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Assessment of Ambient Air Quality and Noise Levels around Selected Oil and Gas Facilities in Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author BY designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BY and JNU managed the analyses of the study. Author JNU managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The study investigated ambient air quality and noise levels around Oil and Gas facilities in Ogba/Egbema/Ndoni Local Government Area (ONELGA), Rivers State. Seven stations including a control were assessed for air quality and noise study. Standard air sampling instruments were used to collect samples with control site located 5km from the study area. The results indicated low noise levels in the host communities; while computed noise Leq around oil and gas facilities in Ebocha, OB/OB and Gas turbine exceeded National Environmental Standards and Regulation Enforcement Agency (NESREA) limit by 10.1%, 5.3% and 1.1% respectively. The study revealed that SO_2, NO_2, PM_{10} and $PM_{2.5}$ particulate matter are the major causes of pollution around the oil and gas facilities. SO_2, NO_2 and $PM_{2.5}$ are the main cause of pollution in Omoku town, while $PM_{2.5}$ is the main cause pollution in Obrikom and Ebocha communities. Computed air pollution indices (API) indicated severe and heavy pollution around the oil and gas facilities; also, API values showed moderate pollution around Omoku town and light pollution around Obrikon town and Ebocha town, which may

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result in chronic health effects due to continuous exposures of host communities. The study further showed that concentration of $PM_{2.5}$ did not meet the ambient air primary standards necessary to protect human health in the host communities. The conduct of epidemiological research in the host communities is necessary to assess and determine the health status of the people. Also, regulatory agencies should enforce compliance laws and regulations on the facilities owners.

Keywords: Air pollution; noise; oil and gas facilities; air pollution index; host communities.

1. INTRODUCTION

Air pollution today is a global problem which has attracted researcher attention. It is simply defined as the presence of certain substances in the air in high enough concentrations and for long enough duration to cause undesirable effects [1]. The protection of the Environment is a major issue confronting oil and gas industry today. This is because of its associated air pollutants that are hazardous to the biophysical environment with a negative impact on human health and the environment. The Niger Delta in Nigeria being the hub of Oil exploration and production is known to be one of the major Gas flaring zones in the world today [2]. Nigeria's gas flaring contributes greatly to the global warming problems in the world [3]. The flares from Oil and Gas facilities which results in air pollution, adversely affect human health, agriculture crops animals and ecosystems [4] of the host communities. This study determined to establish the ambient air quality and noise levels in selected facilities in the Oil producing area in Nigeria.

It has been proved [5,6] that air pollution is costing over 2% of gross domestic product in developed nations and 5% of developing nations. Over 10% of air pollutants are attributed to pollution from Oil and Gas facilities. Major components of criteria pollutants from flared gases include nitrogen oxide (NO_2), Sulphur Oxides ($SO_{2)}$, Carbon oxide (CO), Methane, (CH_4), and particulates [1]. Nkwocha and Pat-Mbonu [2] have revealed that SO_2, NO_2 and Particulate matter are the major pollutants in the study area. The effects of ambient air pollution include human health, building facades and other exposed materials, vegetation, agriculture crops aquatic and terrestrial ecosystems and climate change. These effects could be Acute, chronic or temporary. Master [7] and Leton [8] clearly stated that compound formed from these gases along with other organic and inorganic chemicals are deposited on the earth or carried as raindrops causing sharp increase on surface water and soil acidity, and damage to buildings or monuments in highly industrial areas. Sulphuric acid, a secondary component of SO_2, can cause impairment of respiratory organs [9]. Jo and Herman [10] stated that hydrocarbon in the air combined with photochemical oxidants may prompt up eye and lung sicknesses. Air pollution is associated with industrial development [11]. It is another environmental factor that regulatory agencies and consultants will have to address in Environmental Impact Statement (EIS) [1].

Excessive noise is no doubt one of the most annoying things in the world [12]. Though noise is so pervasive that is difficult to absolutely escape from it [13], prolonged exposure to excessive noise levels cause damage to hearing cell which subsequently result in progressive impairment. Best control methods could be engineering (introduction of proof devices, modification of acoustic path, ear protective devices and improved facility designs etc.) and administrative (such as change in employee, shift duty or reductions in time spent at the plant) [14], [8]. Exposure regulation stated that maximum facility noise exposure permit is 90dB (A) for eight-hour (8-hour) period [15]. The aim of the study was to assess and describe air pollutants concentration levels and noise associated with oil and gas facilities and its effects on host communities. The study has the potential to attract the audience because it reveals the level of air pollution from oil and gas facilities in the Niger Delta that has long been overlooked in Nigeria. The high potential risk of air pollution to human health and the proximity of the oil and gas facilities to the host communities necessitated the conduct of this study.

