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**IMPACT OF FLARED GASES ON BIOTIC AND ABIOTIC COMPONENTS OF THE ENVIRONMENT
AROUND AGBADA FLOW STATION, RIVERS STATE**

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Abstract

This study investigates the effect of gas flaring on the environs around the Igwuruta flow station. The study adopted the completely randomized block design (CRBD) due to the similarity of the experimental points where the ambient air quality readings (from 4 stations). Instruments like Aero Qual 500 Series (Gas Monitor), GT 321 Particulate Metre, Automated Global Position System (GPS), Extech Meteorology Metre, and Measuring Tape were used to assess the parameters or pollutants in the environs around the Igwuruta flow station. The study revealed that the environs around the Igwuruta flow station is polluted with pollutants like: $\text{CO}_2 = 563.5 \mu\text{g}/\text{m}^3$, $\text{NO}_2 = 0.070 \mu\text{g}/\text{m}^3$, $\text{O}_3 = 0.0175 \mu\text{g}/\text{m}^3$, $\text{SO}_2 = 0.00 \mu\text{g}/\text{m}^3$, $\text{H}_2\text{S} = 0.00 \mu\text{g}/\text{m}^3$, $\text{CH}_4 = 0 \mu\text{g}/\text{m}^3$, $\text{CO} = 0.2 \mu\text{g}/\text{m}^3$, $\text{NH}_3 = 0.2 \mu\text{g}/\text{m}^3$, $\text{Pm } 2.5 = 0.009 \mu\text{g}/\text{m}^3$, $\text{Pm } 10 = 0.0134 \mu\text{g}/\text{m}^3$, noise = 54.2dBA, temperature = 31.7 °C, WS = 1.43 m/s, and RH = 71.2% which differ from the daily WHO and DPR standards. Furthermore, the study found that the concentration of CO_2 could lead to the

possibility of respiratory diseases, skin disease, ear defects, etc. While the high temperature could lead to intense heat that can affect humans (especially pregnant women delivering prematurely), including plants and animals. The study recommended amongst others that: trees should be planted to absorb the excess

concentration of CO₂ around the environs of the Igwuruta flow station, alongside high temperature resistant plant like Lantana should be planted in the communities bordering the Igwuruta or Agada flow station with high intensity of temperature.

Introduction

Certain options adopted during crude oil exploration could speedily lead to the discharge of gaseous impurities or pollutants (like Pm 2.5, Pm 10, NO₂, CO, SO₂, O₃, CO₂, NH₃, etc.) that sternly or severely damage the environment (Dami et al., 2012; Osuoha, 2017). This awareness necessitates the incorporation of high technology, cost-effective, legitimate, biologically friendly, commercially viable, and sustainable exploration method like gas re-injection/storage for use as an energy source in different downstream applications like electricity generation and cooking gas (Seiyaboh & Izah, 2017; Odjugo & Osemwenkhae, 2019). However, the deliberate cutting of cost, lack of policy direction and weak environmental regulatory institutions is responsible for oil companies' opting for flaring of gas as cost-saving but environmentally devastating option and illegitimate method (Manby, 2009; Ayoola, 2011).

Gas flaring involves the practice of burning off the natural gas associated with petroleum into the atmosphere instead of deploying alternative removal methods that are environmentally friendly (Seiyaboh & Izah, 2017). Gas flaring as the continuous burning of excess gas from oil extraction processes releases large quantities of heat and various atmospheric pollutants into the surrounding environment (Enetimi & Izah, 2017). Similarly, Osuoha (2017) reiterates that gas flaring is the primary source of

anthropogenic and toxic pollutants that are responsible for poor air quality, serious public health issues, and ecological degradation, including the generation of greenhouse gases, chronic respiratory diseases, vegetative discoloration, etc. (AAAS, 2015).

Nigeria currently produces about 3.5 billion cubic feet (100,000,000 m³) of associated gas annually, out of which 2.5 billion cubic feet (70,000,000 m³), or about 70% estimated to US\$2 billion per year are flared or wasted (NNPC, 2014). This makes the issue of gas flaring as one of the fieriest discussed subjects in oil producing communities and beyond due to the trans-boundary effect of air, and the devastating consequences that offset the ability of the ecosystem to provide its services, perform its functions, and sustain a wide variety of crops (Amaize, 2012). Owing to the devastating effect of gas flaring on the environment, the Nigerian government and the oil corporations appear to be in agreement to curtail, eliminate or eradicate gas flaring in Nigeria. However, weak institutional and regulatory framework accounts for the relative reduction rather than the total or complete eradication of flaring that has been declared illegal since 1984 under section 3 of the "Associated Gas Reinjection Act" of Nigeria (NNPC, 2014).

