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Particulate Matter Monitoring Around Selected Oil Exploration Areas in ONELGA, Rivers State, Nigeria

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ABSTRACT
This study was carried out to ascertain the levels of particulate matter ($PM_{2.5}$ and PM_{10}) and some metrological parameters and their influence on the air pollutants within the oil communities in Ogba/Egbema/Ndoni Local Government Area in Rivers state. Digital handheld monitor was used to monitor $PM_{2.5}$ and PM_{10} while digital anemometer was used for the metrological parameters. Sound pressure level meter with model TES1352H was used to measure the noise level at each point in decibels. The mean values obtained from all the study areas include control site (dry 0.074, wet 0.071), Obagi (dry 0.076 wet 0.026), Obite (dry 0.092, wet 0.026) and Obrikom (dry 0.095, wet 0.020) respectively for $PM_{2.5}$ while for PM_{10} the control site Ahoada (dry 0.402, wet 0.074), Obagi (dry 0.401, wet 0.039), Obite (dry 0.620, wet 0.030), Obrikom (dry 0.436, wet 0.034). The results obtained suggest the need for periodic monitoring within the area of study.
Keywords: particulate matter, air pollutant, periodic monitoring, pollution, dry, wet, environmental pollution, oil exploration, commercial and industrial.

1.0 INTRODUCTION

The oil exploration areas within Rivers state in Ogba/Egbema/Ndoni local government area has several oil companies, which include Total Exploitation and production Nigeria Limited (TEPNL), Nigeria Agip Oil Company (NAOC) and Shell Petroleum Development Company (SPDC). Some of the oil communities include, Obrikom, Obite, Obagi, Omoku, Egbema, Oboburu, Amah and others (Owhoeke et al., 2019). The area boost of several flack stack which is a major source of release of gaseous pollutants to the atmosphere with several gas turbines, gas plants within this oil exploration zone.

Among the key problems that the world is tackling today is environmental pollution. Nigeria is known to be one of the top natural gas flaring countries in the world (Nkwocha & Mbonu, 2010); flaring equivalently, about 40 percent of Africa's total flaring. These flares originate from oil and gas facilities, most of which are located in the Niger Delta. The danger of continuous flaring of associated oil and gas is that it may become a source of air pollution which changes the conformation of atmosphere and affect the biotic environment and endanger the health of humans, vegetation, as well as destroy the ozone layer and contribute to climate change, global warming and environmental pollution (Board, 2006; Onunugbo et al., 2011; Akuro, 2012). Oil exploration and production originated with a lot of complex activities, burdened with environmental issues and problems including air and noise pollution since its origin in later years of 1950's (Igoni, 2018). The study area is a crucial factor in the development of Rivers State and the entire nation at large and due to the high concentration of oil facilities owned by the multinational companies. (Igoni, 2018; Ugorji, 2000; Abam & Unachukwu, 2009).

Air is an important resource for life, hence, it is indispensable for us to check and control its contamination due to human activities (Singh & Chakraborty, 2010).

2.0 METHODOLOGY

2.1 Study Area

The study area (Figure 1) is located between latitude 006º39'31.4316"E and 6º39'30.4812"E; and longitude 5º14'48.33636"N and 5º48'458.1412"N. The area hosts major oil companies which include the Nigeria Agip Oil Company NAOC), Total Exploitation and production Nigeria Limited (TEPNL) and SHELL Petroleum Development Company (SPDC). Air quality monitoring was carried out within the host communities of Obite town, Obrikom town and Obagi town as shown in Figure 1.

