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Crude Oil Exploration Activities and Particulate Matter Pollutants Concentration in Selected Rivers East and Rivers South-East Senatorial Communities, Rivers State

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Abstract

The study examined crude oil exploration activities and particulate matter pollutants concentration in selected Rivers East and Rivers South-East communities, Rivers State. The study adopted the completely randomized block design (CRBD). Ambient air quality readings were taken in-situ in four (4) stations (two each from each of the communities) using the Aero Qual 500 Series (Gas Monitor), GT 321 Particulate Metre, Automated Global Position System (GPS), and Extech Meteorology Metre, While mean and clustered column chart was used to analyze the data. The study revealed the concentrations of 694 ppm and 613 ppm for CO_2 in Bodo and Igwuruta communities respectively which were higher than the WHO daily approved limit of 462 ppm. The study further revealed that the higher concentration of particulate matter pollutants (PMPs) like (NO_2 = 0.098 μg/m^3, O3 = 0.04 μg/m^3, So_2 = 0.00 μg/m^3, H_2S = 0.01 μg/m^3, CH_4 =0 μg/m^3, CO = 0.5 μg/m^3, NH_3 =0.3 μg/m^3, Pm 2.5 = 0.022 μg/m^3, Pm 10 = 0.018 μg/m^3, temperature = 34.6 ^{o}C) obtained at the Bodo artisanal refining sites and that obtained at the Igwurats flow station were all still within the WHO daily approved limits for the specific PMPs. Also, the excessive concentration of CO_2 accentuates the presence of soot that exacerbates the discolouration of vegetation as well as poor air quality, residents' high susceptibility to skin diseases, cancer and respiratory ailments, intense heat, respiratory complications like cough, carthar, etc. The study recommended amongst others that more trees should be planted to absorb the excess CO_2 that accentuates the buildup of soot that damage the built environment; destroy car windshield, roof surfaces, house floors and windows and also, causing health risk of rashes, aging, asthma, bronchitis on the residents around the environs of the Agbada/Igwuruta flow station and Bodo artisanal refining site.

Keywords: Crude Oil Exploration Activities, Particulate Matter Pollutants, Rivers East, Rivers South-East.

1.0: INTRODUCTION

Crude oil exploration activities whether ethically or unethically conducted are very highly susceptible to accentuating the release of gaseous effluences likely to deteriorate the quality of the recipient environment; the atmosphere, waterbody, wetland etc. The activity of crude oil exploration both the legitimate and illegitimate exert either positive or negative impacts on any environment (Barango, 2023). Crude oil exploration and refining when conducted in defiance of the extant standardized regulations could likely accentuate unavoidable oil spillage, pipeline leakages, gas flares, and release of untreated forms of effluents. Thus, the release of liquid, gaseous and solid forms of effluents could result to air pollution and environmental degradation that may likely diminish and extinct the vast mangrove habitats and even other environmental resources and functions in any area (Sibe *et al*., 2019).

Rapid oxidation of natural gas with the discharge of gaseous, particulate matter, pollutes and heat up the atmosphere (Fawole *et al*., 2016). Also, the release and subsequent concentration of particulate matter in the atmosphere would over the near or long-run be responsible for triggering pollutants. The existence of toxic pollutants are known to exert poor air quality, infections among other negative impacts on living things like humans, microorganisms, plants and animals (Onugha, 2022). Also, the presence of toxic pollutants could specifically lead to the decolouration and corrugation of the non-living components like plastics, pipes, rods, etc. in that environment (Ubong *et al*., 2015; Amaecho-Onyerimma & Onugha, 2021). In this regard, the American Association for the Advancement of Science (AAAS) earlier reported that gas flaring is responsible for the generation of greenhouse gases, chronic respiratory diseases, and vegetative discoloration among others in an environment (AAAS, 2015). Against this backdrop, the flaring of gas could be ascribed as the primary source of human or anthropogenic activities inducing toxic pollutants that are responsible for poor air, water and soil quality that would seriously trigger public health issues and ecological degradation likely to distort ecosystem services (Osuoha, 2017).