Deductively, flared gas during the processes of crude oil exploitation contains several gases chiefly among which are

carbon monoxide (CO) whose consistent inhalation affects respiratory system, causing diseases, illnesses and other bio-concentrations that could affect the proper functioning of the body system. Furthermore, gas flaring could lead to the concentration of other pollutants like NO₂, SO₂, O₃, etc. including Temperature that there concentration triggers the issue of poor air quality, ecological degradation, climatic changes, intense heat that can affect certain vital native agricultural crops, including the health of humans (like pregnant women) even at considerably and visibly very long distances due to the trans-boundary effect of air pollution or certain pollutants released in the air. This is the crux of the matter in this study.

Statement of the Problem

There is no doubt that human activities (like crude oil exploration) could generate certain wastes (i.e. domestic, industrial, etc.) and pollutants which overtime distorts and dislodges the natural components and processes in the fragile environment. However, the ineffectiveness and conflicting jurisdiction of environmental regulatory institutions like National Environmental Standards Regulatory Agency (NESRA) and the Department of Petroleum Resources (DPR) has unfettered the continual use of non-environmentally friendly option, economically wasteful and unsustainable exploration method like gas flaring with its detrimental or adverse effect on the host environment. Hence, this regulatory conflict has made all efforts aimed at curbing natural gas flaring to remain an imagination rather than a reality since 1984 gas flaring was declared illegal (NNPC, 2014).

Furthermore, the inability to effectively implement anti-flaring policies in Nigeria has led to the setting and extension of the time limits for the ending of gas flaring in Nigeria, initially programmed to end in 2000, 2010, 2015 and now extended to 2020. However, though unfortunately, while the issue of gas flaring persists, toxic chemicals (carbon monoxide, carbon dioxide, nitrogen dioxides, sulphur dioxide, etc.) are daily released into the atmosphere. This results to climatic change, distorting the ecosystem services, functions and supports for the native flora and fauna, and devastating the health and livelihood of humans or residents in the environment exposed to substances that aggravates their susceptibility to respiratory problems, asthma, pain, chronic bronchitis, etc.

Although there is insufficient data linking destruction of the ecosystem with gas flaring based on the deliberate ploy by the government in conjunction with multinational oil companies to hide the truth from the teeming populace and other stakeholders affected by adverse effect of gas flaring on the environment. Against this background, this study attempts to examine the effect of gas flaring on the environs around the Igwuruta flow station, Ikwerre Local Government Area Rivers State, with a view to attempting to close this yawning gap by articulating the following questions that guided this research.

1. What is the composition of the flared gases around the Igwuruta flow station?
2. What is the concentration of gases and particulate matter released from flared gases around the Igwuruta flow station?
3. What is the impact of the monthly concentration of CO₂ and Temperature on the environs around the Igwuruta flow station?

Aim and Objectives of the Study

The aim of this study was to examine the effect of gas flaring on the air quality around the Igwuruta flow station in Ikwerre Local Government Area Rivers State. The specific objectives include to:

1. Determine the composition of the flared gases around the Igwuruta flow station.
2. Determine the concentration of gases and particulate matter released from flared gases around the Igwuruta flow station.
3. Determine the impact of the monthly concentration of CO_2 and Temperature on the environs around the Igwuruta flow station.

Significance of the Study

1. The study would provide information that enhanced the sustainable and improved environment in oil bearing communities.
2. This study would serve as a reference material for researchers and future studies.
3. The study would be beneficial as it would help to advocate the zero flaring of gases whose effluences impacts negatively on both the air quality and inherent residents.

Scope of the Study

This study centred on the effect of gas flaring. In terms of geographic scope, the study would focus on the Igwuruta flow station. Furthermore, the independent variable is gas flaring while the dependent variable is air quality.

Materials and Methods

Study Area: The study was conducted at the Igwuruta flow station (otherwise Agbada II Flow Station) located in Igwuruta Community in Ikwerre Local Government Area. The Agbada Flow Station is owned and operated by the Nigeria National Petroleum Corporation (NNPC)/Shell Petroleum Development Company (SPDC) Joint venture gas gathering station with open gas flaring station (Gobo, Richard & Ubong, 2009). Geographically the facility is located on longitude $7^\circ 0' - 7^\circ 10'E$ and latitude $4^\circ 31' - 4^\circ 40'N$ in Rivers State of Nigeria (Gobo *et al.*, 2009). The facility is bounded on the north by Igwuruta town, on the south by Eneka town, on the east by Eneka-Igwuruta road and on the west by Airport Road. The facility has three different flare points consisting of two vertical flare stack or point and one horizontal flare stack or point.