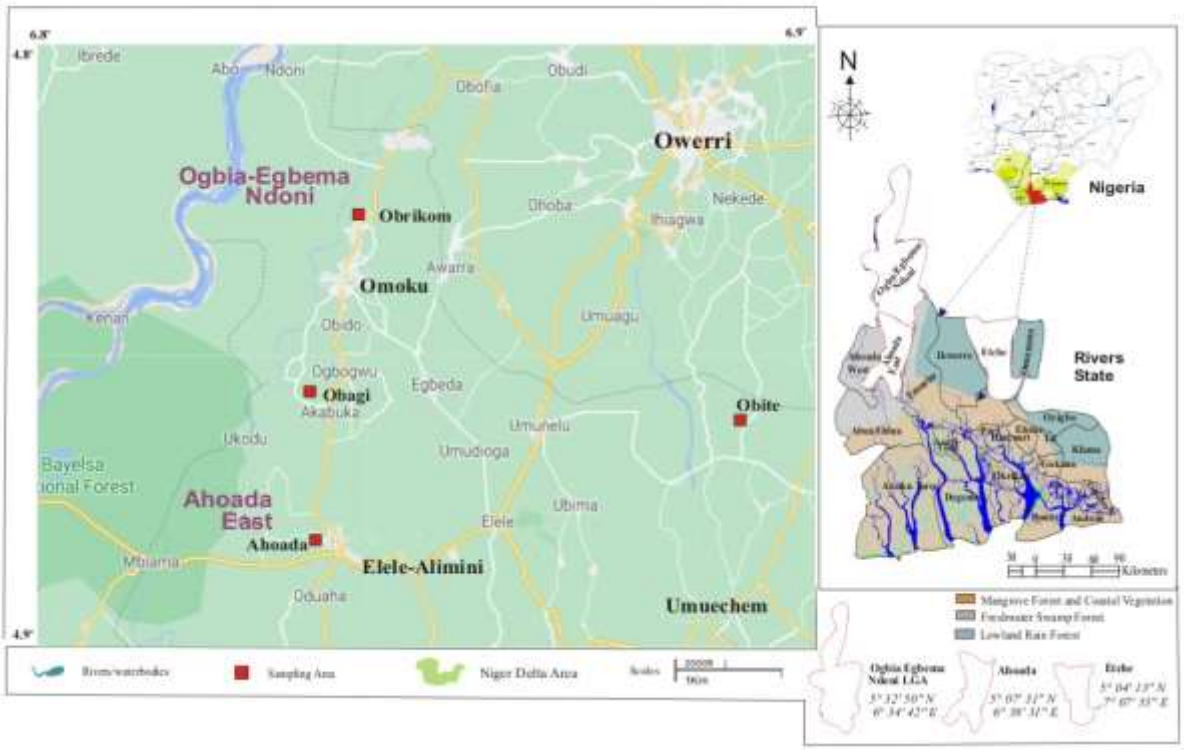

Figure 1: map of the study area

Table 1: Location coordinates of the study area

Location	Community	Coordinates	
		Longitude	Latitude
1	Obite	5º14'48.33636"N	006º39'31.4316"E
2	Obagi	5º14'12.6294"N	006º38'2.69412"E
3	Obrikom	5º23'48.33636"N	006º39'3.4316"E
4	Ahoada (Control)	5º48'458.1412"N	6º39'30.4812"E

2.3 Monitoring Locations

Four areas (three host communities within the study area and one control) were monitored. These areas were chosen as a result of its massive contribution to air pollutants. The monitoring points and their coordinates are shown in Table 1.

2.4 Sampling Equipment

A mini volume instrument, Aerosol gas monitor was used to measure particulate matter ($PM_{2.5}$ & PM_{10}). Mini vol portable air sampler, kanomax 3900 particle counter manufactured by Andover, USA. Sound pressure level meter with model TES1352H was used to measure the noise level at each point in decibels. A multi- parameter digital anemometer was used for the measurement of relative humidity, wind speed and temperature as shown Table 2. This instrument was held up in an open space with a consideration of a distance for about 3 minutes. This is to avoid unnecessary interference from shades and to burn off any contaminant on the sensor of the instrument.

Table 2: Results of the mean values of particulate matter monitoring in study area

Parameters	Obite		Obagi		Obrikom		Ahoada (Control)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
PM_{10} (mg/m^3)	0.620	0.030	0.401	0.039	0.436	0.034	0.402	0.0074
$PM_{2.5}$ (mg/m^3)	0.092	0.026	0.076	0.026	0.095	0.020	0.074	0.071
Temperature (^0C)	38.96	31.08	47.40	31.83	36.90	29.68	32.14	26.63
Rel. humidity (%)	17.80	79.29	18.80	83.50	23.70	81.55	25.20	82.25
Wind speed (m/s)	4.975	1.700	2.750	1.750	2.850	1.850	5.750	2.775
Noise level (dB)	49.20	61.28	48.73	60.15	61.03	67.80	50.65	49.28