Amaechi-Onyerimma *et al*., (2023) demonstrated the effect of gas flaring around the environs of the Igwuruta or Agbada flow station and revealed that the emission of pollutants like CO_2, NO_2, So_2, H_2S, CH_4, CO, NH_3, Pm 2.5, Pm 10 among others significantly contributed to poor air quality that heightens the occurrence of skin diseases, cancer and respiratory ailments (especially cough, cold and Cathar, etc.). This standpoint was earlier corroborated in the study by Monday (2018) that the release and presence of Pm 2.5, Pm 10, CO_2, H_2S, NH_3, and NO_2 among other particulate matter pollutants in a specific gas-flared environment severely impacts a very long distance and area beyond the pollutant generated community due to the trans-boundary nature of air pollution.

Industrial, artisanal refining, and construction among other human-driven land-use activities appear to be the common sources for the emission of substances with certain levels of toxicity into the atmosphere. This act could result in air pollution that would likely occur from human activities and practices that accentuate the emission of varying quantities of harmful substances into the atmosphere. Thus, a toxin or pollutant saturated environment triggers the alteration of the natural air condition of that place thereby, causing breathing complications that discomforts or harms the health of human and animals as well as destroy plants and vegetation that all play vital functions and services in any ecosystem (Simbi-Wellington, 2020).

The increasing spate of illegal refining heightens the presence of pollutants (conceptualized as blighted, wrecked or ruined carbon and impurities in the air, land and waterbody. In specificity, a pollutant is a carbonaceous substance produced from incomplete combustion of coal, wood and oil that is synonymous with artisanal refining processes (UNEP, 2011; Cho, 2016; Giwa *et al*., 2017). This standpoint could imply that illegal or artisanal refining could account for the release of majority of the pollutants from spatial land-use activities. Thus, the eventual release of pollutants into the atmosphere alters the erstwhile clean and decent air quality to polluted air that is saturated with pollutants. Pollutants are so tiny that they can penetrate the spores on the human body and the nostrils thereby, affecting human visibility and health as well as harm ecosystems, reduces agricultural productivity and exacerbates global warming (WHO, 2017; UNESCO, 2020).

The sufficient concentration of solid, liquid and gaseous substances or elements over a period of time and under certain concentration would give rise to air pollution that would tend to interfere with human, biodiversity and environmental health, welfare and safety (WHO, 2014; 2022). Monday (2018) reiterated that air pollution occurs when harmful substances including particulates and biological molecules are introduced into the atmosphere causing alteration of the atmospheric conditions. Implicitly, the alteration of the atmospheric conditions can cause discomfort and unsafe conditions to humans resulting to diseases, allergies or death to humans as well as causing harm to other living organisms such as animals, and food crops that may damage the natural or built environment.

In specificity, the presence or existence of toxic or harmful pollutant substances in the air, cloud or atmosphere accentuates air pollution that would in-turn affect human and environmental health and wellbeing in and beyond the source region or area (Ede & Edokpa, 2015). In a nutshell, human-driven spatial land-use activities appear to be one of the major source of air pollution with contaminants likely to negatively impact firstly on the immediate and adjoining environment (Osuoha, 2017). Corroborating these views, Onugha (2022) observed that the consequence of these pollutants could have debilitating or devastating effects on the edaphic, aquatic and atmospheric systems and resources as well as biodiversity and humans in and around the particulate matter sourced or generated and saturated environment.

The saturation of pollutants on the air would severely impact on human health and skin include; skin aging, atopic dermatitis and psoriasis (Drakaki *et al*., 2014), eye and skin irritation (Ideal-response, 2021), skin cancer (Kohanka & Kudasz, 2022) including eczema, urticaria, rashes and skin infection (Puri *et al*., 2017). Also, impurities or pollutants in the atmosphere can trigger respiratory diseases such as asthma, skin disorders and reproductive problems from exposure to polluted air that can lead to the presence of black carbon (i.e. black patches and droppings) on roof surfaces, cars, floors, windows, etc. (Owhor *et al.*, 2023). Thus, the varying effects of gas flaring on the quality and health of humans and the environment put to naught the oil companies' idea of saving operational costs for venturing into gas flaring as well as consideration of the revenue of about 85% and 90% of the country's earning and export respectively generated from petroleum (Izah & Ohimain, 2015). In light of the foregoing, Monday (2018) stressed the relevance of integrating mitigating strategies to address the transboundary effect of air pollution, which could severely impact a very long distance beyond the pollutant sourced area, community or environment hosting that spatial land-use activities like crude oil exploration, artisanal refining, etc.

