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Research Article

INVESTIGATION OF THE LEVEL OF AIR POLLUTION CAUSED BY CRUDE OIL PRODUCTION AND ITS HEALTH EFFECTS ON THE INHABITANTS OF THE PRODUCTION AREA

Ntesat U.B, *Nweke Bright, Didi Ikechukwu Chima and Miebaka Josiah Ayotamuno

Department of Agricultural and Environmental, Rivers State University NkpoluOroworukwo, PMB 5080, Port Harcourt, Nigeria

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Abstract

The study investigated air pollution level triggered by production of crude oil atOgbogu. Obagi, Obite communities in Ogba/Egbema/Ndoni Local Government Area of Rivers State for three months, while Ahoada serve as control (S). The three communities are the major oil and gas hub and have oil and gas facilities such as the Ogbogu flow station, Ogbogu cluster, Obagi Flare pit, Obite gas plant metering station, several kilometres of pipes and numerous oil wellheads. Gaseous pollutants and particulate matter were determined in-situ using digital handheld gas monitors with electrochemical sensors. The result for Nitrogen, show that NO_2 recorded (0.5ppm, 0.89ppm, 0.72ppm and 0.19ppm) at Ogbogu. Obagi, Obite and Ahoada which far exceeds the permissible value of the US National Ambient Air Concentration of 0.053µg/m3 as well as control. Similarly, SO_2, CO, PM_{10} and $PM_{2.5}$followed same trend. The concentrations of NO_2, SO_2, CO, $PM_{2.5}$and PM_{10} exceeded WHO, NAAQS and FMEnv recommended limits especially at Obite, while Ogbogu and Obagi sampled locations remained within the target value of WHO, NAAQS and FMEnv (10ppm and 9ppm),The highest concentration of PM_{10} was recorded at Obite axis. The study concluded that the communities were exposed to moderate to high concentrations of gaseous and particulate matter pollutants which may adversely affect the health of the people under prolonged exposure. The air quality at Obite was also poor. The control station (Ahoada) generally showed significantly ($p<0.5$) lower level of gaseous pollutants and particulates than the study areas. The study, therefore recommended that the air quality in the area should be regularly monitored and gas flaring by oil industries and other practice by the residents should also be monitored. Health impact assessment should also be conducted regularly in the communities to determine the level of impacts of the pollutants.

Keywords: Air quality, Gaseous pollutants, particulate matter, Obagi, Obite, Ogbogu and Ahoada.

INTRODUCTION

Air pollution has been a major cause for worry on a global scale due to its detrimental impact on plants, animals, the environment, and human health. According to [11], rising population, industrialization, traffic congestion, and space heating are all contributing factors to the on-going increase in air pollution emissions. Gas flaring due crude oil exploration in Ogba / Egbema/Ndoni Local Government Area and Niger Delta region at large has recently raised concerns about gaseous hydrocarbon emission, which have prompted urgent attention. In addition to several petroleum explorations and exploitations, the region's ambient air quality has also been impacted by other crude oil production activities like transportation, gas flaring, and venting [5]. One of the significant air emissions is referred to as hazardous air pollutant (HAPS), which may also be known as volatile organic compounds (VOCS). They are classified as organic chemical compounds that quickly evaporate at standard pressure and temperature levels. As a result of the burning fuels like coal and gasoline, benzene is present in the surrounding air. In Unleaded fuels, benzene is frequently used as a lead replacement allowing for smoother operation of gasoline engines [10]. [13] defined air pollution as "the presence of contaminants or pollutant substances in the air that interfere with human health or welfare or produce other harmful environmental effects". Air quality and air pollution study is however complex, due to the multitude and extreme variability of the pollutants, their sources, classification, and impacts.

Corresponding Author:** ***Nweke Bright,
Department of Agricultural and Environmental, Rivers State University NkpoluOroworukwo, PMB 5080, Port Harcourt, Nigeria.