Table 3: Mean values of the metrological parameters from the study

Parameters	Obite		Obagi		Obrikom		Ahoada (Control)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Temp (^0C)	38.96	31.08	47.40	31.83	36.90	29.68	32.14	26.63
Rel. humidity (%)	17.80	79.29	18.80	83.50	23.70	81.55	25.20	82.25
Wind speed (m/s)	4.975	1.700	2.750	1.750	2.850	1.850	5.750	2.775
Noise level (dB)	49.20	61.28	48.73	60.15	61.03	67.80	50.65	49.28

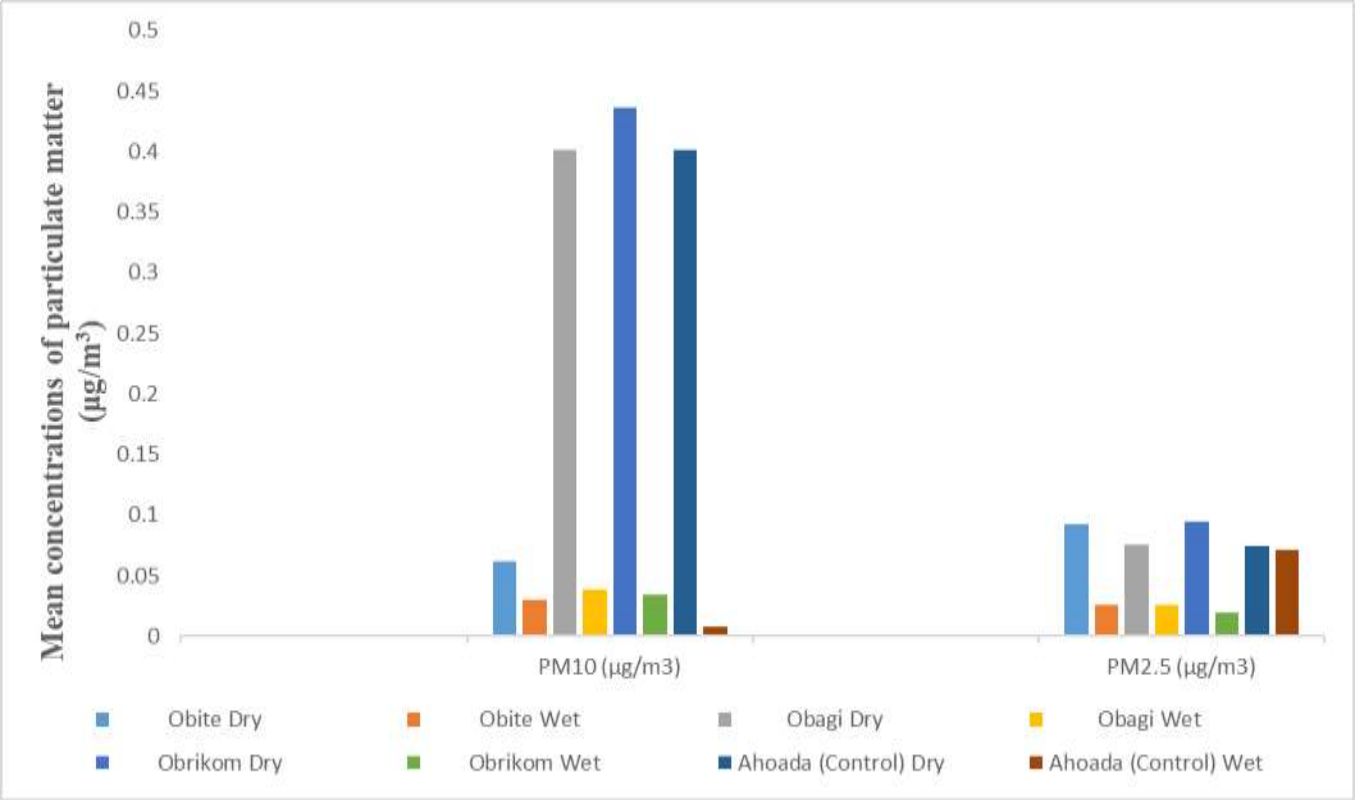

Figure 2 Seasonal variation of particulate matter from the study

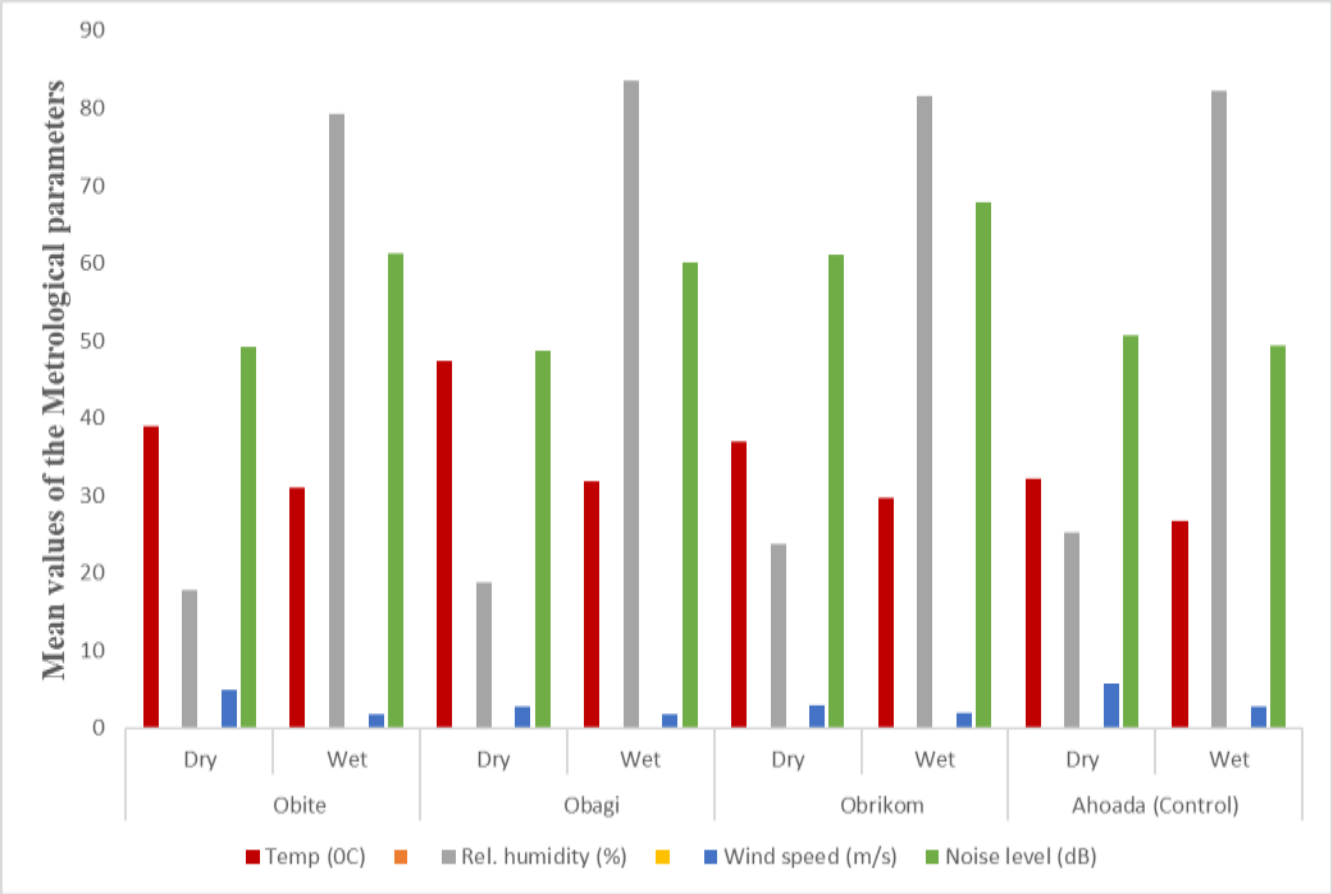

Figure 3 seasonal variation of the metrological parameters from of the study

DISCUSSIONS

Table 2 shows the results from the sampling locations of particulate matter and metrological parameters from the study. Most of the values obtained were higher than that of the control $PM_{2.5}$ (0.148 mg/m^3), PM_{10} (0.805 mg/m^3). The results obtained for $PM_{2.5}$ and PM_{10} for Obagi, Obite and Obrikom is as follows 0.076 mg/m^3 , 0.401 mg/m^3; 0.092 mg/m^3, 0.620 mg/m^3; 0.095mg/m^3, 0.436 mg/m^3 respectively. The results suggested that Obagi had highest values, followed by Obite and the least was Obrikom. This is expected as Obagi has a gas plant that flares gases on daily bases, though Obrikom also have about 5 flare stacks but the site of Obrikom is closer to the river which might be a factor while the level of the pollutant are lower and can easily be dispersed to other areas by wind, since it had higher wind speed than the other areas within the area of study. The metrological parameters were thus; Ahoada, relative humidity was 25.20%, Wind speed was 5.750 ms, temperature was 32.14 ^{o}C, the noise level indicated 50.65 dB, Obagi (relative humidity (18.80%), Wind speed (2.750 ms), temperature was (47.40 ^{o}C), the noise level (48.73 dB), Obite (relative humidity (17.80%), wind speed (4.975 ms), temperature was (49.20 ^{o}C), the noise level (49.20 dB), while Obrikom (relative humidity (23.70 %), wind speed (2.800 ms), temperature was (36.90 ^{o}C), the noise level (61.03 dB) which plays an important role on the level of pollutants.

For the wet season, Obagi sites were as follows; 0.026 mg/m^3, 0.039 mg/m^3 which were for $PM_{2.5}$ and PM_{10}. The mean for Obite sites were thus; 0.026 mg/m^3, 0.030 mg/m^3, for $PM_{2.5}$ and PM_{10} While the mean of Obrikom sites were thus; 0.020 mg/m^3, 0.034 mg/m^3, for $PM_{2.5}$ and PM_{10}. The result indicated that Obagi

had the highest pollutant level during the wet season followed by Obite and then Obrikom was the least. Many factors could have led to these, like the number of flare stack around the Obrikom area is highest but the flare stack is situated close to the river, so high humidity with high wind around the wet season could make the pollutants less in that area. The average values for the meteorological factors like Relative humidity, Wind speed, Temperature and Noise for Ahoada were 82.25%, 2.775 ms, 26.63ºC and 49.28 dB respectively. Obagi (83.50 %, 1.750ms, 31.83ºC, 60.15 dB) for relative humidity, wind speed, temperature and noise level. Obite (79.20 %, 1.700 ms, 31.08ºC and 61.28 dB) for relative humidity, wind speed, temperature and noise level while Obrikom (81.55 %, 1.850 ms, 29.80 ºC and 67.80 dB) for relative humidity, wind speed, temperature and noise level respectively.

Figure 2 and 3 indicates that pollutants level were higher during the dry season than in the wet season. Differences in the season played a major role in the distribution of the pollutants across the season. The temperature is normally low in the wet season and high in the dry season which encourages pollutants movement during the dry season but disfavors that in the wet season, while the high relative humidity is also a factor too.