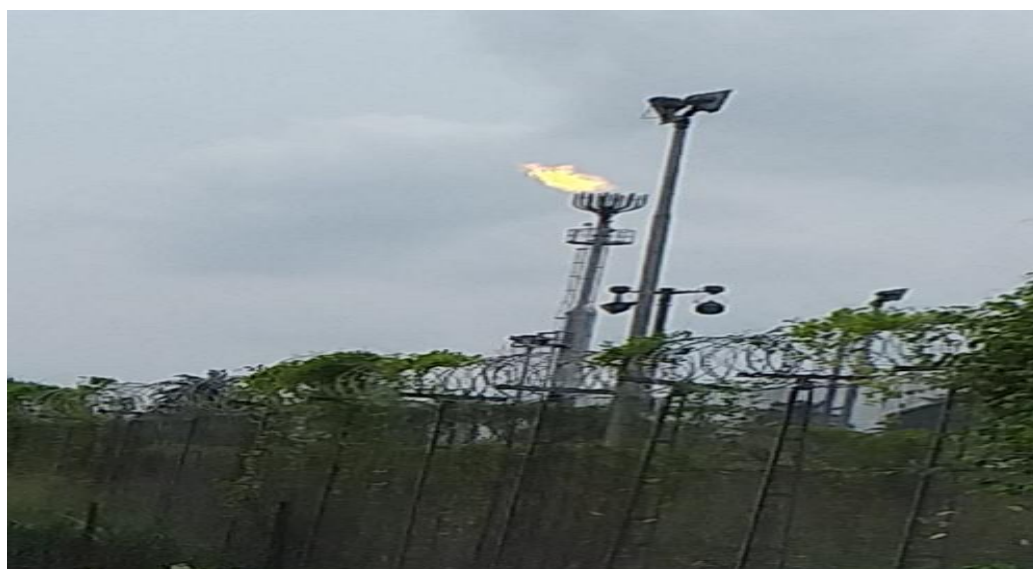


Plate 1: One of the Two Vertical Flare Stack or Point in the Agbada (Igwuruta) Flow Station

Sample Site Location: Four (4) sampling points or stations conducted in four successive months (via June-September, 2021) at monthly interval constituted the sample location and period that was used in this study. The sampling points or stations were purposively selected for the air quality parameters in Station A (Upstream of the Agbada Flow Station II), Station B (Downstream of the Agbada Flow Station II), Station C (Life Camp of the Agbada Flow Station II), and Station D (Control, at the Bolingo Junction Igwuruta). This include: Point A (100m from the flow station) with **Northings**-04° 55' 57.0"N, and **Eastings**-007° 0' 55"E, Point B (200m from the flow station) with **Northings**- 04° 55' 57.0"N, and **Eastings**- 007° 0' 56"E, Point C (500m from the flow station) with **Northings**- 04° 55' 58.446"N, and **Eastings**- 007° 0' 53.598"E, and Point D (Control, at 1000m from the flow station) with **Northings**- 04° 56' 5.568"N, and **Eastings**- 007° 0' 27.75"E.

Research Design: This study adopted the experimental design. The experimental design is applied to a study where the manipulation and control of one or more intervening variables may depend on the subjects, experimenter, tools of experiment and other paramount environmental factors (Nwankwo, 2013). Furthermore, the study also adopted the completely randomized block design (CRBD). The CRBD is applied in a work where the experimental points are similar (i.e. the study area is similar).

Ethical Clearance of the Study: Ethical clearance was obtained prior to the commencement of the data collection

process (i.e. air quality assessment) from the management of the Igwuruta or Agbada flow station (i.e. SPDC). In the same vein, permission was also obtained from the staff or personnel that were directly involved in conducting the air quality assessment.

Instrumentation and Method of Data Collection:

Five instruments via: Aero Qual 500 series gas detector (for obtaining indoor air quality (IAQ)), the handheld GT 321 (is a portable particle counter that counts particles down to 0.3 microns), the Automated GPS (used for taking the coordinates of the sampling points above), Extech Meteorology Metre (used for collecting the Temperature, Relative Humidity, and Windspeed readings), and Measuring Tape (used for the determination of the distance of the sampling points) were used by the researcher and research assistant for conducting the air quality assessment around the Igwuruta flow station or a gas flared environment.

Instructively, four (i.e. Aero Qual 500 series, GT 321, the Automated GPS, and Extech Meteorology Metre, except for the Measuring Tape) out of the five instruments or equipment were pre-calibrated before usage for quality assurance purposes.

Data Analysis: Relevant Statistical Analytical tools like mean, standard error, charts (line and bar), graphs and Analysis of Variance (ANOVA) at 0.05 level of significance were utilized or deployed to answer or determine the objectives stated in this study.