The integration of a non-environmentally friendly option like gas flaring during a human-induced land-use activity (like crude oil exploration) could lead to the emission of particulate matter pollutants like CO_2, NO_2, So_2, H_2S, CH_4, CO, NH_3, Pm 2.5, and Pm 10. The presence of these pollutants overtime distorts and dislodges the natural air components thereby, escalating the fragility and pollution of the environment. Besides, the inability of the environmental regulatory institutions notably; the Federal Ministry of Environment (FME) and National Environmental Standards and Regulations Enforcement Agency (NESREA) to effectively implement anti-flaring policies in Nigeria is indeed worrisome. This scenario has resulted in institutional fragility evident in ineptly creating a conflict and conundrum of setting and extending the time limits to end gas flaring in Nigeria, initially planned to end in 2000, 2010, 2015, 2020 and now extended to 2030.

Unfortunately, while the issue of gas flaring persists in Nigeria, toxic chemicals like carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxide, ozone, etc. are daily released into the atmosphere. Thus, the concentration of these particulate matter pollutants results in climatic change, distorting the ecosystem services, functions and supports for the native flora and fauna. Also, the resultant natural distortions could devastate the health and livelihood of humans or residents in and around the environment that is exposed to the toxins that aggravate their susceptibility to skin problems like rashes and respiratory problems like asthma, chronic bronchitis, etc.

Amidst the adverse environmental effects of gas flaring, the connivance of the government, and its regulators with multinational oil companies to present insufficient data linking the destruction of the ecosystem with gas flaring is indeed more problematic. Therefore, this study examine crude oil exploration activities and particulate matter pollutants concentration in selected Rivers East and Rivers South-East Senatorial Communities, Rivers State. The study would enhance the adoption of ethical exploratory activities that would sustain and improve the total environment in the study area.

2.0: STUDY AREA

Igwuruta and Bodo are two communities selected from Ikwerre Local Government Area in Rivers East Senatorial District and Gokana Local Government Area in Rivers South-East Senatorial District, respectively. Geographically the facility is located on longitude 7° 0' – 7^0 10'E and latitude 4^0 31' – 4^0 40'N in Rivers State of Nigeria (Gobo *et al*., 2009). Also, Igwuruta community is bounded on the north by Okomoko community (Etche Local Government Area), on the south by Eneka community, on the east by Rukpokwu community (both in Obio-Akpor Local Government Area), and on the west by Omagwa community (Ikwerre Local Government Area).

Similarly, Bodo community is located approximately on latitude 4° 66' 049'' N longitude 7° 28' 347'' E (Geody, 2017). Equally, the meteorological conditions of these two communities in the study area display climatic characteristics that could be classified as semi-hot equatorial zone. The equatorial maritime air mass characterizes the climate with high humidity and heavy rainfalls (annual mean ranges between 72% -81% and 3,000mm-4,000mm while average monthly temperatures vary from 28°C to 33°C and 21°C to 23°C, respectively (Oweisana *et al*., 2021). As indicated in figures 1 and 2, economically, both communities have oil installations. Igwuruta community play host to Agbada flow station (as a legitimate and approved exploratory land-use activity) while artisanal or illegal refining activities was investigated at Bodo, which is also an oil bearing community (Shell Nigeria, 2017). However, both the legitimate and approved exploratory crude oil activity in Igwuruta community as well as the illegitimate artisanal crude oil refining activities in Bodo community practice "open gas flaring". Gobo (2009) described this as an illegal practice with far-reaching social, economic, health, aesthetic and developmental effects on humans, biodiversity and environment.

