Ambient Air Quality Assessment Of Communities Around Gas Flare Stack –Olomoro Oleh Flow Station In Isoko South, Nigeria.

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Abstract

Studies show that a significant percentage of the global population inhale air with contaminants that exceed WHO limits, with the population in the low and middle income countries being the worst hit. This study was designed to monitor the ambient air quality at graduated-distances around the gas flare stack (GFC) at Olomoro-Oleh flow station for air contaminants like CO, NO_2, O_3, $PM_{2.5}$, PM_{10}, SO_2, and VOCs for a 12 months duration study period, comprising six (6) weeks in each of rainy and dry season. The samples were collected in triplicates at locations 0.1km, 0.2km, 0.3km and 1km from the (GFS) at Olomoro -Oleh. The concentrations of gaseous pollutants in air were determined using Aeroqual Monitor S500 for CO, NO_2, O_3, SO_2, and VOCs, while that of particulate matter ($PM_{2.5}$, and PM_{10}) was measured using AEROCET 531S mass monitor /particle counter. The mean concentrations of air pollutants obtained for six (6) weeks monitoring of the dry and rainy seasons in 2021-2022 showed, carbon dioxide (CO_x) levels at 0.1 km, 0.2 km and 0.3 km of (26.05 ±0.82, 18.50 ±1.63; 15.75 ±1.63) mg/m^3 for dry and (15.20 ±1.00, 7.90 ±0.56; and 3.30 ±0.22) mg/m^3 for the wet season of the year evaluated. The 1km sample location showed a carbon- concentration range of (3.75 ± 0.82 mg/m^3 and 1.07 ± 0.06 mg/m^3) for the dry and wet seasons respectively. The dry season concentrations of NO_x was (30.00km,21.00km, 24.00km and 10.00km for km 0.1, 0.2, 0.3 and 1.0km respectively) while the values for the rainy season was 20km, 20km, 10km and 10 km for km 0.1, 0.2, 0.3 and 1.0 respectively. The dry season levels of O_3 for km 0.1 and 0.2 were 80ug/m3 and 64ug/m3 while that of the rainy season was 65ug/m3 and 59ug/m3 for km 0.1 and 0.2 respectively, all within the WHO allowable limits. The mean SO_x values for dry and rainy seasons in locations 0.1km, 0.2km, 0.3km was (12.50ug/m3; 9.55ug/m3; 5ug/m3 and 9.50ug/m3; 7.50ug/m3; 3.50ug/m3 respectively. The concentrations of SO_x for the 1km locations of both dry and rainy seasons were below the equipment detection limit (ND). The concentrations of particulate matter ($PM_{2.5}$, PM_{10}) and VOCs (at km 0.1) were above the WHO limits at all the locations monitored. This study revealed the presence of significant ($P \leq 0.05$) concentrations of air contaminants in locations closer to the gas flare stack at Olomoro- Oleh flow station. This study therefore intends to promote responsible and routine monitoring of air quality by stakeholders of inhabited communities around flow stations in the Niger Delta region as an index of health impact on the community.

Keywords: Ambient air quality, Assessment, Gas Flare Stack, Olomoro-Oleh, Flow station, Isoko South

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Introduction

The detrimental effects of air pollutants are of global concern. Air pollution from crude oil exploration and exploitation activities is one of the major problems ravaging the Niger Delta region of Nigeria. This is due to the abundance of upstream, midstream, downstream, and a wide range of related anthropogenic activities in this region. Report shows that settlements around the Liquefied Natural Gas Company (LNG) in a certain part of the Niger Delta region had elevated levels of toxic metallic pollutants above WHO limits occasioned by flaring and emissions (Ede *et al.*, 2011). There are various studies showing the impact of flared gases on ambient air (Pope *et al.*, 2006; Bravo *et al.*, 2016;

Soni *et al.*, 2018; Schleicher *et al.*, 2019; Zhang *et al.*, 2019). Many of the drivers of air pollution are also directly and indirectly linked to greenhouse gas emissions. For example, carbon-based air contaminants like CO and CO_2 besides its effect on the availability of oxygen to the lungs of people, also contribute to an increase in the temperature of earth leading to climate change and its attendant consequences. Besides the aforementioned environmental impacts, air pollutants like particulate matter can also predispose the immediately exposed- population (IEP) to numerous respiratory health risks like asthma, allergies, and worsened bronchitis. WHO (2019) reports that ambient air pollution and household air pollution are associated with 6.7 million premature deaths annually. Pollutants like NOx contribute to respiratory health problems and also correlate directly with ground level ozone formation (WHO, 2019). Communities around and near flow stations are usually the worst hit. Olomoro- Oleh with geographical coordinates as 5º 25'0" North and 6º 9' 0" East (NEGIP-PDF, 2021) is a community located in Isoko South Local Government Area of Delta State with many oil wells. Oil and gas began in the area in the 1950s.