2. METHODOLOGY

Study area covers Ebocha, Omoku and OB/OB Oil and Gas facilities, the catchment towns and environs. The locations were in the North West of Rivers State within latitudes 5^0 23'N and 5^0 26'N and longitudes 6^0 33'E and 6^0 42'E (Fig. 1). Air quality and meteorological monitoring, and noise survey were carried out around the oil and gas facilities in selected study locations.

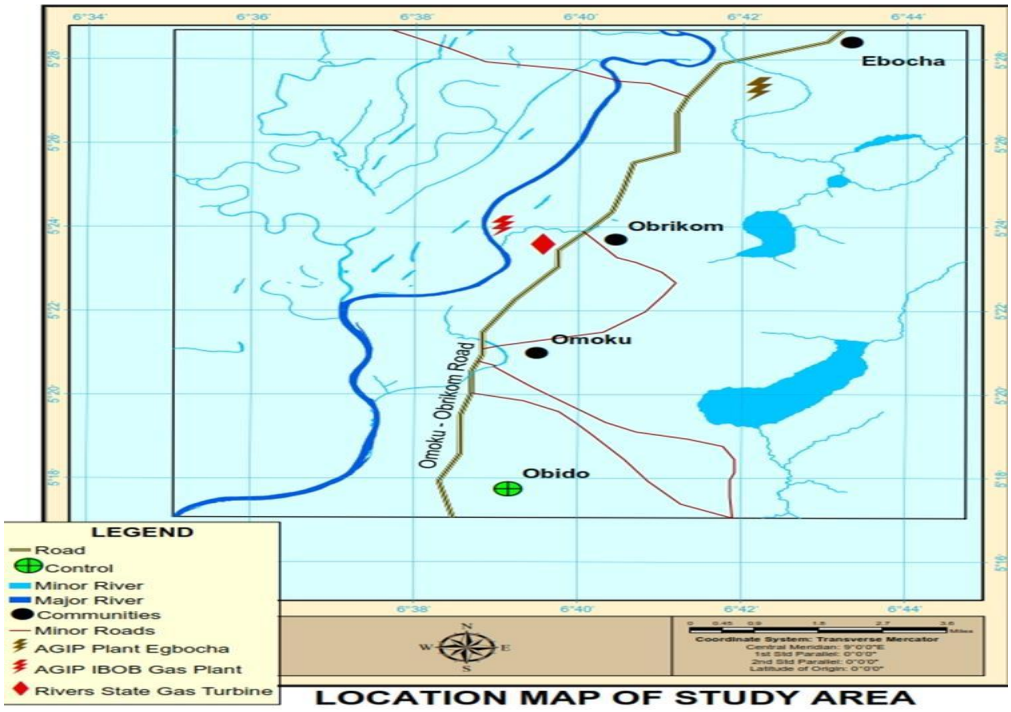

Fig. 1. Map of study area

In situ (on-the-site) measurements of pollutant concentrations, noise levels and meteorological parameters were conducted at selected sampling points around AGIP Plant Ebocha, AGIP Gas Plant OB/OB, Rivers State Gas Turbine, Omoku Town, Ebocha Town, Obrikom Town and a control location 5 kilometres away from the area. Air quality sampling was carried out to determine the concentrations of nitrogen oxide (NO_2), Sulphur Oxides (SO_2), Carbon oxide (CO), Methane hydrocarbons, (CH_4), hydrogen sulphide (H_2S) and particulate matter (TSP, PM_{10} and $PM_{2.5}$) in the area. Noise levels and meteorological parameters such as wind speed, wind direction, temperature and relative humidity were also measured. Air quality samplings were conducted using a Multi Gas Detector instrument (GA-21plus, 2013 model) with complete gas conditioning systems and electrochemical measurement principles. A CW HAT-200 particulate sampler that displays readings in microgram per cubic meter (μg/m³) was used to measure the concentrations of PM_{10} and $PM_{2.5}$ particulate matters, while an air metric Minivol particulate sampler with filter was used for total suspended particulate matter (TSP) at each monitoring point. The CW HAT-200 measurement principle is by light scattering using laser diode method and gives direct real-time reading of particulate concentrations. Noise level at each sampling point was measured using a Smart Sensor sound pressure level meter (model AR854); while a multi-purpose digital Kestrel digital weather tracker (model 4500) was used to measure wind speed, temperature and relative humidity, while wind vane was used to determine the wind direction. Field measurement was carried out from 10th to 26th of October 2016. Measurement of air pollutants was taken within 1 hour intervals and then averaged up to 8 hours (08:00-16:00). The instruments were placed at 1.5m above ground level to accurately capture data. A total of fourteen samples of each pollutant were collected from each location. The results were compared with the National Ambient Air Quality Standards (NAAQS) and the Nigerian Federal Ministry of Environment permissible Limits.