Results

Table 1: Composition of flared gases in the four selected stations around the Igwuruta flow station

Gases	Unit	Period	Measured Values				WHO Standard Compared	Daily Standard Compared	DPR Standard Compared
			ST A	ST B	ST C	Control			
Pm 2.5	µg/m ³	30 mins	0.009	0.009	0.011	0.008	35 µg/m ³		150 – 230
Pm 10	µg/m ³	30 mins	0.013	0.013	0.016	0.012	150 µg/m ³		250
NO ₂	µg/m ³	30 mins	0.056	0.064	0.069	0.090	100 ppb		0.04 – 0.06
CO	µg/m ³	30 mins	0.2	0.2	0.2	0.2	200 µg/m ³ / 9 ppm		10 – 20
SO ₂	µg/m ³	30 mins	0.00	0.00	0.00	0.00	75 ppb/ 0.5 ppm		0.01 – 0.10
CH ₄	µg/m ³	30 mins	0	0	0	0	0.83		2
H ₂ S	µg/m ³	30 mins	0.00	0.00	0.00	0.00	125		120
O ₃	µg/m ³	30 mins	0.02	0.01	0.03	0.01	100 µg/m ³		0.070 ppm
NH ₃	µg/m ³	30 mins	0.2	0.2	0.2	0.2	0.53		0.51-0.55
CO ₂	µg/m ³	30 mins	613	565	549	527	462		467
Noise	dBA	30 mins	57.2	55.6	46.0	58.1	75 - 90		80 -100
Temp.	°C	30 mins	34.0	30.4	30.6	31.6	-		-
WS	m/s	-	0.9	0.9	1.9	2.0	-		-
WD	-	-	WS 52°	NE 25°	NE 37°	NE 25°	-		-
RH	%	-	65.3	69.9	71.6	78.1	-		-

Source: Researcher's Fieldwork Measurement, 2021; DPR, 2002; World Health Organization, 2005; Akpogheli, Ilerhievwie, Agbaire & Orisaremi, 2016; USEPA, 2016.

From Table 1 the various air quality parameters (otherwise pollutants) shows that at Station A (Upstream of the Agbada or Igwuruta Flow Station) with coordinates 04° 55' 57.0"N, and 007° 0' 55"N. The parameter measured revealed that the highest level of concentration was observed at CO₂, thus, the measured values for CO₂ is 613 ppm, NO₂ is 0.056 ppm, O₃ is 0.02 ppm, SO₂ is 0.00 ppm, H₂S is 0.00 ppm, CH₄ is 0 ppm, CO is 0.2 ppm, NH₃ is 0.2 ppm, Pm 2.5 is 0.009 ppm, and Pm 10 is 0.013 ppm, also noise was 57.2 dBA, Temperature was 34.0 °C, wind speed (WS) was 0.9 m/s, wind direction (WD) was WS 52°, while Relative Humidity (RH) was 65.3%. In Station B (Upstream of the Agbada or Igwuruta Flow Station) with coordinates 04° 55' 57.0"N, and 007° 0' 56"E, the parameter measured revealed the values for CO₂ is 565

ppm, NO₂ is 0.064 ppm, O₃ is 0.01 ppm, SO₂ is 0.00 ppm, H₂S is 0.00 ppm, CH₄ is 0 ppm, CO is 0.2 ppm, NH₃ is 0.2 ppm, Pm 2.5 is 0.009 ppm, and Pm 10 is 0.013 ppm, also noise was 55.6 dBA, Temperature was 30.4 °C, wind speed (WS) was 0.9 m/s, wind direction (WD) was NE 25°, while Relative Humidity (RH) was 65.3%.

In Station C (Life Camp of Flow Station) with 04° 55' 58.446"N, and 007° 0' 56"E, the parameter measured revealed the values for CO₂ is 549 ppm, NO₂ is 0.069 ppm, O₃ is 0.03 ppm, SO₂ is 0.00 ppm, H₂S is 0.00 ppm, CH₄ is 0 ppm, CO is 0.2 ppm, NH₃ is 0.2 ppm, Pm 2.5 is 0.011 ppm, and Pm 10 is 0.016 ppm, also noise was 46.0 dBA, Temperature was 30.6 °C, wind speed (WS) was 1.9 m/s, wind direction (WD) was NE 37°, while Relative Humidity (RH) was 71.6%. While in

Station D (Control at Bolingo Junction Igwuruta) coordinates with 007° 0' 53.598"N, and 007° 0' 27.75"E, the parameter measured revealed the values for CO₂ is 527 ppm, NO₂ is 0.090 ppm, O₃ is 0.01 ppm, SO₂ is 0.00 ppm, H₂S is 0.00 ppm, CH₄ is 0 ppm, CO is 0.2 ppm, NH₃ is 0.2 ppm, Pm 2.5 is 0.008 ppm, and Pm 10 is 0.012 ppm, also noise was 58.1 dBA,

Temperature was 27.1 °C, wind speed (WS) was 2.0 m/s, wind direction (WD) was NE 25°, while Relative Humidity (RH) was 78.1%. The implication of the foregoing is that all the selected air quality parameters (pollutants) around the Igwuruta or Agbada flow station differ or above the daily WHO and DPR standards.

