Environment Pollution and Climate Change

Research Article Open Access

$_2$ gas has always been overlooked. In the face of climate change þoods along river, experience nutrient loading from þood waters, and tend to release CO_2 in signiýcant amounts. The present study therefore examines two climatic factors as these relate to $_2$CO concentrations along river Nworie and compared with control. Reconnaissance study with land use namely bridge, road construction, busy junction and waste dumpsite were designated sampling points while the control was an area with very little anthropogenic disturbance. CO_2 concentrations were measured three times daily, for seven weeks and weekly average was recorded using CO_2 analyzer AZ77535. Temperature and relative humidity were measured concurrently as CO_2 concentrations. Results showed that CO_2 concentrations ranged from 500 ± 7.35 to 579 ± 4.18 ppm with average value of 575.5 ± 2.76 ppm which was higher than control (470.71 ± 15.43 ppm). Temperature was lowest at point B and D (30.7°C) and showed an average ranged of 33.03 ± 0.76 to 38.35 ± 1.65°C> Control (29 ± 0.82°C). Relative humidity (RH) was generally low at all points with an average of 56.18 ± 1.18 to 68.98 ± 1.43% <control (66.70 ± 6.37%). Standard deviations were low for all parameters signifying good results with all parameters showing 0.5% to 10.3% variability. All relationships between $_2$CO temperature and CO_2/RH were positive and better described as exponential relationship. Anthropohenic impact estimate were very high with respect to control point which ranged 103.88% to 127 Nigeria 25%. The high estimate obtained suggested that the many activities experienced along the river is causing high temperature and thus high $_2$CO concentrations. However, a bigger study with more study sites is required to elucidate more accurate distributions of emissions and their source regions for tracking the changes associated with anthropogenic activities and emission mitigation policies.

K **:** Climate change; Greenhouse gases; Pollution; Relative humidity; Temperature; Wetlands

I

e worldwide concern with global climate has highlighted the challenges faced by both industrialized and developing countries on the issue of increasing greenhouse gas emissions. ese gases are chloro uorocarbons (CFC), carbon dioxide (CO_2), methane (CH_4), and nitrogen oxides (NO_x) which absorbs the radiation in the earth atmospheric system. Excess of these gases o en a ect the environment causing global warming [1]. While the greenhouse e ect has been bene cial to maintain global temperatures compatible to human life, recent increases in average temperatures due to human activities are causing great alarm.

Of all greenhouse gases responsible for global warming, CO_2 is of major concern. Atmospheric CO_2 is produced naturally from volcanic out gassing, the combination of organic matter and the respiration processes of living anaerobic organisms [2] and arti cially from combustion of various fossil fuels and deforestation etc. e arti cial sources of CO_2 emissions are generally thought to be responsible for global warming causing increase in atmospheric CO_2 by about 43 % since the beginning of the age of industrialization. In 2016, the Earth's atmosphere CO_2 concentration is averagely 402 parts per million (by volume) which continues to increase [3].

The concentrations of carbon dioxide in the atmosphere as well as climatic parameters such as temperature and relative humidity fluctuate slightly with the seasons and on regional basis. This is evident in some studies conducted from different areas of the world [4-11], in sub-Saharan West Africa [12-15] and Nigeria has been

River. It is about 9.2 km long. Imo state is situated in the southern rain forest vegetation belt of Nigeria, it has between latitude 5 ^{o} and longitude 7^{o} 34^{o}E. It has an annual rainfall of about 1700-2500 mm. e climate of the study area follows a tropical pattern with the rainy season lasting between seven and eight months between April and October with interruption in August and dry season running through November to March. Average humidity of 80%-85% occurs during the rainy season. Temperature is similar all over the state, with maximum values ranging from 280^{o}C to 350^{o}C and minimum values from 190^{o}C to 240^{o}C.

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e control is a land area that is saturated with water from the rainy season. e area experiences no anthropogenic disturbance and located around Bishop's Court, Owerri which is more than 7 km away from river Nworie. Geographically, it is located at Latitude-N 5^{o} 29.3623', Longitude-E 7^{o} 1.4622' and area is lled with grassland Figure 1a and 1b.