The study used measurement and statistical analysis to evaluate levels of air pollutants in the area. Assessment of air pollution impacts in the study area was based on computed exceedance factors (EF) and air pollution indices (API) using the National Ambient Air quality Standards (8 hour averaging for CO, 1 hour averaging for NO_2, 8 hour averaging and scaled up to 24 hours for SO_2 and particulate matter). Exceedance factor for each pollutant was computed using Equation (1), while air pollution indices were computed

using Equation (2) and result compared to the Rating Scale for API [11] as shown in Table 1. Exceedance factor is a numeric value that indicates by how much a particular criteria pollutant exceeds its prescribed limit and was calculated using the following expression [16]:

$$q_i = \frac{C_{oi}}{C_{si}} \quad (1)$$

Where, q_i is the exceedance factor for the i^{th} parameter, C_{oi} is the observed concentration of the i^{th} parameter in the ambient air; C_{si} is the recommended permissible standard concentration for the particular parameter. CPCB [16] has classified exceedance factor into four categories as follows: q > 1.5 implies critical pollution (C); q between 1.0 - < 1.5 implies high pollution (H); q between 0.5 - < 1.0 implies moderate pollution (M) and q < 0.5 implies low pollution (L).

Air Pollution Index (API) is a numerical rating that indicates how polluted each sampled location is. Air pollution index was computed for all sampled locations to obtain an insight into how polluted the air at each location was. The API rating scale [11] categorized API values into clear air, light pollution, moderate pollution, heavy pollution and severe pollution as shown in Table 1. Air Pollution Index (API) of each location was determined using the following expression [11]:

$$\mathrm{API} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \mathrm{A}_i \quad (2)$$

$$\text{Where } \mathrm{A_i} \text{ is the sub - index given as :}$$

$$\mathrm{A_i} = 100 \frac{C_{oi}}{C_{si}} = 100 q_i \quad (3)$$

C_{oi} is the concentration of the i^{th} pollutants and C_{si} is the air quality prescribed standard for the i^{th} pollutant.

3. RESULTS

Statistical results of pollutants, meteorology and noise measured in the study area are presented in Tables 2 and 3. The minimum, mean, maximum values and standard deviations of all the parameters are shown in Tables 2 and 3. SO_2 concentrations varied from 0.11ppm at Omoku and Ebocha towns to 1.1ppm at the oil and gas facilities. The highest mean value of 0.36ppm was obtained at AGIP Gas Plant Ebocha, while Omoku and Ebocha towns showed mean values of 0.08ppm and 0.03ppm respectively. Nkwocha and Pat-Mbonu [2] obtained a mean SO_2 value of 0.09ppm in Omoku town.

Table 1. API rating scale for Indices

S/n	Index value	Rating	Health Concern
1.	0-25	Clear air	Good
2	36-50	Light air pollution	Acceptable
3	51-75	Moderate air pollution	Unsatisfactory
4	76-100	Heavy air pollution	Unhealthy
5	>100	Severe air pollution	Severe and unhealthy

Source: [11]

Concentrations of NO_2 (Table 2) ranged from 0.1 ppm at Omoku and Ebocha towns to 1.1ppm at AGIP Gas Plant Ebocha. The maximum mean value was recorded at AGIP Plant Ebocha and AGIP Gas Plant OB/OB. NO_2 was not detected at Rivers State Gas Turbine and Obrikom town, while mean concentrations of 0.05ppm and 0.03 ppm were obtained at Omoku and Ebocha towns respectively. An average value of 0.12ppm was obtained by Nkwocha and Pat-Mbonu [2] in Omoku town.

Highest value (3.27 ppm) of CO was obtained at the Rivers State Gas Turbine while the lowest value (0.11 ppm) was each obtained at Obrikom and Ebocha towns. Similarly, the highest mean value was obtained at the Rivers State Gas Turbine, while the lowest mean value was obtained at Obrikom town as shown in Table 2.

