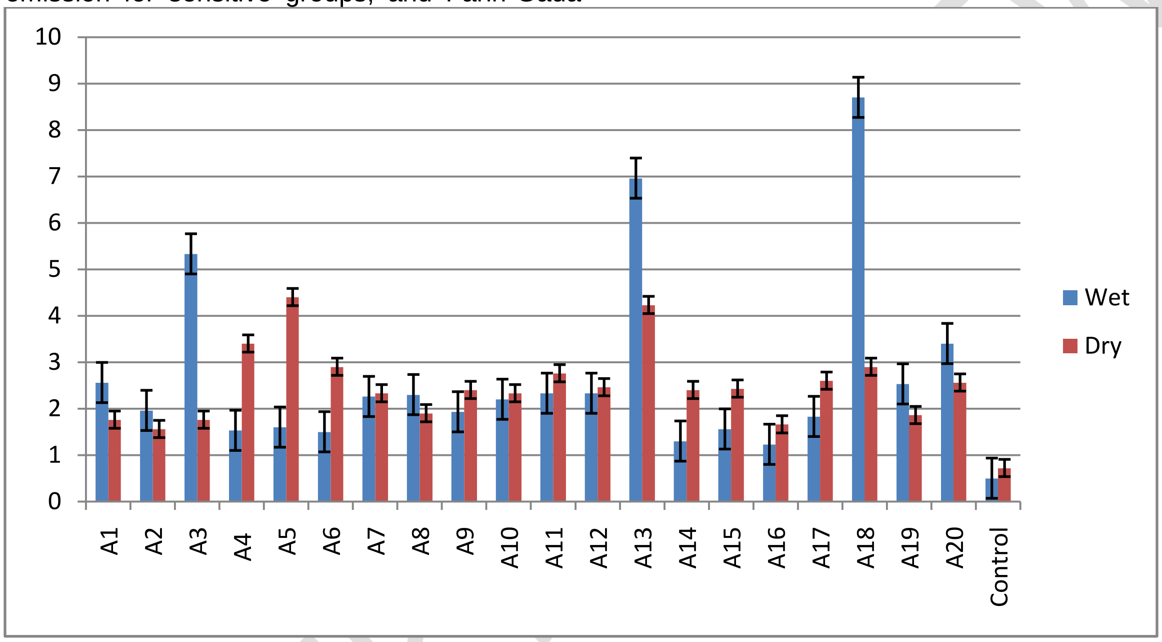

Figure 5: Mean Concentration of CO Air Sample in Dry and Wet Season

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 Figure 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 wet season. Rim-Rukeh [17] recorded SO2 values which ranged from (27.7 to 37.1 ppm), Weli and Adekunle [23] recorded 0.67 ppm and Ubouh and Nwawuike [24] recorded a high SO_2 values and by Olayinka [25] 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. [26] evaluating air pollution by PM_{10} and SO_2 levels in Erzun province, Turkey and the results showed 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 [27].