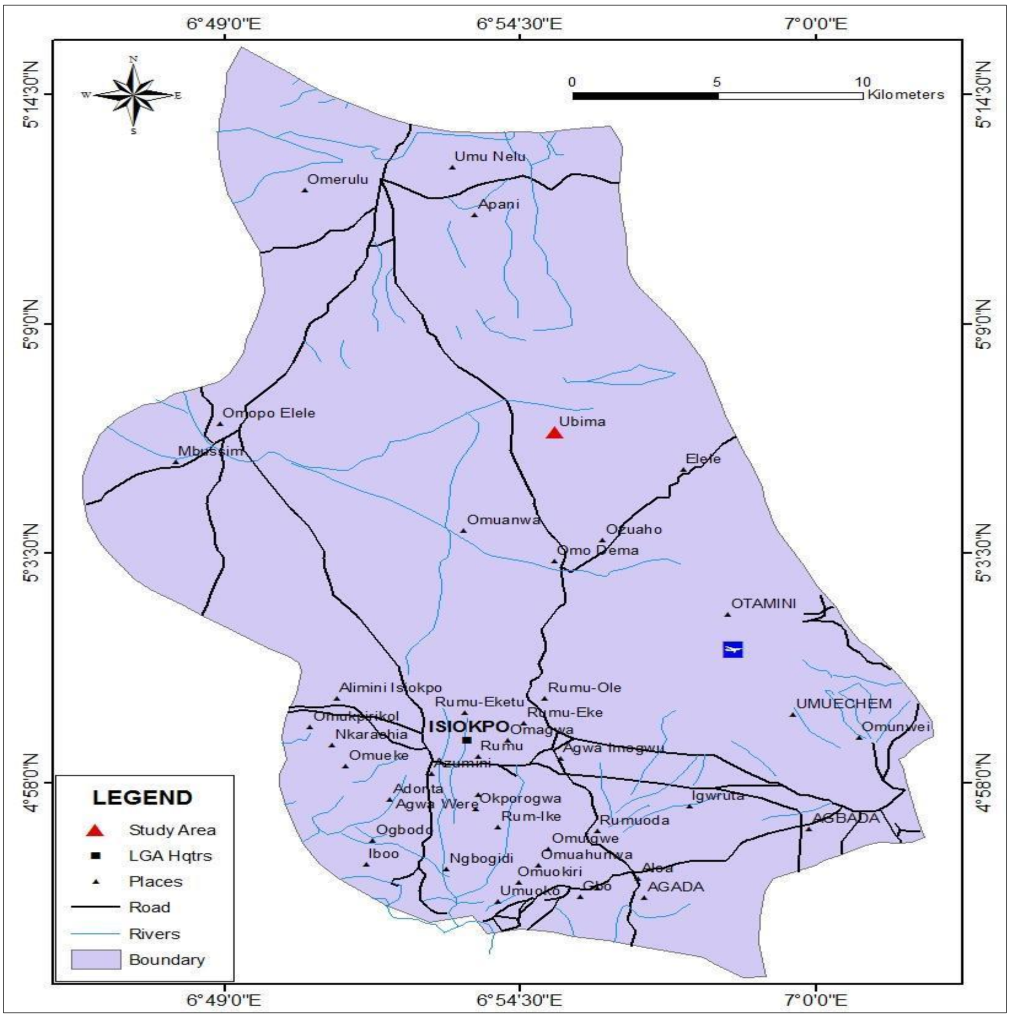

Figure 1: Ikwerre Local Government Area showing Igwuruta Community

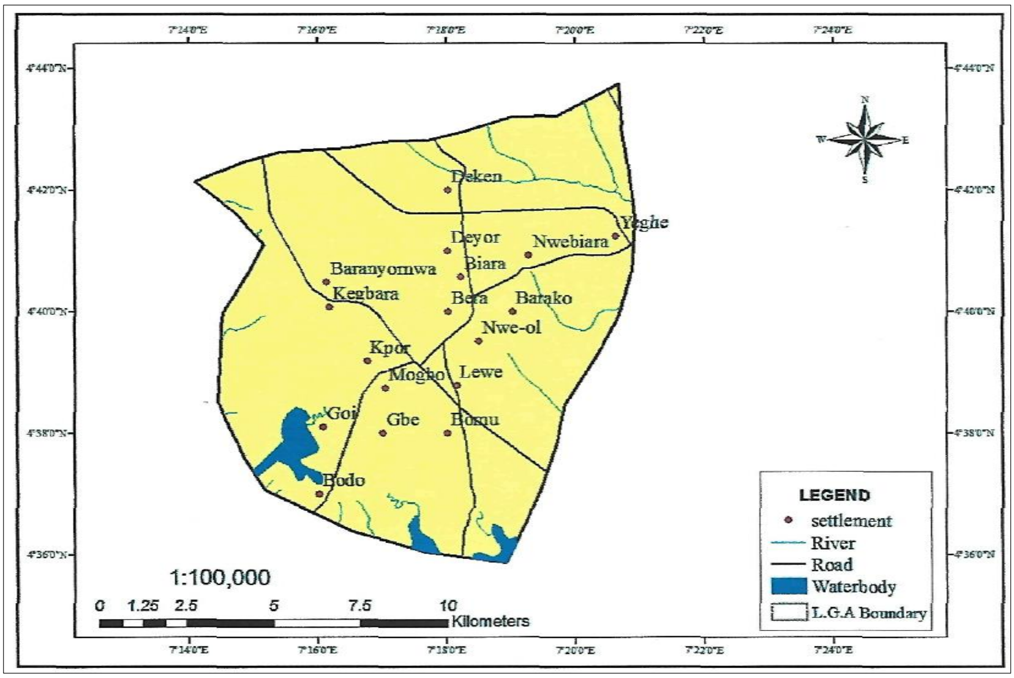

Figure 2: Gokana Local Government Area showing Bodo Community

3.0: MATERIALS AND METHODS

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, 2016). Furthermore, the study also adopted the completely randomized block design (CRBD) due to the similarity of the experimental points. Four (4) sampling points or stations across the two (2) sampled communities were 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), and Station B (Downstream of the Agbada Flow Station II) both in Igwuruta community. While Station C (St. Pius College), and Station D (Artisanal refining site) were all located in Bodo community. The coordinates of the sampling stations include: Point A (100m from the flow station) with Northings-04^0 55' 57.0"N, and Eastings- 007^0 0' 55"E, Point B (200m from the flow station) with Northings- 04^0 55' 57.0"N, and Eastings- 007^0 0' 56"E. Also, Point C (500m from artisanal refining site) with Northings- 04^0 37' 33.1"N, and Eastings- 007^0 16' 16.50"E, and Point D (100m from the artisanal refining site) with Northings- 04^0 61' 91.106"N, and Eastings- 007^0 28' 97.348"E.