Methane concentrations (Table 2) varied from 54.5 ppm at Omoku and Ebocha towns to 763.33 ppm at AGIP plant, Ebocha. The highest mean value of 290.8 ppm was recorded at AGIP Plant Ebocha; the lowest mean value (38.2 ppm) was obtained at Rivers State gas turbine. Omoku, Obrikom and Ebocha towns showed mean values of 149.9 ppm, 54.5 ppm and 68.2 ppm respectively.

Table 2 indicated that H_2S concentrations ranged from 0.11 ppm at Omoku town to 1.1 ppm at AGIP plant Ebocha and AGIP gas plant OB/OB. The highest mean value of 0.18 ppm was obtained at AGIP plant Ebocha and the lowest value of 0.03 was obtained at Omoku town.

Total suspended particulate matter varied between 36.0 µg/m^3 at AGIP gas plant OB/OB and 93.6 µg/m^3 at AGIP oil facility Ebocha (Table 2). Mean concentrations obtained at each location. PM_{10} concentrations in the area (Table 2) varied between 35.0 µg/m^3 and 89.0 µg/m^3 at AGIP plant facility Ebocha. The highest mean value (71.1 µg/m^3) was obtained at AGIP plant facility Ebocha and the lowest mean value (49.6 µg/m^3) was obtained at Rivers State gas turbine facility as indicated in Table 2. Omoku town showed a mean value of 54.0µg/m^3 which is close to the value of 59.0µg/m^{3}obtained by Nkwocha and Pat-Mbonu [2]. Concentrations of $PM_{2.5}$ (Table 2) varied from 21.0 µg/m^3 at Obrikom town to 77.2 µg/m^3 at AGIP gas plant, Ebocha. The highest mean value of 62.3 µg/m^3 was also obtained at AGIP gas plant, Ebocha and the lowest mean value of 32.0 µg/m^3 was obtained at Obrikom town.

3.1 Meteorology of the Study Area

Statistics of meteorological parameters are presented in Table 3. Ambient temperature levels measured in the area varied from 30.10C at Rivers State Gas Turbine to 33.4°C at AGIP Plant Ebocha. The highest mean temperature of 32.4°C was obtained at AGIP Plant Ebocha and the lowest value of 30.4°C was obtained at AGIP Gas Plant OB/OB. Temperature levels of this range are common with the tropical climate of the study area with high sunshine [17,18]. Temperature levels influenced the concentrations of air pollutants in the area [18].

Relative humidity observed in the area (Table 3) varied from 79.4% at Rivers State Gas Turbine to 64.8% at Obrikom town. Rivers State Gas Turbine also showed the highest mean value, while AGIP Plant Ebocha showed the lowest mean value. Relative humidity in the area oscillates in tandem with air temperature, but as opposite fluxes [19]. High relative humidity is expected in the month of May because of the coastal nature of the area, and irrespective of the season the area experiences high relative humidity that is maximum at dawn (over 90%) and minimum by late afternoon (<60%) [17], [18]. Mean wind speed values measured in the area varied between 2.8m/s at AGIP Gas Plant OB/OB and 0.4m/s at Rivers State Gas. The highest mean values were obtained at AGIP Gas Plant OB/OB and Obrikom town, while the lowest mean value was obtained at Ebocha Town as indicated in Table 3.

Wind directions were predominantly North-Easterly with some periods of North-West and South-East as represented in the pollution roses of Fig. 2. Wind speed and direction determine the dispersion of air pollutants from the oil and gas facilities in the area. It is observed from Fig. 2 that concentrations of pollutants increase with increased wind speed along the prevailing wind direction. No period of calmness was observed during field survey as shown in Fig. 2. It is the period of calm that is of importance to atmospheric dispersion of pollutants and this constitutes 0.0% of the total hours of measurement (Fig. 2). Calms usually slow dispersion of pollutants thereby leading to ground surface accumulation of pollutants. This indicates that wind speed transport pollutants from the facilities to the adjoining communities.

3.2 Noise Levels in the Study Area

Noise levels measured during field survey are shown in Table 3; mean noise values and computed Leq values in comparison with NESREA standard are shown in Figs. 3 and 4 respectively. Noise levels observed in the area varied from 57dB (A) at Obrikom and Ebocha towns to 80.1dB (A) at AGIP Gas Plant Ebocha. The highest average noise value was obtained at AGIP Gas Plant Ebocha, while the lowest average noise value was obtained at Ebocha town.