Table 2: Comparison of the mean values from the composition of gases and particulate matter released from the flared gas in the three sample points and the control Igwuruta flow station

Gases	Unit	Mean	Control	Decision
Pm 2.5	µg/m ³	0.010	0.008	High
Pm 10	µg/m ³	0.014	0.012	High
NO ₂ (Nitrogen Dioxide)	µg/m ³	0.063	0.090	Low
CO (Carbon monoxide)	µg/m ³	0.2	0.2	Same
So ₂ (Sulphur Dioxide)	µg/m ³	0.00	0.00	Same
CH ₄ (Methane)	µg/m ³	0	0	Same
H ₂ S (Hydrogen Sulphide)	µg/m ³	0.00	0.00	Same
O ₃ (Ozone)	µg/m ³	0.02	0.01	High
NH ₃ (Ammonia)	µg/m ³	0.2	0.2	Same
Co ₂ (Carbon Dioxide)	µg/m ³	575.7	527	High
Noise	dBA	52.9	58.1	Low
Temp. (Temperature)	°C	31.7	31.6	High
WS (Wind Speed)	m/s	1.2	2.0	Low
RH (Relative Humidity)	%	68.9	78.1	Low

Source: *Researcher's Computation, 2021*

Table 2 show the mean values of the various air quality parameters in the three selected sample points and the control around the Igwuruta or Agbada flow station. The mean values of the measured air quality parameters include: CO₂ is 575.7 ppm, NO₂ is 0.063 ppm, O₃ is 0.02 ppm, SO₂ is 0.00 ppm, H₂S is 0.00 ppm, CH₄ is 0 ppm, CO is 0.2 ppm, NH₃ is 0.2 ppm, Pm 2.5 is 0.010 ppm, Pm 10 is 0.014 ppm, noise is 52.9 dBA, temperature is 31.7 °C, WS is 1.2 m/s, and RH is 68.9%. The implication of the foregoing is that the mean value in all the air quality parameters (pollutants) in the selected sample points for CO (Carbon monoxide), So₂ (Sulphur Dioxide), CH₄ (Methane), H₂S (Hydrogen Sulphide), and NH₃ (Ammonia) around the Igwuruta or Agbada flow station is same for the Control Point.

Also, the mean value of the parameters (pollutants) in the selected sample points for NO₂ (Nitrogen Dioxide), Noise, WS (Wind Speed), and Relative Humidity (RH) around the Igwuruta or Agbada flow station is lower than the value for the Control Point. While the mean value of the parameters in the selected sample points for O₃ (Ozone), Co₂ (Carbon Dioxide), and temperature are higher than the value for the Control Point. Furthermore, the data in Table 4.3 showed indicated a high concentration of CO₂, Temperature, O₃, including Pm 2.5, and Pm 10. Similarly, the high level of noise, WS, RH, and temperature indicates that the residents around the Igwuruta flow station could have hearing defects, shock, and possible of hypertension.