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 Agbada flow station in Igwuruta community and artisanal refining site in Bodo community. 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. Relevant Statistical Analytical tools like mean, and clustered column chart were utilized to determine the objectives stated in this study.

4.0: RESULTS

Table 1: Concentration of the particulate matter pollutants (PMPs) in the exploratory land-use activity existing in each of the selected communities in the study area

PMPs	Unit	Igwuruta Community		Bodo Community		WHO Daily Standard Compared
		ST A	ST B	ST C	STD	
Pm 2.5	μg/m^3	0.009	0.009	0.011	0.018	35 μg/m^3
Pm 10	μg/m^3	0.013	0.013	0.016	0.022	150 μg/m^3
NO_2	μg/m^3	0.056	0.064	0.069	0.098	100 ppb
CO	μg/m^3	0.2	0.2	0.4	0.5	0.200 μg/m^3/9 ppm
SO_2	μg/m^3	0.00	0.00	0.00	0.00	75 ppb/ 0.5 ppm
CH_4	μg/m^3	0	0	0	0	0.83 μg/m^3
H_2S	μg/m^3	0.00	0.00	0.01	0.01	125 μg/m^3
O_3	μg/m^3	0.02	0.01	0.03	0.04	0.10 μg/m^3
NH_3	μg/m^3	0.2	0.2	0.3	0.3	0.53 μg/m^3
CO_2	μg/m^3	613	565	594	572	462 μg/m^3
Temp.	^{o}C	34.0	30.4	32.3	34.6	-