4. DISCUSSION

The nearest human settlement to the AGIP gas plant Ebocha is Ebocha town located about 1500 meters on the North-Eastern part of the facility. This settlement is in the prevailing wind directions (North-Easterly) relative to the facility and therefore may experience major air quality impacts from the oil and gas facility. Another identified sensitive receptor in the study area is Obrikom town located about 1200meters from the OB/OB AGIP gas plant and 700meters from the Rivers State gas turbine. This town is situated in the North-Eastern part of both facilities along the prevailing wind direction. The next sensitive human receptor identified in the study is the Omoku town, which is situated about 4500 meters from the OB/OB AGIP gas plant and the Rivers State gas turbine. The town is located in the South-Eastern part of both facilities. The pollution roses (Fig. 2) indicated that Ebocha town is affected by AGIP gas plant Ebocha; while Omoku town and Obrikom town are affected by both the OB/OB AGIP gas plant the Rivers State gas turbine.

Table 2. Statistics of pollutants in the study area

S/n	Location/Parameter		SO_2 (ppm)	NO_2 (ppm)	CO (ppm)	H_2S (ppm)	CH_4 (ppm)	TSP (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
1	AGIP Plant Ebocha	Min	0	0	0	0	0	59	35	58
		Max	1.1	1.1	1.09	1.1	763.33	93.6	89	77.2
		Mean	**0.36**	**0.09**	**0.09**	**0.18**	**290.8**	**78.7**	**71.1**	**62.3**
		Std	**0.54**	**0.03**	**0.31**	**0.24**	**326.6**	**3.1**	**13.5**	**18.9**
2	AGIP Gas Plant OB/OB	Min	0	0	0	0	0	36	38	34
		Max	1.1	1	1.09	1.1	436.19	84	82	74
		Mean	**0.18**	**0.09**	**0.55**	**0.42**	**190.8**	**69.4**	**66.8**	**49.9**
		Std	**0.42**	**0.03**	**0.57**	**0.3**	**147.9**	**15.9**	**14.6**	**15.6**
3	Rivers State Gas Turbine	Min	0	N/D	0	N/D	0	57	36	28
		Max	1.1		3.27		109.05	81	64	45
		Mean	**0.18**		**1.27**		**38.17**	**69.6**	**49.6**	**36.1**
		Std	**0.42**		**1.22**		**52.7**	**8.6**	**9.9**	**4.9**
4	Omoku Town	Min	0	0	0	0	54.5	51	45	26
		Max	0.11	0.1	0.22	0.11	327.14	72	61	42
		Mean	**0.08**	**0.05**	**0.08**	**0.03**	**149.9**	**64.8**	**54**	**36**
		Std	**0.05**	**0.06**	**1.0**	**0.05**	**120.9**	**9.5**	**7.1**	**7.0**
5	Obrikom Town	Min	N/D	N/D	0	N/D	0	49	42	21
		Max			0.11		109.5	61	57	42
		Mean			**0.05**		**54.5**	**53.3**	**50.5**	**32**
		Std			**0.06**		**44.5**	**3.7**	**6.9**	**9.3**
6	Ebocha Town	Min	0	0	0		54.5	67	59	28
		Max	0.11	0.1	0.11	N/D	109.5	72	71	40
		Mean	**0.03**	**0.03**	**0.07**		**68.2**	**69.3**	**64**	**35.5**
		Std	**0.05**	**0.05**	**0.05**		**27.3**	**2.2**	**5.4**	**5.0**
7	Control (5Km)	Min	0	N/D	N/D	0	0	41	43	17
		Max	0.1			0.1	0.5	83	64	35
		Mean	**0.01**			**0.01**	**0.04**	**67.2**	**50**	**21**
		Std	**0.02**			**0.001**	**0.01**	**7.6**	**3.8**	**2.1**
	FMEnv limit		**0.1**	**0.06**	**10**	**-**		**250**	**-**	**-**
	NAAQS limit		**0.14**	**0.1**	**9**	**-**	**-**	**200**	**150**	**35**

