ASSESSMENT OF GREENHOUSE GAS EMISSION STATUS FOR SELECTED AREAS IN DAKACE TOWN, ZARIA, KADUNA STATE

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Abstract: Air pollution emissions are commonly known as air pollutants are species found in the air that cause acute or chronic human health problems and negative environmental impacts. GHGs are not toxic unless at extremely high concentrations, and the concentrations in the atmosphere may cause global warming and climate change which may cause Ozone layer depletion. The main objective of this research is to assess Greenhouse gas emission status of some selected areas in Dakace town (an industrial area) in Zaria, Kaduna State for the period of six months. The study employed multiple regression method of data analyses where carbon dioxide (CO_2) is the dependent variable and Oxygen (O_2) Carbon monoxide (O), Humidity (H) and the Temperature (T) are the independent variables of the study. The study found that the positive coefficient shows that there is a strong influence on residual of carbon dioxide concentration while the negative coefficient shows the reduction in residual carbon dioxide emissions concentration. The study recommends that to reduce the adverse effects from reservoir GHG emissions is to adhere to the environmental protection protocols and policies as well as using of renewable sources of energy for powering of plants in industry and development of yearly GHG emissions measurement and inventor.

Keywords: Carbon Dioxide, Carbon Oxide, Emission, Greenhouse gas, Pollution

1. INTRODUCTION

Air emissions are air pollution emissions and greenhouse gases (GHG) emissions. Air pollution emissions are commonly known as air pollutants are species found in the air that cause acute or chronic human health problems and negative environmental impacts. GHGs are not toxic unless at extremely high concentrations, and the concentrations in the atmosphere may cause global warming and climate change which may cause Ozone layer depletion. Air pollution is taking place when unwanted materials are added to the air, especially in large quantities, resulting in effects on the environment and health. These unwanted materials include carbon dioxide gas, liquid droplets and / or solid dust particles. A material is known as an air pollutant only when it is against the interest of human beings (Tan, 2014).

Similarly, Pepper *et al.,* (2006) stated that particulates contaminants (wastes) are either of natural or human-made origin. These particles can pollute both air and water.

Nowadays, industrial pollution is the fast major problem faced by many developing countries. The extensiveness of these problems is affecting the economies negatively. This is as a result of the absence of reliable and comprehensive system of monitoring of environmental data on industrial emissions. Recently advances, are being gained on cheaper and reliable ways of monitoring and generating environmental data on industrial emissions. Nowadays models are gaining wide acceptance in this area as such models are currently in used by organizations like the Industrial pollution projection survey (IPPS). Hence, the importance of monitoring and data recording of greenhouse gas emissions cannot be overemphasized (Etim, 2012).

On the greenhouse gases monitoring equipment, Schifftner (2014) stated that air pollution control equipment are usually

sized based on the actual volume, temperature and pressure of the gas or mixture of gases that must pass through the unit at a particular stage of the separation process. Nowadays there are handheld portables monitoring equipment.

Sources of air pollution could be man-made or natural. The man-made sources are what to focus on due to the fact that it can be control. Both gases and particulates sources are pollutions that are troublesome. Standards have been set for concentrations for both of these materials in the atmosphere and emission from industries (chimneys) for those sources considered to be harmful. The concentration and the flow rate of the emissions are information required to determine the downwind transport of the pollutants. Annually the Environmental Protection Agency (EPA) is estimating the quantities of pollutants emitted (Brown *et al.*, 2022).

OECD (2018) stated that the best available techniques known as "BAT" has produced a concept as a key policy tool for preventing and controlling industrial emissions, thus ensuring a high level of environmental and human health protection. BAT and similar concepts state essential elements for setting limit values of emissions and other conditions (permits) for industrial emissions in many developing countries around the world.

The burning of fossil fuels by industries at the current rate can cause global warming and climate change, which as a result causes the chain reactions of ice (melting), land flooding, desert formation, tornadoes, hurricanes, extinction of species, diversion of ocean current etc.

Theodore (2008) stated that there are two fundamental purposes for the cleaning (mitigating) of gas emissions from industries, which are profit and protection.

Nigeria as the most populous nation in Africa, is witnessing rapid industrial development most especially in the major cities. Dakace is one of such industrialized area located in Zaria local government area of Kaduna states in the northwestern Nigeria.

Despite several works on three principal greenhouse gases (GHGs); Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the atmosphere, report regarding the effects of the concentrations of some of these gases on the environment are lacking. Also, there is insufficient information to understand spatial and temporal changes in GHGs (CO_2, CH_4 and N_2O) concentration and emission pathways in the water bodies, dams and reservoirs. Therefore, this research is a novel attempt to understand the emission of GHGs from such water bodies. Nigeria as a developing country is evolving gradually; it is paramount to be concerned about all causes of climate change that could have significant impact on the environment such as GHG emission. The selected sites are multipurpose, impacting various aspects of human life, supporting activities such as industrial activities, farming, irrigation, laundry etc. These activities have significant impact on sustainable development. Therefore, this research will help in developing policy and guidelines on environmental impact resulting from GHG effect in the sites. It will also improve available information and serve as a tool to support sound decisions on the GHG status of existing and new water bodies and provides mitigation measures that may be necessary. This research will thus contribute significantly in providing accurate first-hand information on the GHG status of the selected sites as it might affect the Dakace and its environment in Zaria local government area.