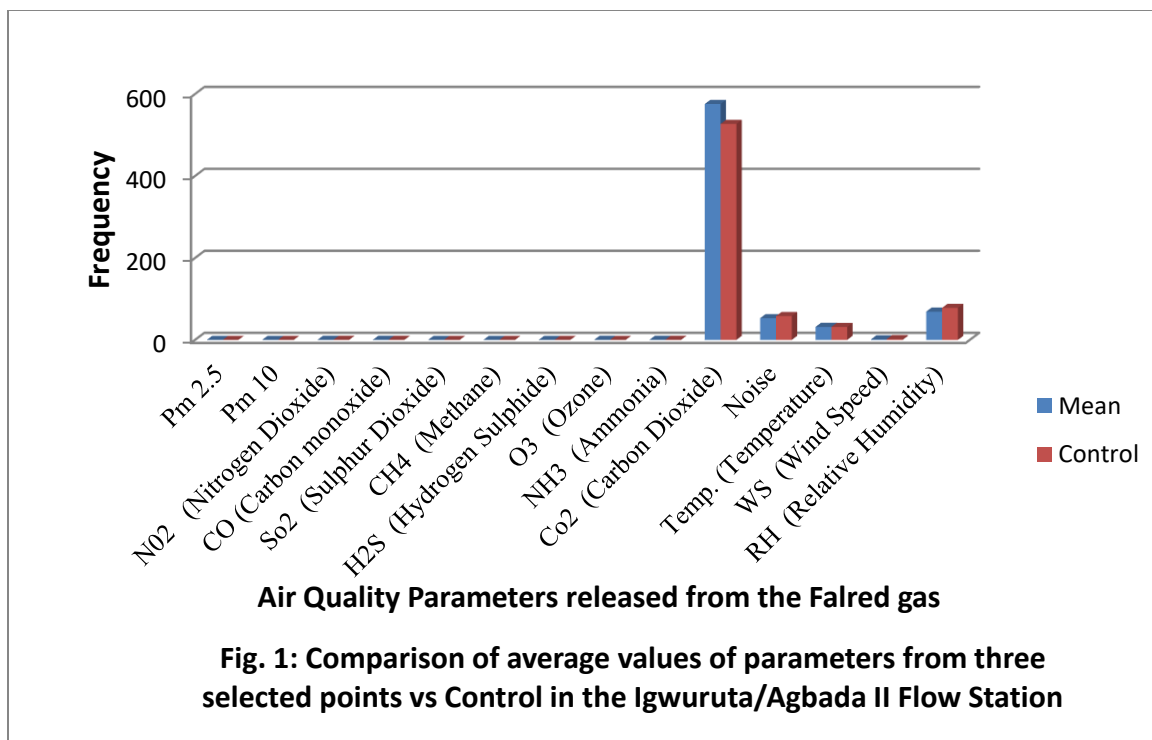


Fig 1 shows that the mean values of CO₂ released due to gas flaring at the Agbada Flow Station is higher than the value of CO₂ taken at the Control, while the mean values of the other parameters from the selected

sample point are lower than the value of CO₂ taken at the Control. This indicates that level of CO₂ around the Agbada Flow Station falls above the value of CO₂ taken at the Control could lead to respiratory problems.

The impact of the monthly concentration of CO₂ on the environs around the Igwuruta flow station

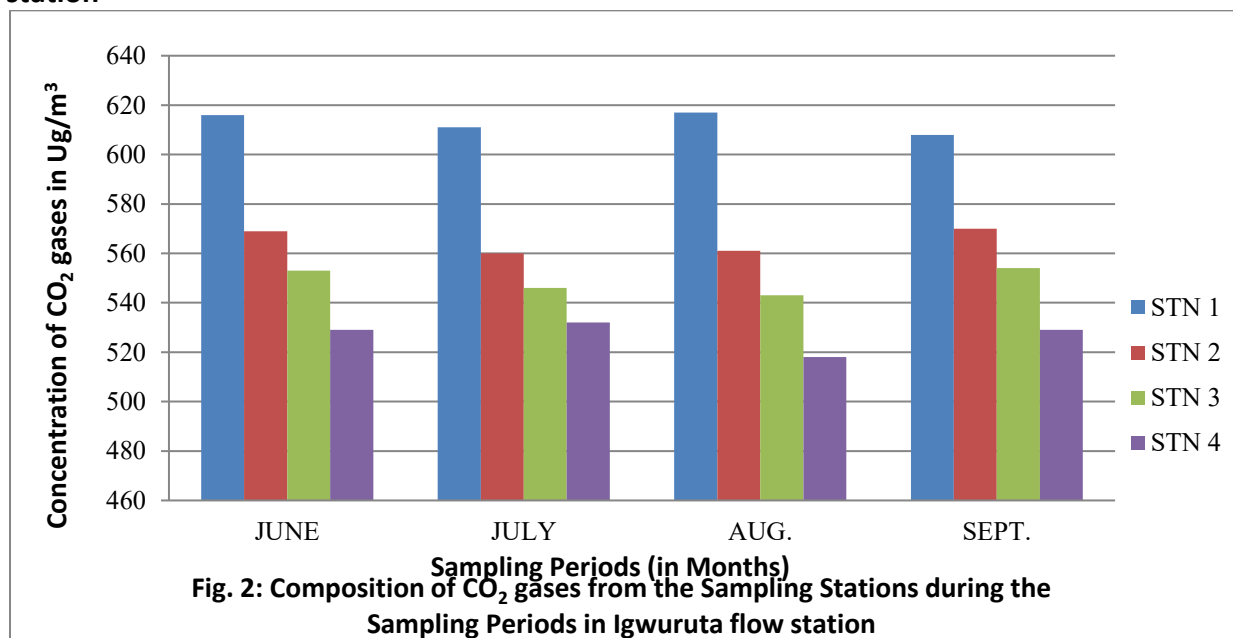


Fig 2 shows that CO₂ values was the highest at station 1 (i.e. 100m from the flow station) in all the sampling periods or months (i.e. June, July, August and September), station 2 (i.e. 200m from the flow station) had the second highest CO₂ values or concentration in all the months or sampling periods, and station 3 (i.e. 500m from the flow station) had the third highest CO₂ values in all the sampling periods (i.e. June, July,

August and September). While station 4 (i.e. the control) had the fourth highest or least CO₂ values in all the four sampling periods. These CO₂ values from the four sampling stations or points and periods were higher than both the WHO and DPR daily standard or limit (see Table 1 above). The implication is that there is high concentration of CO₂ gases due to the gas flaring activities at the Igwuruta/Agbada flow station.