N/D = Not detected; Std = Standard deviation

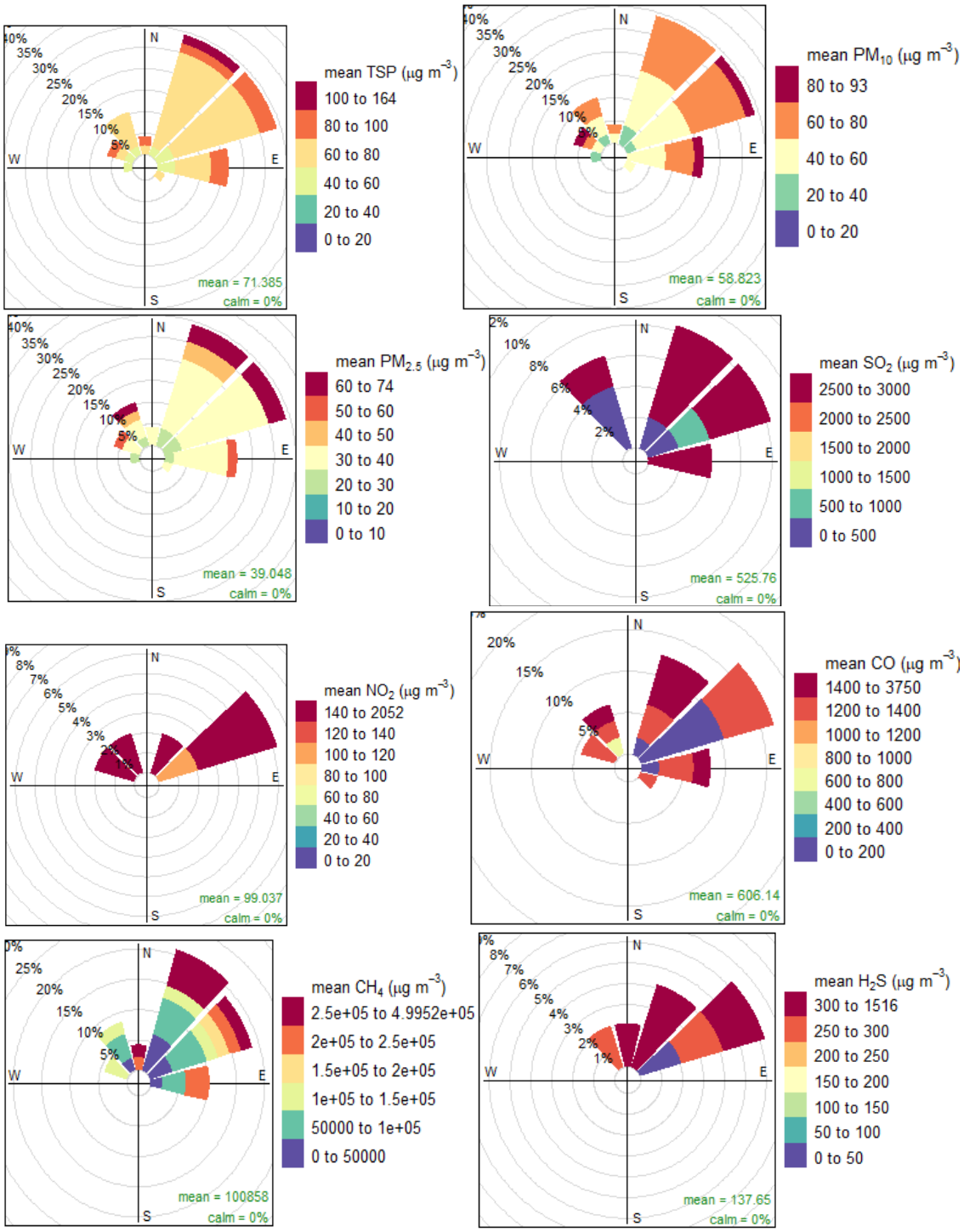

Fig. 2. Pollution roses for study area

Table 4 indicated pollutants exceedance factors for each location. Computed exceedance factors (Table 4) showed that the area is polluted mostly by SO_2 and $PM_{2.5}$. Pollutants concentrations were mainly high in the facility areas and less in the community areas. The high concentrations of pollutants observed in the area may possibly be attributed to stationary source emissions, to gas

flaring and fugitive emissions within the oil and gas facilities. This finding corroborated study conducted in the area by Nkwocha and Pat-Mbonu [2]. The study revealed that the oil and gas the facilities are major sources air pollution in the area. The study further showed that concentration of $PM_{2.5}$ does not meet the ambient air primary standards necessary to protect human health in the host communities.