A CO_2

AZ 77535 CO_2 gas analyzer (AZ Technologies, Taiwan) was the instrument used to determine the CO_2 on the surface/air above the water. e instrument is designed with NDIR (Non-Dispersive Infrared) waveguide technology sensor. e instrument carried out automatic analysis of the sample of ambient air with the use of the physical properties that gives continuous output signal to the analyzer which returns the values of the CO_2, temperature and relative humidity, which were read from the screen. e instrument which was held at arm length from 280Maeguidson. Tm47 0ich wadataescreecattec

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Data analysis was done using Microso excel 2007 and values of all the results from the sampling points was recorded as calculated mean values of ambient temperature, relative humidity and air CO_2 concentrations for morning, a ernoon and evening hours. e standard deviation (SD) was determined and co-e cient of variation (CV %) was used to determine variation in the concentration of CO_2 between samplings points using equation 1.

$$CV(\%) = \frac{SD}{Mean} \times 100 \quad (1)$$

Variation was categorized as little variation (CV% <20), moderate variation (CV%=20-50) and high variation (CV% >50) [20-22].

Anthropogenicity was estimated according to [23] given in equation 2. It is the ratio actual carbon dioxide concentration to reference concentrations expressed in percentage. is estimates the impact of human activities on ambient concentration of carbon dioxide along river Nworie.

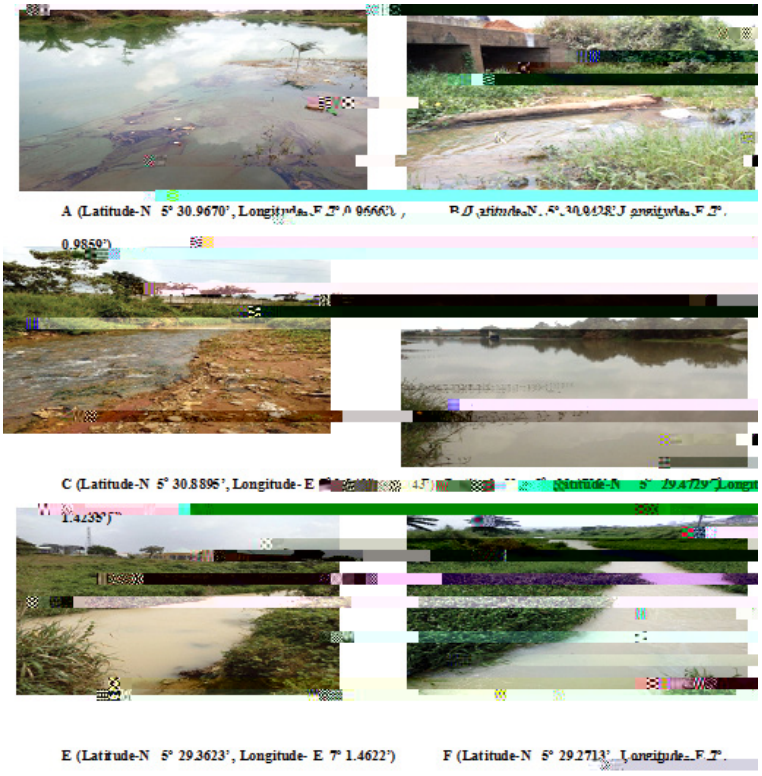
$$APn = \frac{Measured\ CO_2\ concentration}{Reference\ CO_2\ concentration} \times 100 \quad (2)$$

e control data were used as the reference concentrations.

D

e results for variability and basic descriptive statistical summary for temperature, relative humidity and ambient CO_2 concentration obtained at various points of the river for seven weeks during November and December 2016 is presented in Table 1. e weekly variations of meteorological parameters: (a) relative humidity (%) and (b) temperature (°C) along river Nworie during 2016 dry season (November and December) are shown in Figures 2 and 3. Mean reported for data collected daily in morning, a ernoon and evening hours.

e trend for CO_2 concentrations for the sampling points and control is presented in Figure 2. e concentration of atmospheric



A (Latitude-N 5° 30.9670', Longitude- E 7° 0.9666', 0.9850')

