Air Pollution and Environmental Implications in Kano Metropolis Nigeria

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Abstract. The study employed both quantitative and experimental approaches, CO and CO\textsubscript{2} was sensed and recorded with the aid of Carbon Monoxide Analyzer and Handheld GPS. Four hundred (400) structured questionnaires was administered and Volumetric traffic count was conducted along seven (7) major junctions across the study area. E. View 8 was adopted for the analysis. Carbon Sensing results depict that Fagge local government area recorded the highest out door CO of 012Ppm. On the other hand, Gwale local government is the top indoor carbon emitters with10Ppm. The field survey indicates that types of land uses, densities and nature of socio-economic activities significantly affect both CO and CO\textsubscript{2} in the metropolis. It indicates that Tarauni local Dangi Junction’s average daily carbon sensed records is the highest with exactly 19.5 Ppm. Fagge, Dala and Gwale local governments areas precisely record the same of 14 Ppm. The quantitative air quality indicators demonstrate that, the coefficient of determination (R\textsuperscript{2}) reveals that relatively 84% of the changes in the dependent variable (DV) environmental impact was fully captured in the study and therefore changes within the explanatory variables have significant environmental impacts. Traffic count result shows that, Nasarawa local governemnt maintains the most traffic flow with 18957 vehicles records within the study days and the study indicates that interaction of traffic flow in the metropolis significantly increases the air pollution. Recommendation is drawn from the identified issues.

Key Words: CO emission, Air Quality, Traffic count, Environmental Implication, Kano Metropolis.

1. Introduction
World energy utilization significantly rose to 389 Gt in 2013 global CO\textsubscript{2} emission. It speedily rose by 50% with 32.2 Gt increment in 2014[1]. [2] the study focused on five (5) ecosystem services. [3], over
dependent on fossil fuels, gas and related tremendously affect the environmental 130 billion cubic meters is emitted yearly.[4], green house generate great global attention nationally and internationally.[5] China is to develop low carbon society which is to handle its global warming challenges. These could be achieved through low carbon system, technologies innovations, subsidy and tax, financing and investing in area necessary for the development of low carbon society is important. [6] elaborated that European Union (EU) is making significant efforts in cutting down its Green House emission within 80% - 90% by the year 2050.[7] on regulation and mitigating emission of Green House gas is gaining more political attentions. [8] demonstrated that Nobel Laureates a great chemist projected that fossil fuel burning will increase atmospheric concentration of carbon.[9], urban expansion in relation to land uses changes has been receiving international attention. [10], comments that high speedy population growth and urbanization leads to shortages in housing supply in the Saudi Arabia. [11] sprawl together with infrastructure generate predicaments with regards to sustainability. [12], urban and expansion has been receiving research efforts with variety of professional. [13] elaborated that land use changes of the urban area distorts and affects ecosystem. [14], Dubai experiences several immigration stages with each stage has peculiar and unique population growth. [15], challenges and predicaments in mass housing estate required effective Policies. [16] Chinses economy experienced significant and rapid development. [17] United Nation comment that 2.8 billion of the world population rely solely on wood-fuel together with rustic stoves for domestic heating and cooking. [18] revealed that unbalance physical infrastructural development and weak management of the energy sector in Nigeria generates predicaments in energy supply. [19] explained that variations in energy sector and insufficient gas supply to the power National grid plants result to shortage in Power Supply in Nigeria.

2. Aim
The research aims at unveiling the air pollution and environmental implications in Metropolis Nigeria with view to identify environmental issues and make spatial planning recommendation towards sustainable development to be achieve in the metropolis.

3. Study Area
Kano Metropolis is geographically located within Latitudes 12 ° 25' N to 12 ° 40' N and Longitude 8° 35'E to 8° 45' E. It is the most developing and urbanizing cities and commercial center of the Northern Nigeria. It has annual growth rate of 3% with projected to population 4.3 millions 2018. It is highly crowded with 1000 people per Square kilometer (KM²) and its climate is wet and dry base on Koppen’s classifications [20], [21] [22].