Table 3. Statistics of meteorological parameters and noise levels in the study area

S/n	Location/Parameter		Wind Speed (m/s)	Temperature (°C)	Relative Humidity (%)	Noise (dB A)
1	AGIP Plant Ebocha	Min	0.8	30.9	64.9	65.7
		Max	2.6	33.4	77.4	80.1
		Mean	**1.2**	**32.4**	**70.1**	**76.0**
2	AGIP Gas Plant OB/OB	Min	1.1	29.9	75.2	70.5
		Max	2.8	31.2	79.4	74.6
		Mean	**1.7**	**30.4**	**76.8**	**71.3**
3	Rivers State Gas Turbine	Min	0.4	30.1	74.2	67.9
		Max	2.4	32.5	79.4	72.1
		Mean	**1.2**	**31.1**	**77.5**	**70.7**
4	Omoku Town	Min	1.0	30.9	69.8	58.0
		Max	1.4	32.1	75.2	68.0
		Mean	**1.2**	**31.5**	**74.0**	**65.3**
5	Obrikom Town	Min	0.8	31.1	64.8	57.0
		Max	2.3	32.2	78.2	69.0
		Mean	**1.7**	**31.7**	**73.2**	**64.5**
6	Ebocha Town	Min	0.8	31.5	70.4	57.0
		Max	1.6	32.2	77.9	68.0
		Mean	**1.1**	**31.9**	**75.4**	**63.4**
7	Control(5Km)	Min	1.0	31.1	70.6	47.6
		Max	1.5	32.0	75.8	52.9
		Mean	**1.3**	**31.6**	**72.8**	**49.3**
	FMEnv limit					**90**