The main objective of this research is to assess Greenhouse gas emission status of some selected areas in Dakace town (an industrial area) in Zaria, Kaduna State for the period of six months.

1. METHODOLOGY

2.1 Description of Study Materials

In carrying out this research, the following materials and equipment in Table 1 were used.

Table 1. Equipment used for the Research

S/No.	MODEL OF EQUIPMENT & USES
1	eTREX LEGEND GARMIN Coordinate (GPS) / measures GPS and Altitude
2	MSN ALTAIR (4XR) / Air Quality Monitor / measures O_2, H_2S
3	Aeroqual Series 500 / Air Quality Monitor / measures NH_3, C_2O, CO, HC_4
4	LT Lutron SP-8001 / Air speed monitor / measures Air speed
5	HT-9600 Air Quality Detector / Air Particle Monitor / measures Air particle, Temperature and Humidity
6	Steinberg System / Noise Monitor / measures Noise level

2.2 Data Collection Method

In each of the sampling points (P1, P2, P3 and P4), three measurements were taken, including the selected control point. The characteristics of the points (such as Air speed, Temperatures, Humidity, Noise, Views and Activities) were also taken in order to enable capture the influence of the gas emission which is caused by anthropogenic activities. The selected points Contro (Dakace community market), Point 1 (100 meters away from Sunseed company), Point 2 (50 meters away from Sunseed company), Point 3 (adjacent of Sunseed company) and Point 4 (50 meters away from rear side of Sunseed company). The points were investigated twice in a month for four months. Varieties of air quality monitoring, portable gas detector, temperature and relative humidity monitoring equipment were used as indicated in Table 1. The data collected will be analyzed using suitable software.

2.3 Description of Study Area

The research location is Dakace, Zaria (see Plate I) located at 11º 09’ 52’’ N & 07º 44’ 37’’ E. The site is within an industrial area with companies such as Sunseed Oil Field, Zaria. There is also a major water body located some meters away from the companies, named river Galma which crosses the New Jos Road adjacent to the Dakace town, Zaria.



Plate I. Dakace and River Galma View

2. RESULTS AND DISCUSSION

The research work commenced in the month of October 2022, comprehensive results of the amounts of GHG emissions and other attributes (weather) were taken and recorded as shown in Figure 2, 3 … and 6 for four consecutive months.

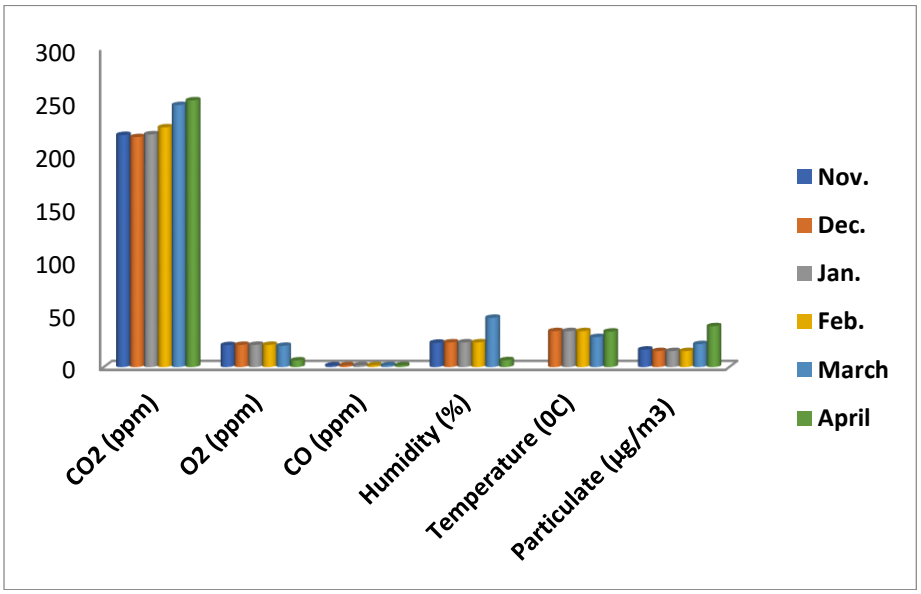

Figure 1. Summary of the Average GHG Emission and Important Weather Attributes of Dakace Area for Months of November –to- April, 2023.