The proliferation of oil and gas industries in this community has resulted in serious environmental challenges for the indigents whose major source of livelihood is farming. Some of the challenges include but are not limited to gas flaring and oil spills from pipelines. The gas flare stack located in Olomoro-Oleh is the primary source of air contaminants in this community. Particulate matter like PM_{10} and $PM_{2.5}$ is common in oil-producing communities due to anthropogenic sources like combustion of fuel and flaring of gasses. Study show that the major pollutants indexes of air are SO_2, NO_2, CO, O_3, NH_4, PM_{10}, $PM_{2.5}$, Pb, Ni, As, Benzo(a) pyrene and benzene (Azman *et al.*, 2017). Owing to the paucity of information on air quality assessment of locations around gas flare stacks in the Niger Delta, this study was undertaken to determine the ambient air quality of communities at pre-determined distances to the gas flare stack at Olomoro-Oleh Station in Isoko South L. G. A of Nigeria with a view to ascertaining its potential environmental and health impacts.

Materials and Methods

Sampling and Analysis of Air Samples

A continuous sampling was done according to the method described by (ref) using the Aeroqual Monitor S500 for CO, NO_2, O_3, SO_2, and VOCs, while that of particulate matter like fine particulate matter ($PM_{2.5}$) and respirable suspended particulate matter (PM_{10}) was measured using AEROCET 531S mass monitor /particle counter, hand held devices. Air samples were collected actively by pressing the start button on the digital devices and using the menu button to trap whole ambient air onto and navigate to the interested air parameter. The values of selected air contaminants were instantaneously displayed on LCD. The air samples at distance 0.1km, 0.2km and 0.3km were trapped over the 8 hrs work day equivalent to 40 hrs. per week .

Data Analysis

The data obtained were analyzed using SPSS 16.0 statistical software package to determine the mean and standard deviation.

Data Presentation

The results were presented as mean ± SD and graphically using bar chat for better appreciation of alterations in the two seasons.

Results and Discussion

Table 1.0 below shows the dry season ambient air quality of gas flare stack at Olomoro-Oleh Flow Station.

Table 1.0: Dry Season Ambient Air Quality Assessment of GFS Olomoro-Oleh Flow Station (October, 2021 – March, 2022).

Distance (km)	mean±SD (mg/m^3) n=3		mean ± SD ($\mu g/m^3$) n=3				
	COx	VOCs	NOx	O_3	$PM_{2.5}$	PM_{10}	SOx
0.1	26.05±0.82	0.58±0.08	30.00±4.08	80.00±7.00	65.00±4.55	85.00±9.25	12.50±0.15
0.2	18.50±1.63	0.45±0.03	21.00±2.45	64.00±5.50	53.00±4.02	70.00±8.16	9.55±0.75
0.3	15.75±1.63	0.30±0.08	24.00±0.62	50.00±4.08	53.00±2.45	60.00±4.08	5.00±0.50
1.0	3.75±0.82	0.10±0.03	10.00±1.63	45.00±1.20	25.55±1.63	25.00±2.45	ND
WHO, 2021	40-400	0.50	40.00	100.00	10.00	20.00	20.00

GFS=gas flare stack

The ambient air quality parameter of community around GFS in Olomoro-Oleh flow station is represented in Table 2.0.

Table 2.0: Rainy Season Ambient Air Quality of GFS in Olomoro - Oleh Flow Station

(April, 2022- September, 2022)

Distance (km)	mean±SD (mg/m^3) n=3		mean ± SD (µg/m^3) n=3				
	COx	VOCs	NOx	O_3	$PM_{2.5}$	PM_{10}	SOx
0.1	15.20±1.00	0.35±0.05	20.00±5.00	65.00±2.00	30.05±0.05	46.35±1.35	9.50±1.50
0.2	7.90±0.56	0.30±0.08	20.00±5.35	59.00±7.35	32.87±2.37	45.50±0.41	7.50±0.40
0.3	3.30±0.22	0.20±0.08	10.00±1.00	45.00±4.08	28.90±2.88	44.50±3.27	3.50±0.80
1.0	1.07±0.06	0.10±0.02	10.00±0.80	44.00±1.63	10.00±0.82	25.00±1.63	ND
WHO, 2021	40-400	0.50	40.00	100.00	10.00	20.00	20.00