4. Methodology.
The study employed both quantitative and experimental approaches in data collection, CO and CO₂ was sensed and recorded with Carbon Monoxide Analyzer 707 and Crowcon Gasman 19259H gas detector device was used. Germin E Trex Legend H Handheld GPS and SD Card Logger CO₂/Humidity/Temp/Data Recorder MCH-383SD was also employed for both indoor and outdoor carbon sensing. Four hundred structured questionnaire was also administered to ascertain the residences perceptions in relations to air pollution within the metropolis. Volumetric traffic count was conducted along seven (7) major junction across the entire metropolis. E. View 8 was adopted data analysis, and interpretation in words form and presentation was supported with pictures (Photos).
4.1. Air Quality Indicator (Table 1)

Table 1. Revealing Air Quality Indicator E. View 8 Ordinary Lease Square Result

| Variable          | Coefficient | Std. Error | t-Statistic | Prob.  |
|-------------------|-------------|------------|-------------|--------|
| C                 | 0.445223    | 0.064669   | 6.884669    | 0.0000 |
| AMT               | 0.000581    | 0.000163   | 3.556980    | 0.0004 |
| FRQ               | 0.383161    | 0.065622   | 5.838866    | 0.0000 |
| HR_GEN            | 0.222481    | 0.014205   | 15.66180    | 0.0000 |
| TWN_SRV           | -0.023673   | 0.037140   | -0.637400   | 0.5242 |
| TYP_EGY           | -0.036610   | 0.039259   | -0.92516    | 0.3516 |
| USE_EGY           | -0.098905   | 0.039822   | -2.483710   | 0.0134 |

| R-squared         | 0.843105    | Mean dependent var | 2.170000 |
| Adjusted R-squared| 0.840709    | S.D. dependent var  | 0.690864 |
| S.E. of regression| 0.275732    | Akaike info criterion | 0.278572 |
| Sum squared resid | 29.87912    | Schwarz criterion   | 0.348423 |
| Log likelihood    | -48.71447   | Hannan-Quinn criter. | 0.306234 |
| F-statistic       | 351.9762    | Durbin-Watson stat  | 0.547709 |
| Prob(F-statistic) | 0.000000    |                   |          |

Looking at the findings of the study, it can be observed that, each of the Slope Coefficient gives the rate of changes in the probability of Environmental Impact (Air Quality) occurring for a given unit change in the value of explanatory variables. Estimated parameters associated with variables influencing Environmental Impacts (Air Quality) had positive sign. The estimated regression above, the Constant Coefficient of 0.445223 implies that holding all others variable constant, the probability of environmental impact increase is by (4.4%). The regression coefficient of the variable amount spent by respondents (AMT) is 0.000581, it implies that Environmental Impact will increase higher by about (0.1%). The regression coefficient of the variable frequency of buying energy sources (FRQ) 0.383161 which implies that probability of Environmental Impact will increase higher by about (38%). The regression coefficient of the variable number of hours respondents used generator (HR –GEN) 0.222481 which implies that probability of Environmental Impact will increase higher by about (22%). The regression coefficient of the variable town services means of transportation (TWN-SRV) -0.023673 which implies that the probability of Environmental Impact will increase lower by about (-2.4%). The regression coefficient of the variable types of energy (TYP ENG) 0.036610 which implies that, holding all other variables constant, a one increase in types of energy (TYP ENG) on an average, the probability of Environmental Impact will increase lower by about (-3.7%). The regression coefficient of the variable purpose for the energy usage (USE ENG) 0.098905 which implies that, holding all other variables constant, a one increase in purpose for the energy usage (USE ENG) on an average, the probability of Environmental Impact will increase lower by about (-9.9%). In addition, the coefficient of determination \( R^2 \) reveals that relatively 84% of the changes in the dependent variable (DV) environmental impact was fully captured therefore the changes within the explanatory variables Amount spent by respondent to buy energy sources (AMT), Frequency of buying energy sources (FRQ), number of hours respondents used generator (HR –GEN), town services means of transportation (TWN-SRV), types of energy (TYP ENG) and the purpose for the energy usage (USE ENG).
4.2. Indoor and Out Doors CO Sense Records Using Carbon Sensing Device

Table 2. Showing Indoor and Out Doors CO Sensed in Selected Points in Seven (7) Local Governments

| Sites    | Stations | Northing | Easting | CO Ppm |
|----------|----------|----------|---------|--------|
| Outdoor  | Dala     | 12.00623 | 8.42924 | 008    |
| Indoor   | Dala     | 12.00627 | 8.42927 | 003    |
| Outdoor  | Gwale    | 11.99294 | 8.51268 | 011    |
| Indoor   | Gwale    | 11.99080 | 8.49632 | 010    |
| Outdoor  | Fagge    | 12.00119 | 8.42129 | 007    |
| Indoor   | Fagge    | 12.00669 | 8.52625 | 012    |
| Outdoor  | Taraini  | 11.97700 | 8.56140 | 006    |
| Indoor   | Taraini  | 11.97758 | 8.56470 | 009    |
| Outdoor  | Nasarawa | 11.98518 | 8.545510| 003    |
| Indoor   | Nasarawa | 11.98938 | 8.281567| 004    |
| Outdoor  | Kumbotso | 11.96632 | 8.29228 | 005    |
| Indoor   | Kumbotso | 11.96367 | 8.08933 | 010    |