Table 3: Two-way ANOVA comparing Spatial and Temporal variations of CO₂ (Carbon Dioxide) in the study area

Source of Variation	SS	df	MS	F	P-value	F crit	Decision
STATION	15980	3	5326.67	218.90	0.00	3.86	S
MONTHS	117	3	39.00	1.60	0.26	3.86	NS
Error	219	9	24.33				
Total	16316	15					

Decision rule: if $p\text{-value} < f\text{-crit}$ accept H_0 , else reject H_0 . NS= Not Significant, S=Significant

The two-way analysis of variance (Table 3) shows that there was significant variation between sites but across sampling

periods no significant difference was recorded at 0.05 confidence level.

The impact of the monthly concentration of Temperature on the environs around the Igwuruta flow station

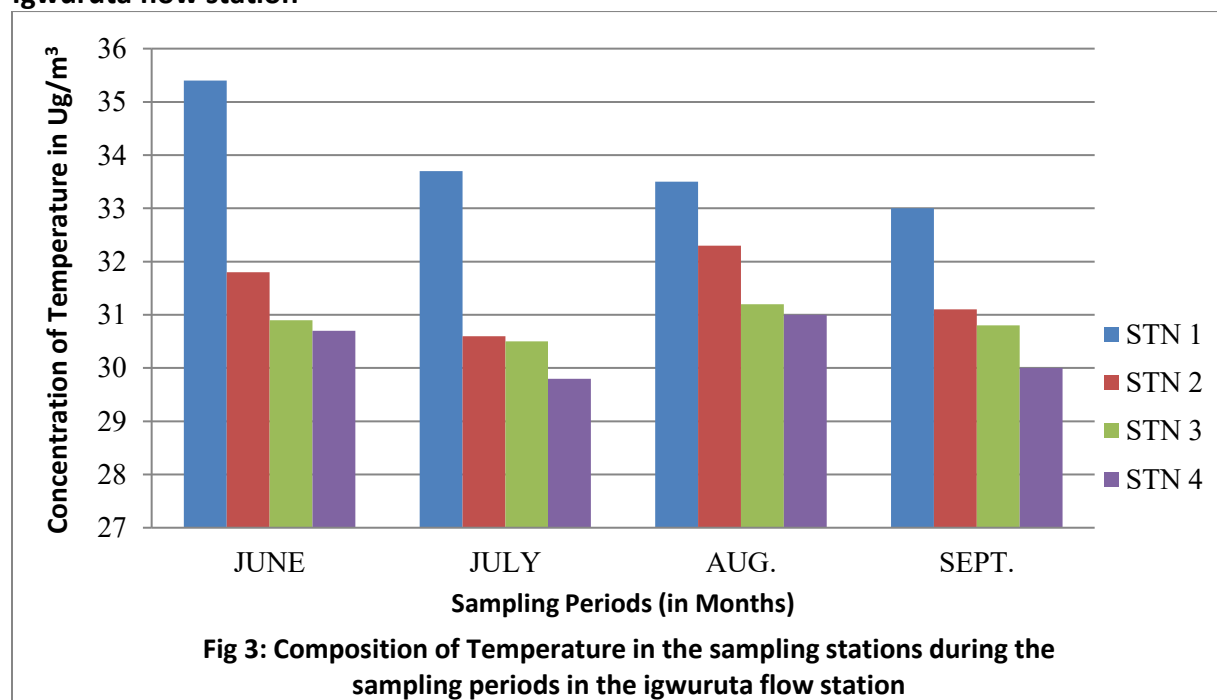


Fig 3 shows that Temperature values was the highest at station 1 (i.e. 100m from the flow station) in all the sampling periods or months (i.e. June, July, August and September), station 2 (i.e. 200m from the flow station) had the second highest Temperature values in all the months or sampling periods, and station 3 (i.e. 500m from the flow station) had the third highest

Temperature value in all the sampling periods (i.e. June, July, August and September). While station 4 (i.e. the control) had the fourth highest or least Temperature values in all the four sampling periods. This high Temperature value was associated with increased intensity of heat due to the gas flaring activities around the Igwuruta/Agbada flow station.

Table 4: Two-way ANOVA comparing Spatial and Temporal variations of Temperature in the study area

Source of Variation	SS	df	MS	F	P-value	F crit	Decision
STATIONS	29.47	3	9.82	32.20	0.00	3.86	S
PERIOD	3.42	3	1.14	3.74	0.05	3.86	NS
Error	2.75	9	0.31				
Total	35.64	15					

Decision rule: if $p\text{-value} < f\text{-crit}$ accept H_0 , else reject H_0 . NS= Not Significant, S=Significant

The two-way analysis of variance (Table 4) shows that there was significant variation between sites but across sampling periods no significant difference was recorded at 0.05 confidence level.