Figure 1 is indicating the average GHG emission and some important weather attributes observed during the period of November, December, January, February, March and April of 2022/2023. The presence of CO_2 was recorded as the predominant GHG gas. The figure also showed a sudden decrease of O_2 in the month of April, which can be attributed to the higher CO_2 emission generated in the same month of April in other words the O_2 level was depleted due to the fact that higher quantity of O_2 is required to oxidized the large quantity of greenhouse gases (CO_2) produced as the company resumed its activities fully in the month April. The CO_2 discharge records exhibits the following decreasing order trend; April, March, February, January, November and December having 250 ppm, 246 ppm, 225 ppm, 219 ppm, 218 ppm and 216 ppm respectively. The higher CO_2 emission during the months of April to February as well as lower in the months of November and December can be attributed to the fact that the company must have return to production fully after end of year (December) break. The GHG emissions recorded for all the four months were all found to be at global safe level target of 350 ppm as recommended by Intergovernmental panel on Climate Change [PCC] (2022) and Goga *et al.* (2022).

The weather attributes and flammable gases measurement in Dakace was depicted in Figure 1 as well, which shows maximum average temperature of $33.72^{O}C$ recorded in all the months with exception of March, whereas Humidity of 46.25% was note as the highest in the same March. Noise of about 77.00 dB at Points 1 and 2 areas were recorded with the higher PM2.5 particulate emission of 38.38 $\mu g/m^3$, which implies that the Air quality is satisfactory posing little or no risk according to Air quality index (AQI) guide of IQAir monitor 2023. The particulate concentration at Point 1 and 2 was as a result of the fast-moving wind speed blowing towards the eastern direction during the months, hence carrying the tiny particles and releasing them at Point 1 and 2. Small sings of flammable gases were only detected at Point 3 and 4, which were due to the closeness of the areas to the company's exhaust.

3.4 Development of a Statistical Model for Predicting GHG emission

Developing of model equation was carried out using multiple linear regression method was adopted in Microsoft Excel software. Some variables of the test were used in predicting the GHG emissions are CO, O_2, temperature and humidity of the environment. Using ANOVA analysis and regression analysis, the carbon dioxide (CO_2) is the dependent variable, while the Oxygen (O_2) Carbon monoxide (O), Humidity (H) and the Temperature (T) are the independent variables (see Table 2).

Table 1. Regression Model Equation and ANOVA Summary Output

Regression Statistics	
Multiple R	0.998968
R Square	0.997937
Adjusted R Square	0.989685
Standard Error	1.556877
Observations	6

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	4	1172.51	293.13	120.93	0.068
Residual	1	2.42	2.42		
Total	5	1174.94			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	702.1	136.10	5.13	0.12	-1038.6	2
O2	9.15	3.151	2.90	0.21	-30.89	49.19
CO	406.4	96.28	4.22	0.14	-816.96	1678
Humidity	-7.63	2.22	-3.43	0.18	-35.82	20.57
Temperature	-33.83	8.79	-3.85	0.16	-145.52	77.86

Where the following can be deducted from the analysis;
R^2 = 0.997973 = 99.7%
$CO_2 = 702.1739+9.150282O_2+406.4122CO–7.62523H–33.8277T$ …… *Equation 1.0*

Where, CO_2 is the Carbon dioxide emission in ppm, O_2 is the Oxygen gas emitted in ppm, H is referring to the weather Humidity in % and T is the temperature in degree Celsius. Considering a Null hypothesis that Humidity and Temperature has no significant effects on the GHG yield at Dakace town. The positive coefficient shows that there is a strong influence on residual of carbon dioxide concentration while the negative coefficient shows the reduction in residual carbon dioxide emissions concentration. It was observed that the coefficient of determination (R^2) for the fitted model is 99.7% which implies that about 99.7% variation in the dependent variable was explained by the explanatory variables. This shows that the model is good enough to be used in forecasting GHG emissions CO_2 concentration in the atmosphere.

3. CONCLUSION

From the obtained results and the analysis, the following conclusion and recommendations are made;

i. Carbon Dioxide (CO_2) was recorded as the predominant Greenhouse gas (GHG) emission affecting Dakace area.

ii. The higher GHG emissions recorded in Dakace area were noted to be taking place in the months of April and March, which is attributed to the huge amount of smoke produced by Exhaust of diesel engines of the industry.

iii. The study found that the highest (CO_2) emissions of 281 ppm was recorded at Point 3, which was within the range of global safe level, this is in line with IPCC (2022) and Goga *et al.* (2022) recommendation of a target of 350 ppm level of GHG emission.

iv. At 0.05 level of confidence, spatial features were found to have statistically significant effects on the level of the GHG emissions at the site.

v. Conclusively, a strong correlation was found to exist between the Temperatures,

Humidity Wind speed and GHG emissions at the site.

4. RECOMMENDATIONS

A way to reduce the adverse effects from reservoir GHG emissions is to adhere to the environmental protection protocols and policies. Using of renewable sources of energy for powering of plants in industry. Development of yearly GHG emissions measurement and inventory.

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