Source: *Researcher's Fieldwork, 2024; WHO, 2005; Akpoghelie et al., 2016; USEPA, 2016.*

The various particulate matter pollutants in the exploratory land-use activities are shown in Table 1. The result of the parameter measured revealed that Station A (i.e. Igwuruta community) had the highest concentration of CO_2, (613 ppm) than Stations C and D (Bodo community) with 694 ppm and 572 ppm respectively. However, the concentrations of CO_2 in all the sample stations were higher than the WHO approved limit of 462 ppm for CO_2 in the air. Also, Stations C and D (i.e. Bodo community) had the highest concentrations of Pm 2.5 (0.011 μg/m^{3}and 0.018 μg/m^3 respectively), Pm 10 had the highest concentration of 0.022 μg/m^{3}and 0.016 μg/m^{3}for Stations D and C respectively. Similarly, Stations C and D had the highest concentration of O_3 (0.03μg/m^3 and 0.04μg/m^3 respectively). For CO, Bodo community had the highest concentrations of 0.4 μg/m^3 and 0.5 μg/m^3 than the Stations in Igwuruta community with 0.2 μg/m^3. While the highest concentrations of 0.098 μg/m^{3}and 0.069 μg/m^{3}for NO_2 that were recorded at Stations C and D in Bodo community were higher than the concentrations of 0.064 μg/m^{3}and 0.056 μg/m^{3}for NO_2 obtained at the sampled stations in Igwuruta community. However, the concentrations of Pm 2.5, Pm 10, O_3, CO, and NO_2 in the selected communities were all below the WHO approved limits of 35 μg/m^3, 150 μg/m^3, 100 μg/m^3, 200 μg/m^3, and 100 ppb respectively.

Station D (i.e. Bodo community) had the highest Temp. (34.6 ^{o}C) than Station A (Igwuruta community) with 34.0 ^{o}C. Also, the concentrations of 0.00 μg/m^3 and 0 μg/m^3 for So_2 (Sulphur Dioxide) and CH_4 (Methane) respectively around the sampled communities were the same but still fell below the WHO approved limit of 75 ppb/0.5 ppm and 0.83 μg/m^3 for So_2 and CH_4 respectively. While H_2S (Hydrogen Sulphide), and NH_3 (Ammonia) had the same concentrations in the sampled stations in the Igwuruta community and Bodo community. Furthermore, the result in Table 1 implies that Station D (artisanal refining site at Bodo community) was the hottest, and Stations C and D (i.e. Bodo community) were filled with the highest level of impurities or pollutants in the air. Hence, the high concentration of Co_2, Temperature, O_3, Pm 2.5, and Pm 10 indicates that the residents around the Bodo community could be susceptible to internal heat, hearing defects, shock, and possible hypertension from exposure to the pollutants.