In term of environmental danger, air pollution ranks first, with 3 million annual fatalities being linked to exposure to outdoor pollution (USEPA, 2016). Only in 2012, Outdoor air pollution was a factor in 6.5 million deaths nationwide, or 11.6% of all fatalities [8]. The little Green Data book 2015 Data for Nigeria's air quality status indicates that 94% of the population is exposed to air pollution with $PM_{2.5}$ levels that are above the WHO standard benchmark. This percentage is higher than the 72% average for Sub-Saharan Africa. Additionally, the poor are disproportionately impacted [5]. [1] found that the levels of all the criterion air pollutants in Egi communities (Ogbogu, Obagi and Obite) were significantly higher than those of WHO specifications in 5-year analysis (2003-2007) epidemiological data. They concluded that the state's air related morbidities and fatalities are attributable to air pollution [15]. Residents of Egi communities comprising of (Ogbogu, Obagi and Obite) and its surroundings have been impacted most recently by soot borne plumes because of artisanry illegal crude oil refining which hit an all-time high in place November 2016. Some locals who were impacted by the situation said that the Government was slow to curb the situation until people started sharing their worries on social media [9].Air pollution also, is defined as all destructive effect of any source which contributes to the pollution of the atmosphere and/or deterioration of the ecosystem. Air pollution occurs during production of crude oil and would mostly result from long term habitant change within the operating communities [9]. In recent years, most countries in Africa have experienced notable economic growth that led to increased motorization, urbanization, and energy use [5, 4]. Air pollution caused from exhaust motor vehicle has become a major cause of worldwide public concern. [7]in their study noted that the rapid increase in motor vehicular traffic and its associated gaseous pollutants in the urban areas, have caused a sharp increase in the respiratory allergies. According to [1], vehicular emission has become one of the most complicated environmental challenges. In fact, cities which depends on many automobiles for most of their daily transportation and offering few efficient public mass transportation modes, may suffer from effect of automobile emission. It is a well-known fact that motor engine will produce only water and carbon dioxide in the process of fuel combustion [2]. In Nigeria, much attention is given to pollution in oil industries and general industrial pollution with little reference to pollution caused by automobile worldwide, air pollution exposure is a public health issue associated with various health effects, including cardiovascular and respiratory disease, cancer, pregnancy, complications, and adverse birth outcomes [6]. Air pollution exposure can be considered a function of the concentration of pollutants in a microenvironment and the time spent by the individuals in that microenvironment [3]. The aim of this study was to determine the major sources, the level of concentration of the particulate matter and the comparison of the concentration of the selected areas in line with the established standard threshold concentration.

Description of the Study Area

The study was carried out at Egi clan made up of three communities (Ogbogu, Obagi and obite) in Ogba/Egbema/ Ndoni Local Government Area of Rivers State, Nigeria. The three communities are the major oil and gas hub. The selected communities are the highest oil producing communities and have oil and gas facilities situated in the communities such as the Ogbogu flow station, Ogbogu cluster, Obagi Flare pit, Obite gas plant, metering station, several kilometres of pipes and numerous oil wellheads are interconnected in the study area. Numerous operations such as handling of general cargo, oil-well equipment, containerized cargoes, and other logistics services are carried out in the Egi. The communities cover an area of 2,538.115 hectares (Oweisana*et al*., 2021). Towns are located approximately on latitude and longitude as shown in Table1, while Ahoada is located on latitude 4° 51' 29.16" N longitude 6° 55' 15.24" E. They are all situated in Rivers State, southern Nigeria in the core of the Niger Delta region which covers an area of about 21,110 square kilometres[13]. shows the map of the study area and as well as location coordinate is in Table 1 below:

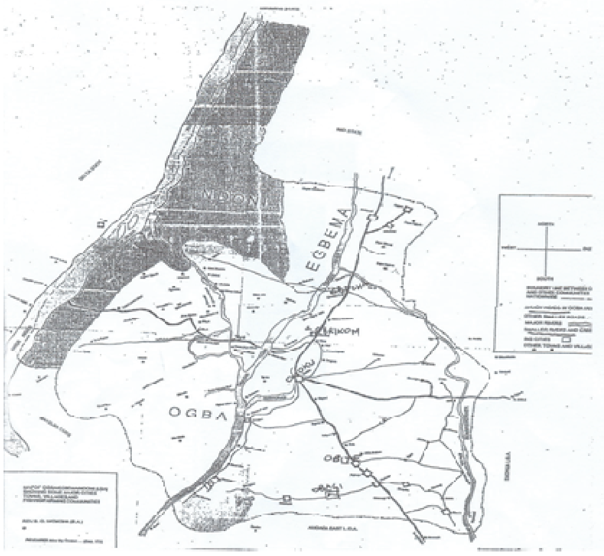

Figure1. Map of Ogba/Egbema/Ndoni local Government Area of Rivers State

Table 1. Location Coordinates of the Study Area

Area	Longitude	Latitude
	Mining Locations	
Obagi I	5°14'12.6294''N	006°38'2.69412''E
Obagi II	5°14'33.83988''N	006°37'12.00612''E
Obite I	5°14'48.33636''N	006°39'31.4316''E
Obite II	5°14'58.83''N	006°39'44.610112''E
Ogbogu I	5°23'48.33636''N	006°39'3.4316''E
Ogbogu II	5°23'27.078''N	006°39'53.74012''E

Equipment Used

Hand-held mobile Aeroqual gas monitors; series 500 was used to detect the presence and precise quantity of the greenhouse gases and some particulate matter.