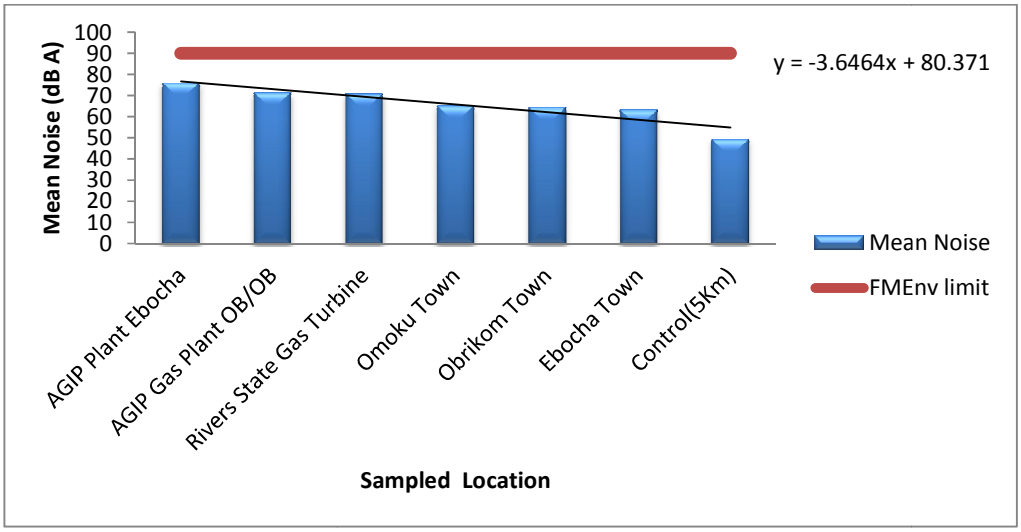

Fig. 3. Mean noise level in the study area

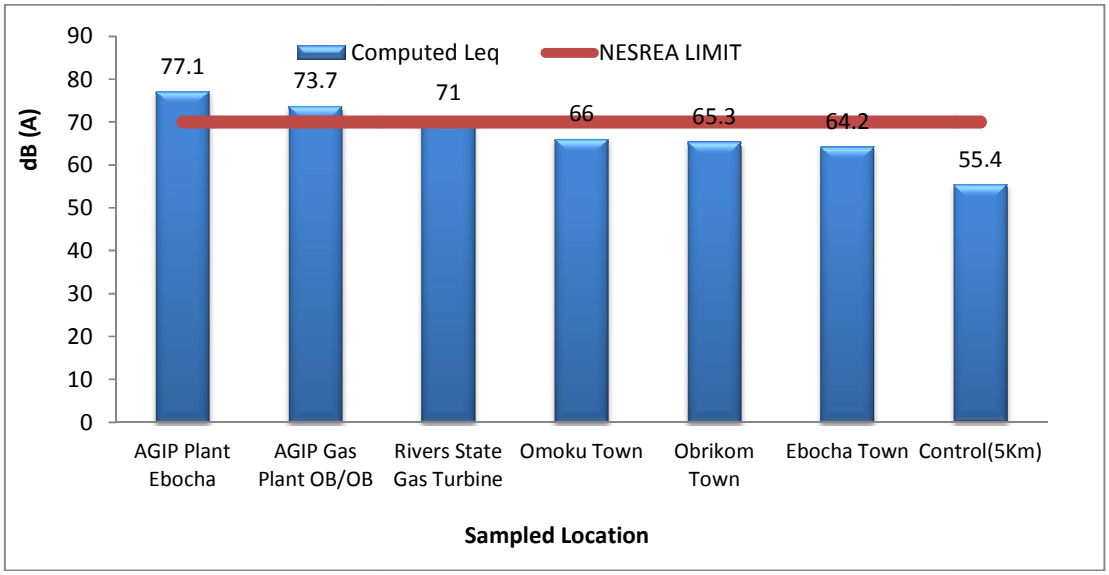

Fig. 4. Computed Leq in comparison with NESREA limit

Table 4. Computed exceedance factors for each sampled location

Parameter/ Facility Location	SO_2	NO_2	CO	TSP	PM_{10}	$PM_{2.5}$
AGIP Plant Ebocha	2.6 (C)	0.9 (M)	0.0	0.4 (L)	0.5 (M)	1.8 (C)
AGIP Gas Plant OB/OB	1.3 (H)	0.9 (L)	0.1(L)	0.3 (L)	0.5 (M)	1.4 (H)
Rivers State Gas Turbine	1.3 (H)	0.0	0.1 (L)	0.3 (L)	0.3 (L)	1.0 (H)
Omoku Town	0.6 (M)	0.5 (M)	0.0	0.3 (L)	0.4 (L)	1.0 (H)
Obrikom Town	0.0	0.0	0.0	0.3 (L)	0.3 (L)	0.9 (M)
Ebocha Town	0.2 (L)	0.3 (L)	0.0	0.3 (L)	0.4 (L)	1.0 (H)
Control (5 Km)	0.1 (L)	0.0	0.0	0.2 (L)	0.3 (L)	0.7 (M)

C = Critical pollution; H = High pollution; M = Moderate pollution; L = Low pollution

Results also indicated that concentrations of methane hydrocarbon are very high in the study area. Methane gas has been associated with oil and gas production and forms between 70% and 90% of natural gas [20]. Exposure to high concentration of methane hydrocarbon may result in acute and/or chronic health effects among host community [9]. Computed API (Table 5) indicated moderate to severe pollution at the facility areas that may seriously affect the health of people around the facility area. Workers might be exposed to high concentrations of air pollutants with significant health consequence. The host communities may experience light to moderate pollution that may pose hazards to human health. Cases of Asthma, respiratory and cardiovascular diseases are envisaged among the habitats of the communities. Therefore, the conduct of the epidemiological study in all the host communities has become necessary to assess and determine the health effects of continuous exposure air pollution from oil and gas facilities in the area.

Table 5. Computed air pollution indices for each sampled location

Parameter/Facility location	API values	API rating	Level of health concern
AGIP Plant Ebocha	117.75	Severe pollution	Severe and unhealthy
AGIP Gas Plant OB/OB	84.21	Heavy pollution	Unhealthy
Rivers State Gas Turbine	57.25	Moderate pollution	Unsatisfactory
Omoku Town	51.06	Moderate pollution	Unsatisfactory
Obrikom Town	25.14	Light pollution	Acceptable
Ebocha Town	38.49	Light pollution	Acceptable
Control (5 Km)	22.01	Clear air	Good

Noise levels measured in all monitoring locations in the study area were below FMEnv exposure limit of 90dB (A). However, computed Leq exceeded NESREA limit at AGIP plant center Ebocha by 10.1%; exceeded in AGIP Gas Plant OB/OB by 5.3%; and exceeded in Rivers State Gas Turbine by 1.4%. Computed noise Leq values in host communities (Omoku, Obrikom and Ebocha towns) are below NESREA limit. The result is consistent with similar result obtained in the area by Alao and Avwiri [21].

5. CONCLUSION

A study on the assessment of ambient air quality and noise levels around selected oil and gas facilities has been carried out. The study concluded that the oil and gas facilities impact negatively on the air environment of the host communities. Long-term health effects due to continuous daily exposure of the host communities are envisaged. Therefore, epidemiological health impact assessment should be conducted in all the host communities in to determine the level of impacts on the people.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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