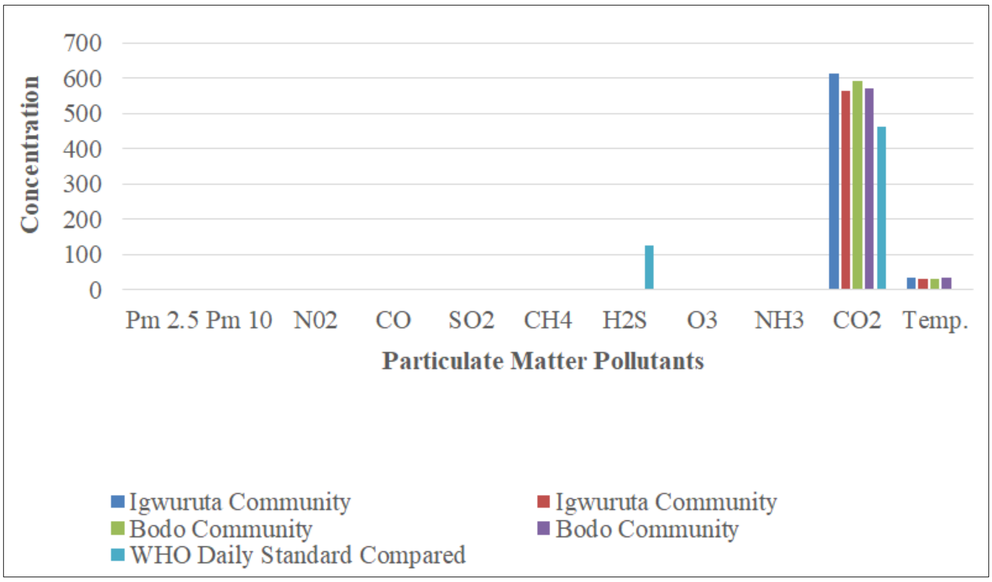

Fig. 3: Mean concentration of the particulate matter pollutants in the exploratory land-use activity existing in each of the selected communities in the study area

Table 2: The impact of the mean concentration of the particulate matter pollutants in the study area

PMPs	Igwuruta Community	Bodo Community	WHO Daily Standard	Decision	Impact on Biodiversity	Impact on Humans
CO_2	589 μg/m^3	583 μg/m^3	462 μg/m^3	Very High	Short and long term effect leading to the: Discolouration of vegetation and intense heat of animals	Short and long term vulnerability to: Skin diseases or disorders, cancer, ear problems, respiratory problems
CO	0.2 μg/m^3	0.45 μg/m^3	0.2 μg/m^3	Very High		
O_3	0.02 μg/m^3	0.035 μg/m^3	0.10μg/m^3	Very High		
NO_2	0.060 ppb	0.084 ppb	0.100 ppb	Fairly High		
SO_2	0.00 ppm	0.00 ppm	0.5 ppm	Fairly High		
NH_3	0.2 μg/m^3	0.3 μg/m^3	0.53μg/m^3	Fairly High		
Temp	32.2 ^{o}C	32.3 ^{o}C	-	Hot		
Pm 2.5	0.009 μg/m^3	0.0145 μg/m^3	35 μg/m^3	Poor air quality	Breathing Difficulty	Breathing Difficulty
Pm10	0.013 μg/m^3	0.021 μg/m^3	150 μg/m^3			
CH_4	0 μg/m^3	0 μg/m^3	0.83 μg/m^3			
H_2S	0.00 μg/m^3	0.01 μg/m^3	125 μg/m^3			

Source: *Researcher's Computation*, *2024*

This table 2 describe the impact of the mean concentration of the particulate matter pollutants on the biodiversity and humans in the exploratory land-use activity existing in each of the selected communities in the study area. The presence or concentration of CO_2, NO_2, O_3, So_2, H_2S, CH_4, CO, NH_3, Pm 2.5, and Pm 10 in the air or environment around the Agbada flow station in Igwuruta community and the artisanal refining site in Bodo community indicates the higher likelihood for the discolouration of vegetation as well as intense heat by animals (see Plates 1 and 2). Also, the high concentration of CO_2, NO_2, O_3, So_2, H_2S, CH_4, CO, NH_3, Pm 2.5, and Pm 10 in and around Igwuruta and Bodo communities could make the residents in these areas to be highly susceptible to skin diseases, cancer, ear problem, respiratory problems or breathing difficulties that heighten the possibility of contacting of cough, cold and carthar, etc.

Plate 1: Discoloured vegetation at St Pius College 500m close to the Artisanal Refining Site in Bodo Community

Plate 2: The colour of the vegetation 100m from the Agbada Flow Station in Igwuruta Community

5.0: DISCUSSION OF FINDINGS

The result in Table 1 revealed that the concentration of particulate matter pollutants like CO_2, $N0_2$, O_3, SO_2, H_2S, CH_4, CO, NH_3, Pm 2.5, Pm 10, and Temperature in the artisanal refining sites in Bodo community was higher than that in the environs around the Agbada flow station in Igwuruta community. This finding aligns with the studies conducted by (UNEP, 2011; Cho, 2016; WHO, 2017; WHO, 2018; & UN, 2020) that artisanal refining account for the release of majority of the pollutants into the atmosphere that eventually alters the erstwhile clean and decent air quality to polluted air. Thus, the accumulation of these heat causing, climatic distortion, global warming exacerbating and health-impacting pollutants that affect human visibility, breathing and skin as well as harm ecosystems thereby, leading to reduced agricultural productivity in the society.