Discussion of Findings

The result in Table 1 revealed that the composition of gases like CO₂, NO₂, O₃, SO₂, H₂S, CH₄, CO, NH₃, Pm 2.5, Pm 10, noise, Temperature, wind speed, wind direction, and Relative Humidity flared in the environs around the Agbada or Igwuruta flow station differ from the daily WHO and DPR standards or limits. This finding is in agreement with Seiyaboh and Izah (2017) that gas flaring leads to release of three major components including noxious gases, heat and noise, including gaseous pollutants or toxic chemicals that generally upset the water food web and affects health and environment of living organisms that depend on them (Dami et al., 2012). The result in Table 2 revealed that the mean values of the various air quality parameters in the three selected sample points and the control around the Igwuruta or

Agbada flow station contain parameters like CO₂, NO₂, O₃, SO₂, H₂S, CH₄, CO, NH₃, Pm 2.5, Pm 10, noise, temperature, WS, and RH contain values that differ from the values in the Control Point. This finding is in agreement with Dami *et al.* (2012) that the concentration of gaseous pollutants, impurities or toxic chemicals like CO₂, NO₂, O₃, SO₂, H₂S, CH₄ from crude oil related activities generally moves into the atmosphere, displace and affect the quality of air by causing breathing difficulty, and other respiratory problems. Also, Ozabor and Obisesan (2015) stated that gas flaring leads to the release of temperature which has the tendency to affect several plant species especially productivity and growth.

The result in Table 3 and Figure 2 revealed a high concentration of CO₂, which affects the environs around the Igwuruta flow station. The high concentration of CO₂ indicates poor air quality which implies that the residents around the Igwuruta flow station could experience or suffer from skin diseases, cancer, ear problem, respiratory problems (like possibility of possible

contacting of cough, cold and carthar, etc. Instructively, CO₂ value reduces as you move away from the gas flare point. Equally, CO₂ values from the study area tend to reduce across sampling periods that is from June to September, thereby showing both temporal and spatial variation. This finding is consistent with earlier finding by Ajugwo (2013) who stated that massive oil exploration and gas flaring in the Niger Delta results in the release of toxic gases like CO₂ with the capacity of triggering respiratory problems, human health, and resulting to severe damage to the environment.

Also, the result in Table 4 and Figure 3 revealed a mean temperature value recorded in this investigation 31.7°C is far lower than the 40.0°C reported by Gobo et al. (2009) at the flare sites around the Igwuruta and Umuechem in Ikwerre and Etche Local Government Areas, Rivers State. This is a result of the fact that, his measurement was taken out of a mean distance of 43.8m from the flare point while this study measurements were taken at distance of 100m, 200m, 500m for stations 1, 2 and 3 respectively. This study however should clearly show that temperature value is dependent on the distances from the gas flare point. As the distance increases from the flare point temperature value reduces and vice versa.

Specifically, the high temperature indicates the possibility of intense heat around the Igwuruta flow station, could led to global warming (climatic change) including pregnant women delivering prematurely as a result of heat that could affect plants and animals in this area which cannot survive under heat. Thereby heightening the issue of poor harvest, death/extinction of certain animals, and the associated food insecurity or scarcity around this gas flared environs. Also, Akuro (2012) emphasized that the high temperature of 40°C at an average distance of 43.8m from flare sites in Isoko, Delta State

makes flares to have negative effects on vegetation growth, animal life and ecological equilibrium in the Niger Delta area.

Conclusion

The study concludes that gas flaring at the Igwuruta or Agbada flow station led to the emission of pollutants like CO₂, NO₂, O₃, SO₂, H₂S, CH₄, CO, NH₃, Pm 2.5, Pm 10 including high level of noise, WS, RH, and temperature. However, the high concentration of CO₂ has contributed significantly to poor air quality that leads to skin diseases, cancer, ear problem, respiratory problems (like possibility of possible contacting of cough, cold and carthar, etc. While the high temperature contributes to intense heat and global warming that could affect humans (especially pregnant women delivering prematurely), including plants and animals around the environs of the Igwuruta flow station and communities beyond. This is due to the trans-boundary effect of air pollution where certain pollutants released in the atmosphere permeate and severely impact a very long distance beyond the point of contact.

Recommendations

Based on the findings of the study the following recommendations were made:

1. As a matter of urgency, the government should ensure that the management of the Agbada flow station embarks on a detailed or comprehensive environmental impact assessment in order to improve the sustainability of the environment of the host community.
2. The management of the Agabada flow station should be made to embark on clean up or remediation of any impacted site around the environment of the Agbada flow station.

3. In view of the high concentration of CO₂, more trees should be planted to absorb the excess CO₂ around the environs of the Igwuruta flow station.
4. High temperature resistant plant like Lantana should be planted in the communities bordering the Igwuruta or Agada flow station with high intensity of temperature.
5. The Department of Petroleum Resources (DPR) should effectively monitor and ensure that the kind of effluences or discharges does not in any way pollute or destroy the environmental quality.

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