Sampling Procedure

In-situ air pollutants were measured in the atmosphere within the study area. The sampling was conducted for three days within the Egi oil and gas stations and its environment including Ahoada axis as the control. Parameters of Carbon monoxide (CO), Nitrogen dioxide (NO_2), Particulate matter ($PM_{2.5}$ and PM_{10}), and Sulphur dioxides (SO_2) were collected. The data were acquired at purposefully selected locations (Ogbogu cluster, Obagi Flare pit, Obite gas plant and Ahoada region) using hand-held Aeroqual Gas analyzer, series 500 and a hand-held Germin-300 Global Positioning System (GPS) device to record theGPS coordinates of the sampling points for geospatial interpolation analysis using Arc Map 10.0

Statistical Data Analysis

For analytical purposes, we consider the sample measurements in the Ogbogu cluster, Obagi Flare pit, Obite gas plant sites as the test group and that obtained at Ahoada as the control. The object tested for significant differences of mean concentration ($\mu g{\cdot}m^3$) of pollutants in the two groups-test and control. Excel spreadsheet was used to calculate the mean values for each air contaminant.

RESULTS AND DISCUSSION

Table 2-5displayed the results of the field sampling and monitoring in the selected study locations. NOx, SOx, H_2S, CO, $PM_{2.5}$, PM_{10} and noiseare the parameters of concern as indicated below in Table.2 to 5 sampled at the respective sampling locations; In addition to the listed parameters, the meteorological factors were also included in Tables7 and their relative approved standards (FMEnv and NAAQS. Table 6 illustrates the mean of all concentrations of the sampled parameters.

Discussion

Table 5 shows the mean concentration of NOx to be at a disturbing rate of 0.5ppm (Ogbogu), 0.89ppm (Obagi), 0.72ppm (Obite) and 0.19ppm (Control), which is against NAAQS and FMEnv that are 0.053ppm and 0.06ppm and SOx concentration was 0.36ppm at (Ogbogu), 1.26ppm at (Obagi), 1.19ppm (Obite) and 0.28ppm (Control), respectively as against the permissible limits of 0.03ppm (NAAQS) and 0.01ppm (FMEnv). The health implications of these abnormal thresholds according to FMEnv and NAAQS include increased respiratory diseases, eye irritation, breathing difficulties, damage to plants and odor.

Table 2. Result of ambient air quality monitoring at ogbogu

		Coordinates from Google Earth						
Time (hr)	NO_2 (ppm)	SO_2 (ppm)	H_2S (ppm)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Noise dB(A)	W speed (m/s)
9	0	0.25	0	0.25	50	99	43.8	0.5
10	0	0.75	0	5	222.5	239	63.25	1.27
11	0.25	1	0	6.25	208	416.5	66.95	2.61
12	1	1.12	0.25	6.16	225	336.5	81.26	2.79
13	0.75	1.87	0.38	6.88	175	102.5	80.88	1.7
14	1	2	0.25	7.22	63	81	85	3.09
15	0.75	2	0.5	6.5	55.5	113.5	67.15	3.63
16	0.25	1.87	1	2.17	18	108.5	76.25	2.04
Range	0.00-1.00	0.25-2.00	0.00-1.00	0.25-7.22	18.0-225	81-416.5	43.81.26	0.50-85.0
Mean	0.5±0.14	1.36±0.30	0.30±0.18	5.05±8.49	127±9648	187±24178	71±272	2.2±1.51
FEMn	0.06	0.01	N/A	10	N/A	N/A		
NAAQS	0.1	0.14	N/A	9	35	150		