B (Latitude-N 5° 30.9428', Longitude- E 7° 1.4235')

C (Latitude-N 5° 30.8895', Longitude- E 7° 1.4238')

D (Latitude-N 5° 29.4729', Longitude- E 7° 1.4238')

E (Latitude-N 5° 29.3623', Longitude- E 7° 1.4622')

F (Latitude-N 5° 29.2713', Longitude- E 7° 1.5029')

Figure 1b:

CO_2 ranged from 550 ppm to 572 ppm in week one, from 547 ppm to 572 ppm in week two, from 544 ppm to 563 ppm in week three, from 536 ppm to 575 in week four, from 568 ppm to 579 ppm in week six while week seven showed ranges of 509 ppm to 574 ppm respectively. Higher concentrations were recorded in the present study when compared with concentration of 402 ppm recorded in early 2016 for average global concentration of CO_2. e obtained concentrations at river Nworie was generally higher than the control with range of 480 ppm (week one) to 490 ppm (week seven) and mean of 470.71 ±

relative humidity. Since, all R^2 values (regression coe cient) are positive. Regression coe cient is adjudged on the scale of -1, 0, +1. Positive relationship suggests the dependent variable and independent variable have direct relationship and vice versa for negative relationships while zero suggests no relationship.

All relationships showed positive slope during the study except in week 5 for temperature-CO_2 relationship. Meanwhile, negative slope were obtained in week 2, 5, 6 and 7 for relative humidity-CO_2 relationship. e relationship equations showed that the plots didn't follow the origin (0) and thus having high intercept. is observation follows the regression coe cient obtained suggesting that the relationship isn't perfect (<1). Positive relationship was also reported for CO_2 emissions from the lower Red River in Vietnam [30].

To determine which relationship is more pronounced with CO_2 concentration, we created a trend plot which compared the di erent relationships. e trend results are presented in Figure 5. Looking at Figure 5a critically, it could be observed that the relationship between CO_2 and temperature is better described by an exponential equation especially in the fourth week. Although a power and linear relationships followed closely. However, with relative humidity the trend follows similar pattern (Figure 5b). ere was high relationship was recorded in week 1 and 2 of the study which drops with weeks.

it is o en used to refer to emissions produced as a result of human activities. We estimate the impact based on data obtained from the control point. e computed anthropogenicity is presented in Table 3.

Generally, high anthropogenic impact estimate were obtained throughout the study period which ranged from 103.88% to 127.25%. e high estimate obtained suggested that the many activities experienced along the river is causing high temperature and thus high CO_2 concentrations. Activities experienced along this area include waste dumpsite which contains organic matter and in the presence of warmer temperature and moisture decomposes and oxidizes, releasing CO_2 in the atmosphere. Other activities include emission for automobile exhaust, automobile workshop, building constructions, road construction, destroyed vegetation mostly grasses and polluted water, sand mining and dredging on both sides of the Nworie River. e drainage and destruction can result in substantial carbon emission [31-33].

e week-wise trend for anthropogneicity is introduced in Figure 6. Week-wise impact showed that the highest human impact on CO_2 concentration was observed in the h week (126.04%) while the least in week one (100.26%). e week-wise impact follows the trend; week 5>week 6>week 4>week 2>week 7>week 1 respectively. Meanwhile, site-wise trend is introduced in Figure 7. e highest estimated value was obtained at point F (121.08%) and least recorded at point C (117.92%). e site-wise impact follows the trend; point F>point E>point B>point A>point D>point C respectively.

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With the rising global warming, awareness results from this work con rm elevated CO_2 concentrations over 44% above early 2016 average global CO_2 concentration. e concentrations according to sampling points varied with low % variability but it was observed that temperature had more linear and exponential relationships with CO_2 concentrations. Relative humidity exhibited similar trend for linear, exponential and power relationships with CO_2 concentrations. e various human activities have contributed to rising CO_2 concentrations along river Nworie which is con rmed by the high annthropohenicity (103.88% to 127.25%) recorded with respect to the control point. However, a bigger study with more study sites is required over multiple years to elucidate more accurate distributions of emissions and their source regions for tracking the changes associated with anthropogenic activities and emission mitigation policies.

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