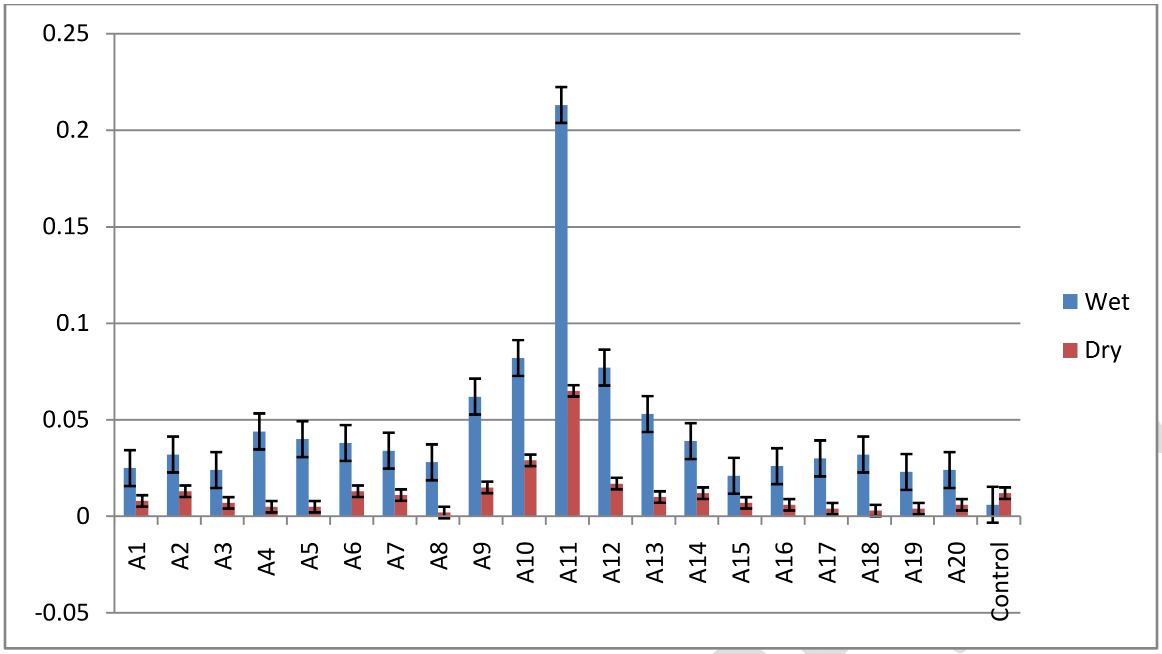

Figure 6: Mean Concentration of SO_2 Air Sample in Dry and Wet Season

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 Figure 6. The mass concentrations of $PM_{2.5}$ were higher in dry season than wet season. 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) set by Federal Ministry of Environment (1991), The $PM_{2.5}$ values recorded in the study of Tianpeng et al., [28] 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. According to the Global Burden of Disease (GBD), PM2.5 is estimated to be the sixth largest risk factor for premature deaths on the global scale[29]. $PM_{2.5}$ caused 2.9 million premature deaths in 2017 or about 9 percent of total deaths in the world [30].