Table 3. Result of ambient air quality monitoring at obagi

		Coordinates from Google Earth						
Time (hr)	$N0_X$ (ppm)	$S0_X$ (ppm)	H_2S (ppm)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} (μgm^3)	Noise dB(A)	WdSpeed (m/s)
9.3	0	0.25	0.5	0.25	93	143.78	38.81	0.65
10.3	0	0.75	1	2.5	50	316.4	68.04	1.54
11.3	0.75	1	1.5	6.25	67	339.22	63.02	2.85
12.3	1.25	1.25	1.75	6.17	61.5	216.6	78.7	2.98
13.3	1.15	1.65	1	6.15	78	83.5	79.82	1.8
14.3	1.5	1.4	0.75	6.89	58.5	78.67	70.41	3.1
15.3	1.55	2	1.43	7.22	58	127.72	56.81	3.76
16.3	0.95	1.75	1.54	6.52	55.5	114.94	66.69	2.41
Range	0.0-1.55	0.25-1.75	0.5-1.75	0.25-7.22	50-93	83.5-339	38.8-79.82	0.65-3.76
Mean	0.89±0.5	1.26±0.47	1.18±0.32	5.24±7.39	65±2050	178±12979	65.3±320	2.88±1.5
FEMn	0.06	0.01	N/A	10	N/A	N/A		
NAAQS	0.1	0.14	N/A	9	35	150		

Table 4. Result of ambient air quality monitoring at obite

		Coordinate from Google Earth						
Time (hr)	$N0_X$ (ppm)	$S0_X$ (ppm)	H_2S (ppm)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Noise dB(A)	WdSpeed (m/s)
9.10	0	0	0	3.5	115.25	99.44	34.1	1.4
10.10	0	1	0	7.5	312.92	236.99	71.65	2.15
11.10	0.25	1.25	0.5	17	192.57	570.65	83.45	2.23
12.10	1	1.5	1	27.34	107.4	751.6	85.74	2.13
13.10	1.25	2	0.5	21.09	393.75	819.5	84.13	2.08
14.10	1	1.5	1.5	11.37	399.65	810	89.35	2.08
15.10	1.25	1.25	1	9.94	162.9	431.75	88.93	2.62
16.10	1	1	0.5	13.08	110.42	165.45	86.17	2.91
Range	0.0-1.25	0.0-1.50	0.0-1.50	3.5-27.34	107-400	99-820	34-89	1.4-2.91
Mean	0.72±0.35	1.19±0.47	0.63±0.33	13.9±69.5	224±29318	485.7±100896	77.9±59.7	2.2±0.5
FEMn	0.06	0.01	N/A	10	N/A	N/A		
NAAQS	0.1	0.14	N/A	9	35	150		

Table 5. Result of ambient air quality monitoring at ahoada (control)

		Coordinate from Google Earth						
Time (hr)	$N0_X$ (ppm)	$S0_X$ (ppm)	H_2S (ppm)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Noise dB(A)	WdSpeed (m/s)
9:50	0	0.25	0	0	45.5	232	17.5	0.25
10:50	0	0	0	0	96	214	42.06	0.77
11:50	0.25	0.5	0	0.5	75	268.5	59.09	1.36
12:50	0	0	0.25	0.02	68.5	221	73.14	1.69
13:50	0.5	1	0	1	77	90	63.93	1.85
14:50	0.25	0.25	1	0.01	73.1	80.25	44.59	1.39
15:50	0.5	0	0.25	0	67.35	71.1	62.63	1.11
16:50	0	0.25	0.5	0.012	50	63.84	68.96	1.22
Range	0.0-0.25	0.0-1.0	0.0-1.0	0.0-1.0	45.5-96.0	71.1-268.5	17.5-73.14	0.25-1.85
Mean	0.19±0.06	0.28±0.15	0.25±0.14	0.19±0.54	59.4±478	155.1±13284	54±272	1.21±6.33
FEMn	0.06	0.01	N/A	10	N/A	N/A		
NAAQS	0.1	0.14	N/A	9	35	150		

Table 6. Mean concentrations at various sampling points

Parameters	Control	Ogbogu	Obagi	Obite	FMEnv	NAAQS
NO_X (ppm)	0.19	0.5	0.89	0.72	0.06	0.1
SO_X (ppm)	0.28	1.36	1.26	1.19	0.01	0.14
CO (PPm)	0.19	5.05	5.24	13.85	10	9
$PM_{2.5}$(μg/m^3)	59.42	127.13	65.19	224.36	NA	35
PM_{10}(μg/m^3)	155.09	187.06	177.6	485.67	NA	150
Noise dB (A)	53.99	70.57	65.29	77.94		
WdSpd (m/s)	1.21	2.2	2.4	2.2		
Temp (0^C)	28.62	28.32	28.93	29.49		
Rel.Hum (%)	72.76	70.52	71.64	73.51		
H_2S (ppm)	0.25	0.3	1.18	0.63		