$PM_{2.5}$ (Particulate matter with a diameter of less than 2.5µm)

The results of air pollutants in the dry and wet season within selected oil exploration areas of Rivers State are shown in Table 2 and figure 2 respectively. From table 2, the $PM_{2.5}$ values was highest in Obrikom (0.095 mg/m^3) in the dry season followed by Obite (0.0092 mg/m^3), Obagi (0.076 mg/m^3) and the least was the control Ahoada (0.074 mg/m^3). The wet season showed that the control Ahoada had higher $PM_{2.5}$ value of (0.071 mg/m^3) followed by Obagi (0.026 mg/m^3), Obite (0.026 mg/m^3) and Obrikom (0.02 mg/m^3) respectively. The highest values of $PM_{2.5}$ in Obrikom could be attributed to the five gas flare stacks that flares gases on daily basis. Though the control Ahoada is not an industrial area, there is still a high concentration of $PM_{2.5}$ (0.07 mg/m^3) in the raining season. This could be attributed to illegal artisanal refinery (kpoo fire) that is taking place in the region. We know that particulate matter is emitted during the combustion of solid and liquid fuels, such as power generation, domestic heating and in vehicle engines. The effect of $PM_{2.5}$ to the inhabitants could better be imagined because they bypass many of our body defenses, nose, hair, mucus, and other defenses work to catch these smaller particles, before they enter deeper into our bodies. They can stay longer in the air up to days or even weeks and can travel farther. The values of the $PM_{2.5}$ obtained in Obrikom is still considered healthy as it is below the 35.4 µg/m^3 24 – hour concentration considered unhealthy.