The indoor and outdoors carbon monoxides records sensed in the selected and sampled local government reveals that Fagge local government area recorded the highest out door CO with precisely 012Ppm, Gwale and Kumbotso local governments which records relatively closely values of 011Ppm and 010 Ppm. The result furthers indicates that Taraini Local government records is twice the record of Nasarawa local governmet that maintain the lease records of 4 Ppm. On the other hand, the indoor CO sense data depicts Gwale local governemnet is the top with record of 10Ppm while Fagge and Trauni local government areas each has above 5 Ppm. The results on ther hand shows Dala and Nasarawa are the lease while Kombotso local government has exactly 5Ppm CO emission. The field survey indicates that types of land uses, densities and nature of socio-economic activities significantly affect the both CO and CO$_2$ in the metropolis.
4.3. Carbon Sensing Records Using Carbon Monoxide Analyzer 707, Germin E Trex Legend

Table 3. Depicting Carbon Sensed in Kano Municipal Local Government area

| S/N | Local Governments | CO Ppm | CO₂ Ppm | T °C | H %rh | Easting | Northing |
|-----|------------------|--------|---------|------|-------|---------|----------|
| 1   | KMC              | 28.0   | 907     | 36.1 | 58.0  | 008.5242| 11.96400 |
| 2   |                  | 10.8   | 1377    | 36.2 | 48.7  | 008.52364| 11.96493 |
| 3   |                  | 2.3    | 165     | 38.2 | 41.3  | 008.523   | 11.96352 |
| 4   | Nasarawa         | 2.4    | 803     | 40.0 | 44.2  |         |          |
| 5   |                  | 21.9   | 780     | 36.7 | 48.7  |         |          |
| 6   |                  | 3.0    | 785     | 31.6 | 67    | 008.58000| 11.98569 |
| 7   | Tarauni          | 50     | 783     | 39.8 | 43.5  | 008.56254| 11.97771 |
| 8   | Tarauni          | 18.9   | 822     | 35.6 | 50.6  | 008.36437| 11.97855 |
| 9   | Tarauni          | 17.6   | 743     | 36.5 | 54.5  | 008.56914| 11.97820 |
| 10  | Kumbotso         | 8.3    | 749     | 36.5 | 52.7  | 008.51816| 11.94290 |
| 11  | Kumbotso         | 10.8   | 1839    | 37.0 | 48.0  | 008.51768| 11.94624 |
| 12  | Kumbotso         | 9.5    | 156     | 34.4 | 53.5  | 008.51744| 11.94849 |

Station A has the highest record of carbon monoxide with exactly (28.0ppm). On the contrary, with regards to temperature records, station C is the highest while The humidity records on the other hand provides station A as the highest. Additionally, Nassarawa Local Government Area has the following records with regards to the Carbon monoxide Station B records is four times of the sum of stations A and B when combined together. Carbon Dioxides records provide station A with (803 Ppm) while temperature records reveal wide variation between stations. Station A is 40.0 °C, then station 37 °C while Station 32 °C. Tarauni local government area, Carbon Monoxide demonstrates Station B and C are closely in value (18.9 Ppm, 17.6 Ppm). In addition, the carbon dioxide data sensed shows quiet close value among the variable stations with station B being the highest with 822 Ppm. The temperature in the study area indicates station A with 39.8 (°C) then Station C with 36.5°C. Humidity record highlights station C as the greatest value (54.6%rh). Kumbotso local government Carbon monoxide, station B has (10.8 Ppm) higher than A and C. Station C (9.5 Ppm) on the other is greater than station A (8.3 Ppm). In addition Station B maintain the greatest value (183 Ppm) of Crabon dioxides, then station A (749 Ppm) while station C (156 Ppm). Temperature and Humidity records has very similar records Station B has Temperature and Humidity values as (37.0°C, 48.0 %rh) as the highest.

4.4. Air Quality Index CO Sensing Outdoor In Kano metropolis Using Crowcon Gasman 19259H gas detector device

Table 4. Portraying Air Quality Index (Carbon Mono x ide (CO) Sensing) In Kano metropolis date: 5/5/2019