Table 7. Result of national ambient air quality standards (NAAQS)

Pollutant	Standard Value	Standard Type
Carbon Monoxide (CO)		
8-h Average	9 ppm (10mg/m3)	Primary
1-h Average	35 ppm (40mg/m3)	Primary
Nitrogen dioxide (No2)		
Annual arithmetic mean	0.053 ppm (100μg/m3)	Primary and Secondary
Ozone (O3)		
1-h Average	0.12 ppm (235μg/m3)	Primary and Secondary
8-h Average	0.08 ppm (157μg/m3)	Primary and Secondary
Particulate (PM 10)		
Annual arithmetic mean	50μg/m3	Primary and Secondary
24-h Average	150μg/m3	Primary and Secondary
Particulate (PM 2.5)		
Annual arithmetic mean	15μg/m3	Primary and Secondary
24-h Average	65μg/m3	Primary and Secondary
Sulful dioxide (So2)		
Annual arithmetic mean	0.03 ppm (80μg/m3)	Primary
24-h Average	0.14 ppm (365μg/m3)	Primary
3-h Average	0.50 ppm (1300μg/m3)	Secondary

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This corroborated the study of [10] that carried out research on evaluation of air quality profile of selected areas in Obio-Akpor local government area and its environment of Rivers State, Nigeria. The outcome of their study revealed that the concentrations of these sampled parameters were above the FMEnv and NAAQS limits and may be liable to the severe public health consequences [13]. Similarly, CO recorded 13.85ppm only at Obite while Ogbogu and Obagi sampled locations remained within the target value of NAAQS and FMEnv (10ppm and 9ppm), respectively. The implication of high CO threshold to persons with long exposure to this air quality conditions include nervous, pulmonary systems breakdown and chronic cardiovascular. In the same light, the mean concentration of the particulate matter ($PM_{2.5}$) for the four (4) stations were 127.13μg/m^3 (Ogbogu), 65.19μg/m^3 (Obagi), 224.36μg/m^3 (Obite), and control 59.42μg/m^3, respectively. The results for PM_{10} for the four (4) stations were 187.06μg/m^3 (Ogbogu), 177.6μg/m^3 (Obagi), 485.67μg/m^3 (Obite) and control 155.09μg/m^3, respectively; $PM_{2.5}$ and PM_{10} exceeded the NAAQS recommended level of 35μg/m^3 and 150μg/m^3, respectively. It is imperative to understand that $PM_{2.5}$ and PM_{10} was necessary in this study because it was among the concerned pollutants. The highest concentration of PM_{10} was recorded at Obite axis. This was not unconnected with the huge crude oil exploration and traffic activities going on around the area, coupled with the Kpor-fire activities. The implication of these high particulate matter thresholds; indicated that long exposure may result to health challenging issues such as eye and throat irritation which may aggravate lung illnesses, accelerate chemical reactions and obscured vision. The lowest recorded mean concentrations were at road the control station, where there were fewer commercial activities. However, the noise index level was at a high level of 77.94db as evaluated using the standard model [15] and this may result in distraction and gradual deafening which may begin to occur with extended long exposure to person(s) who constantly spend close to six (6) to eight (8) hours on daily bases at the selected sampled areas considering that it's a densely populated and a high business environment [14].

Conclusion

The analysis results of the gaseous pollutants showed that nitrogen oxide (NOx) was 0.5ppm, 0.89ppm, 0.72ppm, and 0.19ppm, respectively which exceeded the limits of FMEnv (0.06ppm) and NAAQS (0.053ppm) standard. Sulphur oxide (Sox) was 1.36ppm, 1.26ppm, 1.19ppm and 0.28ppm, respectively which also exceeded the permissible limits of FMEnv (0.01ppm) and NAAQS (0.03ppm). The analysis proved that CO exceeded acceptable limits only at the Obite axis with a mean concentration of 13.85ppm but remaining stable at all Ogbogu and Obagi sampling locations. The particulate matters of $PM_{2.5}$ and PM_{10} at Ogbogu had a threshold of (127.13μg/m^3 and 187.06μg/m^3), Obagi (65.19μg/m^3 and 177.6μg/m^3), Obite (224.36μg/m$^{3)}$ and 485.67μg/m^3) and Ahoada (59.42μg/m^3 and 155.09μg/m^3). Investigation showed that most of the parameters analyzed within Ogbogu, Obagi and Obite contributed to the levels of air pollution from these locations. The high mean concentrations of Nitrogen oxide (NOx), Sulphur oxide and Carbon monoxide (CO) were because of crude oil exploration, Kpor-fire activities and, burning of fossil fuel from various carbon driven engines. The concentrations of these sampled parameters were above the FMEnv and NAAQS limits. This is an indication that the public may suffer health risk in study areas.