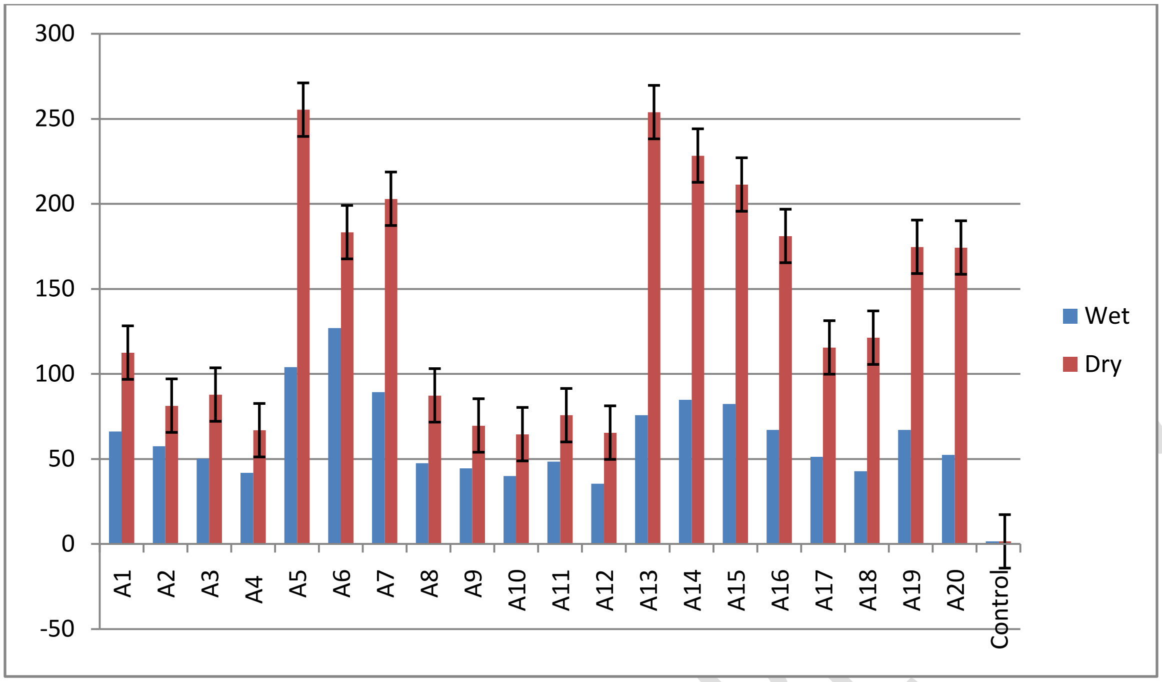

Figure 7 Mean Concentration of PM2.5 Air Sample in Dry and Wet Season

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 Figure 7. The PM_{10} values recorded in this study were found to be within the Nigerian ambient air quality standard (250 µg/m3) set by Federal Ministry of Environment (1991). In the studiesofOgbemudia [31], Ubouh and Nwawuike [24] and Rim-Rukeh [17], 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 (2005) [32] limits. Higher values of PM were observed in the dry and wet season with highest records around A5.

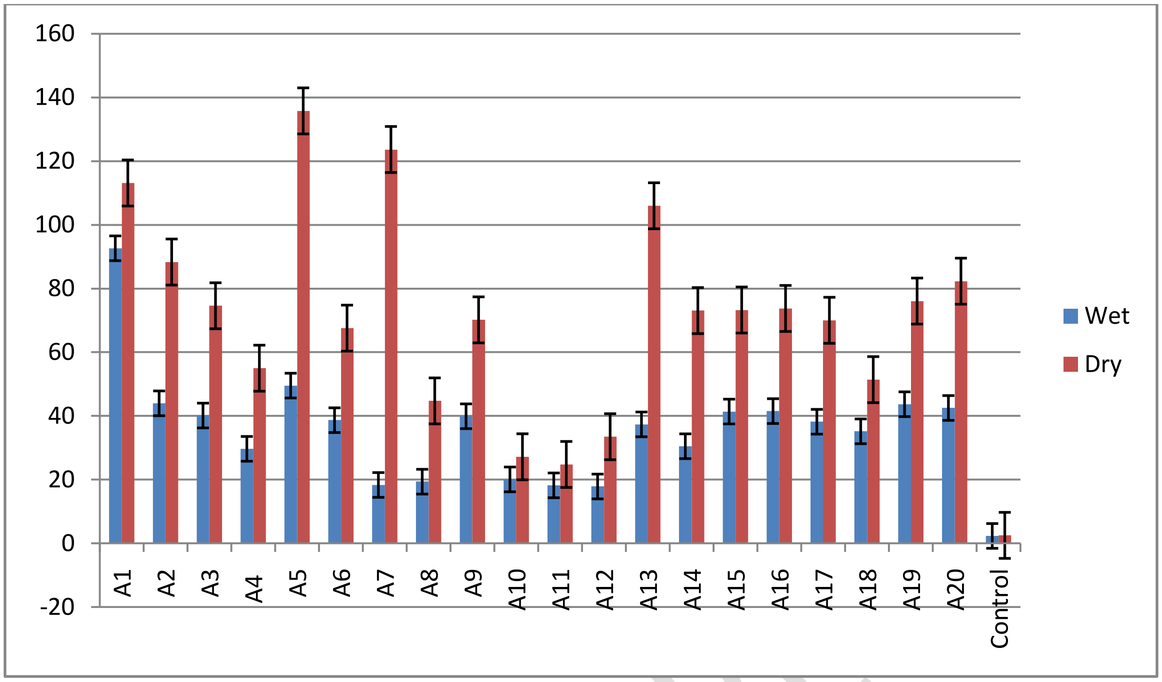

Figure 8 Mean Concentration of PM10 Air Sample in Dry and Wet Season

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			
SO2	Dry Season	0.09	0.11	3.242	0.002	Significant
	Wet Season	0.05	0.04			
PM2.5	Dry Season	133.94	72.83	7.471	0.000	Significant
	Wet Season	60.84	26.96			
PM10	Dry Season	69.91	33.35	7.275	0.000	Significant
	Wet Season	35.30	17.72			

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.

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 wet season and the $PM_{2.5}$ values at A5 and A13 in dry season were aboveNigerian ambient air quality standardof 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 level heavy. The levels of air pollutants in and around the study area should be assessed regularly in order to monitor the impact of the scrapping activities on the environment.

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