Also, the result in Table 1 revealed that the concentration of CO_2 in Bodo and Igwuruta communities were both higher than the daily WHO standard or limit for CO_2 in the atmospheres while the other particulate matter pollutants like $N0_2$, O_3, SO_2, H_2S, CH_4, CO, NH_3, Pm 2.5, and Pm 10 were within the daily WHO standards or limits for the specific particulate matter pollutant. This finding is in agreement with the previous findings by Dami *et al*., (2012); Seiyaboh and Izah (2017) and Owhor *et al*., (2023) that gas flaring leads to the 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.

The result in Table 2 revealed a high concentration of Pm 2.5, Pm 10, CO, O_3, and Co_2, which affects the environs around Bodo and Igwuruta communities. The high concentration of Pm 2.5, Pm 10, CO, O_3, and Co_2 indicates poor air quality which implies that the residents around the Bodo and Igwuruta communities could experience or suffer from skin diseases, cancer, ear problem, respiratory problems (like possibility of possible contacting of cough, cold and carthar, etc. Instructively, CO_2 value reduces as you move away from the gas flare point. Equally, CO_2 values from the study areas tend to reduce across sampling periods thereby showing both temporal and spatial variation. This finding is consistent with earlier finding by Ozabor and Obisesan (2015) that high concentration of temperature from flared gases has the tendency to stir hot climate that affect several plant species especially productivity and growth. In addition, this finding is consistent with the studies by (Drakaki *et al*., 2014; Giwa *et al*., 2014; Giwa, 2017; Puri *et al*., 2017; Kohanka & Kudasz, 2022; & Owhor *et al*., 2023) that humans exposure to air that is inundated with pollutants accentuates the presence of carbonaceous black carbon or black soot substance on roof surfaces, cars, floors, windows, etc. alongside triggering skin problems (like eczema, urticaria, atopic dermatitis, rashes, skin aging and skin infection), respiratory disorders like asthma, bronchitis, etc. as well as health effects that can climax to reproductive complications.

6.0: CONCLUSION

The study established that both the legitimate and illegitimate crude oil exploration activities in Igwuruta and Bodo communities respectively were conducted in defiance to the operational, regulatory and environmental standards thereby, accentuating the issue of gas flaring. However, the flare of gas from the artisanal refining site in Bodo community led to the emission and high concentration of pollutants like CO_2, NO_2, O_3, So_2, H_2S, CH_4, CO, NH_3, Pm 2.5, Pm 10 and Temperature more than the concentration in the Agbada flow station in Igwuruta community. The high concentration of Pm 2.5, Pm 10, CO, O_3, Co_2, and NO_2 could significantly contribute to poor air quality. Thus, the presence of poor quality air saturated with smog and soothe could increase humans exposure and vulnerability to eczema, rashes, other skin diseases, eye irritation, cancer among other respiratory problems. In specificity, breathing complications could heighten the possibility of contacting mild infectious diseases like cough, cold and carthar as well as severe respiratory diseases among which include asthma, heart pain and chronic bronchitis in and around these two selected communities.

7.0: RECOMMENDATIONS

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

1. The government should as a matter of urgency ensure that the management of the Agbada flow station embarks on an unbiased, all-inclusive, comprehensive and implementable UNEP recommended pre and post procedural environmental and social impact assessment in order to adopt sustainable oil exploration methods that would help preserve and enhance the wellbeing, health, and safety of the humans, biodiversity and environment in the two communities.
2. Given the high concentration of CO_2, more trees specifically the "*Dogoyaro*" should be planted to absorb the excess CO_2 that accentuates the buildup of black carbon or black soot that can dirt car windshield, roof surfaces, house floors and windows including causing skin: rashes, aging and infections, asthma, bronchitis among other health effects on the residents around the environs of the Agbada/Igwuruta flow station and Bodo artisanal refining site.
3. High temperature-resistant plants especially Lantana should be planted in the communities bordering the Agada/Igwuruta flow station and Bodo artisanal refining sites with high intensity of temperature.

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