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Competing Interests

Authors have declared that there is no conflicting interest associated during research.

REFERENCES

Aigberua. A. O., Ekubo, A.T., Inergite, A. K. & Leah, S.C. (2017). Assessment of Some Selected Heavy Metal and their Pollution Indices in an Oil Spill Contaminated Soil in the Niger Delta: A Case Study of Rumuolukwu Community. *Biotechnological Research,* 3(1), 11-19.

Benaissa, F., Bendahmane, I., Bourfis, N., Aoulaiche, O., &Alkama, R. (2019). Bioindication of Urban Air Polycyclic Aromatic Hydrocarbons Using Petunia Hybrida. *Civil Engineering Journal*, *5*(6), 1305–1313. 10.28991/cej-2019-03091333.

Borowski, P. F. (2020). New Technologies and Innovative Solutions in the Development Strategies of Energy Enterprises. *HighTech and Innovation Journal*. DOI: 10.28991/HIJ-2020-01-02-01.

Emam, E.A. (2015). Gas Flaring in Industry: An Overview of Petroleum and Coal. 57(5), 532-555.

Edokpolo, B., Qiming, J. Y., & Connell, D. (2015). Health risk assessment for exposure to Benzene in petroleum refinery environments. *International Journal of Research and Public Health*, *12*(1), 595–610. 10.3390/ ijerph120100595.

Health Effect Institute (2010). Traffic Related Air Pollution: A Critical Review of the Literature ON Emission. Health Effects of Outdoor Air Pollution.

Lawson, A.O., Imevbore, A.M. A., &Fanimokum, V.O. (2016). The Effect of Waste Gas Flares on the Surrounding Cassava Plantation in the Niger Delta Region of Nigeria. University of Ife, Ile-Ife, Nigeria, 6^{th} Symposium. Pp. 235-242.

Nweke. B. Okogbule-Wonodi. A. &, Ekemube. R. A. (2023). Combine Effect of Dry and Decomposed Raffia Palm in the Bioremediation of Oil-based Drill Cutting. *International Journal of Composite Materials and Matrices.* ISSN: 9(1), P (1- 9).

Odekunle, (2017). Air Pollutant Emissions by Anthropogenic Combustion Processes.

Onwuegbuchunam, D. E, Egelu, F., Aponjolosun, M.O. &Okeke, K.O. (2021).Measuring Traffic Induced Air Pollution in Onne Port's Environment.*Open Journal of Air Pollution*, 10, 63-75.

Ozabor, F. &Obisesan, A. (2015). Gas Flaring: Impact on Temperature, Agriculture and the People of Ededei in Delta State, Nigeria. *Journal of Sustainable Society,* 4(2), 5-12.

Osaiyuwu, R.C.,&Ugbebor, J.N. (2019).Air Quality Assessment of Some Oil Facilities Host Communities in Rivers State. *Nigerian Journal of Technology*, 38(1), 242 – 252

Oweisana, I., Gobo, A. E., Daka, E. R., &Ideriah, T. J. K. (2021). Evaluation of Ambient Air Quality in Obrikom and Omoku Communities in Rivers State Nigeria. *Journal of Research in Environmental and Earth Sciences,* 7(4), 18-39.

Purohita, P.,Amanna, M.,Kiesewettera, G.R.P., Chaturvedi, V.,Dholakiab, H.H.,Kotib, P. N.,Klimonta, Z.et al. (2019).Mitigation pathways towards national ambient air quality standards in India. *Journal of Environment International*, 133, 1-16.

Umunnakwe, J. E. & Aharanwa, B. C. (2015). Post Impact Studies of Hydrocarbon Leakage into GroundwaterWells of Egita/Obite Community, Rivers State Nigeria. *Journal of Environment and Earth Science*, 5(2),67-79.

United State Environmental Protection Agency (USEPA) (2016). Ambient Air Sampling. U.S. Environmental Protection Agency Science and Ecosystems Support Division Athens, Georgia: Operating Procedure.

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