PM_{10} (Particulate matter with a diameter of less than 10µm)

The average level of PM_{10} obtained from the selected oil exploration areas of Rivers state for the dry and wet season is represented in table 2 and in figure 2. The values for PM_{10} was highest in the dry season in all the monitoring locations than during the wet season. The results indicates that Obite during the dry season had the highest level of PM_{10} of 0.620 mg/m^3 followed by Obrikom (0.436 mg/m^3), control Ahoada (0.402 mg/m^3) and the least is the Obagi (0.401 mg/m^3). This could be as a result of windblown dust from the roads, emissions from machines in the industry, gas flaring activities, emission from generators and vehicular emission.

The wet season shows minimal concentration level. The values obtained were lower than the WHO set limit which is an indication that rainfall had a greater effect on the pollution level as most pollutants might have been washed off during rainfall thereby rendering the rain less in the amount of pollutants. One of the major difference between $PM_{2.5}$ and PM_{10} is that the later can stay in the air for minutes, perhaps up to a couple of hours.

The $PM_{2.5}$ and PM_{10} variation in figure 2 shows that it had its peak in the dry season than during the wet season. The figure showed that the pollutants level were in order of Obite>Obrikom>Obagi>Ahoada in both seasons. This shows that wind, humidity and temperature played active role in the spread of the pollutants during the dry season, while the mist and hazy nature of the atmosphere prevented the spread of the ambient air pollutants.

Relative Humidity

The Relative humidity recorded within all the sampling locations is higher during the wet season than in the dry season as shown in tables 2, 3 and figure 3. The highest value is recorded during the dry season were in order of Ahoada > Obrikom > Obagi > Obite while Obagi > Ahoada > Obrikom > Obite was the order of the wet season. The result of the relative humidity was higher than reports by Swemgba et al., (2019), where values were; Rumukrushi Park 69.5, Rumuobiakani Junction 66.7, Eliozu Flyover 68.5, Choba Junction 55.75. High relative humidity in the study areas points to increased rainfall and reduces atmospheric particles (Misra et al., 2008), thus lessening atmospheric particulate mass concentration.

Wind Speed

Pollutant dispersion is influence prominently by wind speed. Wind speed is dominantly greater in the dry season than in the wet season across all the study locations as shown in tables 2, 3 and figure 3. The smallest value of wind speed is recorded in the wet season at Obite site while highest value of 5.750 ms is recorded in the dry season at the control site Ahoada. The average wind speed within the dry season was (Ahoada: dry 5.750, wet 2.775), Obagi (dry 2.750, wet 1.750) Obite (dry 4.975, wet 1.700) and Obrikom (dry 2.850, wet 1.850).

Temperature

Temperature measurement supports air quality assessment, air quality modeling and forecasting activities. The effect of temperature on the pollutants could be because hot air situations were more appropriate for atmospheric dispersion than cold air masses (Owoade et al., 2012). Temperature observed within the area of study is higher in dry season than in wet season as shown in tables 2, 3 and in figure 3. Average temperature observed within the study area is Ahoada (dry 32.14^{o}C and wet 26.63^{o}C), Obagi (dry 47.40^{o}C and wet 31.83^{o}C) Obite (dry 38.96^{o}C and 31.08^{o}C in wet season) and Obrikom (dry 36.90 ^{o}C, wet 29.68 ^{o}C).

Noise Level / Atmospheric Pressure

Tables 2, 3 and figure 3 represented the levels of noise in the study area. The values stood at dry season; 50.65 dB, wet season; 49.28 dB for the control, dry; 48.73 dB, wet; 60.15 dB for Obagi, dry; 49.20 dB, wet; 61.28 dB for Obite, dry; 61.03 dB, wet; 67.80 dB for Obrikom all in the study locations. The result clearly indicated that the noise level was higher in the wet season than the dry season.

CONCLUSION

The study estimated the level of particulate matter exposure to the inhabitants of oil exploration communities in Ogba/Egema/Ndoni Local Government Area in Rivers State. The $PM_{2.5}$ variation shows that it had its peak in the dry season with its values across the three zones triple the values in the wet season. The PM_{10} variation followed the same trend as the $PM_{2.5}$ with values high during the dry season than the wet season. This shows the level of intense human activities that is going on within the area of study as such advised the oil companies within the host communities to continually monitor the environment to determine the level of air pollutants and extent of pollution.

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