GFS=gas flare stack

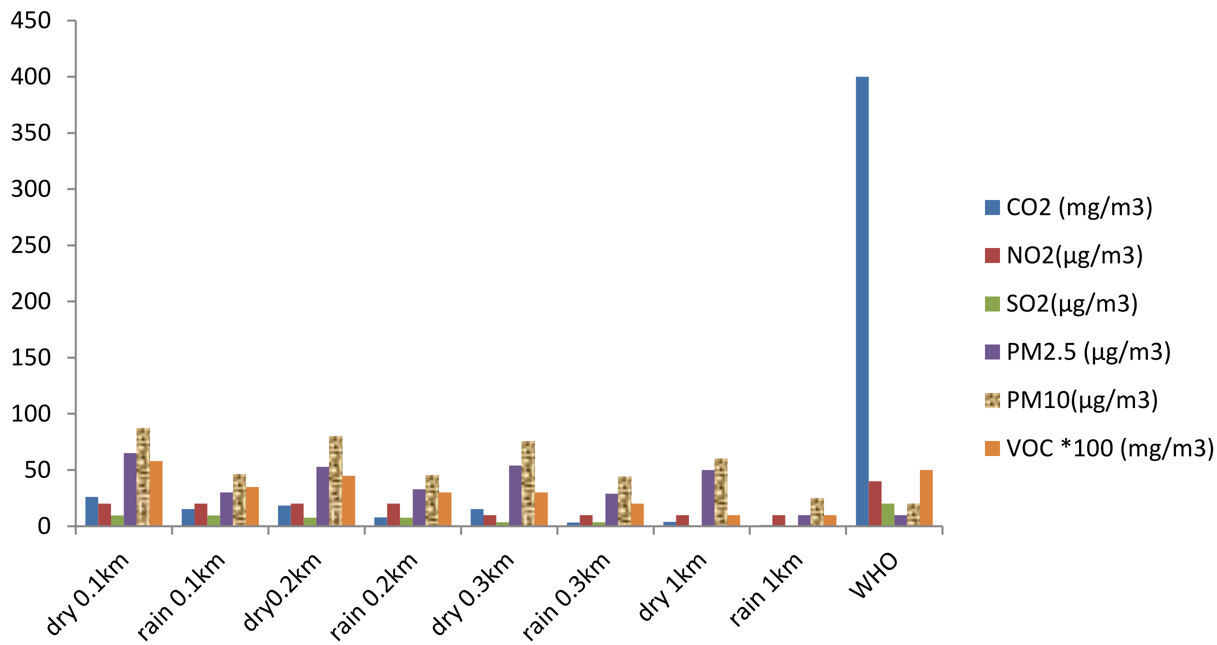

Figure 1.0: Dry and wet season values of COx, SOx, NOx and particulate matter at Olomoro Oleh Gas Flare Stack

Discussion

This study sort to investigate the ambient air quality of communities around gas flare stack in Olomoro-Oleh with a view to ascertaining its potential health impact on all stake holders of the community. Table 1.0 shows elevated levels of CO_x, NO_x and SO_x in the dry season, relative to the levels obtained in the rainy season (Table 2.0). The high levels of the Cox, NOx and Sox may be due to the continuous combustion of gases especially in the dry season and the absence of clouds in the season. The findings from this study agrees with the report of Etiuma and Anaekwe (2015) who showed that ambient air sulphur was higher in the dry than in the wet season.

The high levels of sulphur dioxide observed in dry season of 0.1km, 0.2 km when compared to distances farther away (0.3km and 1.0km) supports the study of Ede *et al.*, 2011 that shows a direct correlation of high SO_2 emission to burning of fossil fuel. The gas flared stack burns continuously for 24 hours daily. Further investigation of Table 2.0 and Figure 1.0 showed high level of NOx in km 0.1, 0.2 when compared to distances further away from the flow station / gas fare stack. The high levels of NOx observed are primarily from the combustion of gases from the gas flare stack. These values show that regions closer to the flow station and gas flare stack are usually worse hit. The finding from this study aligns with the report of (Ede *et al*., 2011)

The result of PM_{10} and $PM_{2.5}$ were lower in the rainy season with a value of 46.35 µg/m^3 for PM_{10} and 30.05µg/m^3 for $PM_{2.5}$ (Table 2.0) when compared to the values obtained for both particulate matters in the dry season with 85.75µg/m^3 for PM_{10} and 65.00 µg/m^3 for $PM_{2.5}$ (Table 1.0).The high level of PM_{10} and $PM_{2.5}$ observed in the dry season when compared to the low levels found in the wet season could be due to the proximity of study to the gas flare stack and the absence of sun and the high presence of clouds in the rainy season. This finding aligns with the report of WHO (2006)

This study also observed the significant increase in the concentration of VOCs during both dry and wet seasons. The high levels of volatile organic compounds observed in km 0.1 and 0.2 in both dry and rainy seasons when compared to the other distances evaluated in this study could be due to their proximity to the source of pollution, The finding from our study is in tandem with the finding of Ede *et al*., 2011.

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