| Location: Tarauni (Dangi Junction) | Location: Nasarawa (K/Nasarawa Junct) | Location: Fagge (Kantin/K. Junct) | Location: Kano MC (Rimi Mit Junct) | Location: DaLa (Gidan Mdl. Junct) | Location: Gwale (Tal’udu Junct.) | Location: Kumbotso (Sharda Junct.) |
|-----------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|----------------------------------|----------------------------------|
| TIME | CO | TIME | CO | TIME | CO | TIME | CO | TIME | CO | TIME | CO | TIME | CO |
| 8:00AM | 007 | 8:00AM | 006 | 8:00AM | 007 | 8:00AM | 006 | 8:00AM | 008 | 8:00AM | 006 | 8:00AM | 005 |
| 12:00AM | 018 | 12:00AM | 006 | 12:00AM | 007 | 12:00AM | 008 | 12:00AM | 008 | 12:00AM | 008 | 12:00AM | 007 |
| 2:00PM | 025 | 2:00PM | 018 | 2:00PM | 018 | 2:00PM | 014 | 2:00PM | 018 | 2:00PM | 017 | 2:00PM | 012 |
| 4:00PM | 028 | 4:00PM | 021 | 4:00PM | 023 | 4:00PM | 017 | 4:00PM | 022 | 4:00PM | 026 | 4:00PM | 025 |
| Average | 19.5 | Average | 12.7 | Average | 14 | Average | 10.1 | Average | 14 | Average | 14 | Average | 12.7 |

The field survey indicates that Tarauni local governmnet Dangi Junction’s average daily carbon sensed records is the highest with exactly 19.5 Ppm. The result points out that Fagge, Dala and Gwale
local governments areas record precisely the same value of an average daily carbon sensed of 14 Ppm. The result further indicates Nasarawa local government record is 1.7Ppm higher than Sharada Junction of Kombotso local government but higher than 2.7 Ppm Kano Municipal being the least in the entire records. This demonstrates that air pollution has no political boundary. This is because, activities related to carbon emission in a local government significantly affect its immediate neighboring local governments within the metropolis. Nasarrawa local government has the highest tendencies of air pollution in the future provided the agents of air pollution in the local government remained constant.

4.5. Traffic Count Along Major Junctions

Table 5. Showing Traffic Counts in Seven (7) Local Governments Selected Major Junctions in August,2019

| Local Govts and Locations                | Cars | T/Cycles | M/Cycles | Cars | T/Cycles | M/Cycles | Cars | T/Cycles | M/Cycles | Total | Average |
|-----------------------------------------|------|----------|----------|------|----------|----------|------|----------|----------|-------|---------|
| Tarauni (Dangi Junction)                | 1299 | 1873     | 962      | 1389 | 1873     | 962      | 1389 | 1873     | 976      | 13774 | 1530    |
| Nasarawa (KN Junctions)                 | 3072 | 2373     | 1752     | 3072 | 2373     | 1754     | 3072 | 2373     | 1754     | 18957 | 2106    |
| Fagge (K/R Junction)                    | 296  | 1689     | 401      | 296  | 1689     | 401      | 296  | 1689     | 401      | 10534 | 1170    |
| KMC (Rimi Market Junction)              | 1618 | 8261     | 1958     | 1618 | 8261     | 1958     | 1681 | 3861     | 1958     | 8942  | 994     |
| Dala (G/Mal Junction)                   | 763  | 3861     | 687      | 763  | 1346     | 687      | 763  | 1346     | 687      | 10626 | 1181    |
| Gwale (Tal’udu Junction)                | 887  | 1346     | 689      | 887  | 1436     | 689      | 887  | 1439     | 689      | 9115  | 1013    |
| Kumbotso (Sharada Junction)             | 3778 | 1378     | 1599     | 3778 | 1378     | 1599     | 3778 | 1378     | 1599     | 12144 | 1349    |

Traffic counts was conducted manually between 6:00 AM to 600PM for three (3) selected days Monday, Wednesday and Friday. Seven major junctions within the metropolis namely Tarauni local government (Dangi Junction), Nasarawa local government (Kwanan Nasarawa junctions), Fagge local government (Kantin Kwari junctions), Kano Municipal ( Kwana Rimi Junctions), Dala local government (Gidan Malam Junction), Gwale local government (Tal’udu Junction) and Kumbotso local government (Sharada junction ) was considered.The result reveals that Tricycles (KEKE NAPEP) is the most popular and common means of transportation within the metropolis. This is because of its comfort, economy and convenient. The result also shows that car is only popular in governemnt researce areas (GRA) and low density lay-out, high income earners only but motor cycles is most popular within the old town (Ancient Ganiwa) , this is because of the below urban planning standard roads with the traditional old town. In addition, Nasarawa local government maintain the most traffic flow with 18957 vehicles records within the study days. This is because it links high commercial areas with residential land uses of the metropolis. Dangi junction also in Tarauni local government has the second significant traffic flow of 13774 vehicles within the study days. This is because of location between major land uses of the metropolis. Sharada junction also depicts high traffic follow but Kantin Kwari Junction maintain the 4th traffic volume flow record as demonstrates by the study. Kantin Kwari is among the high densely commercial center of the metropolis that attract high population and traffic jams that makes motorists deviate from its junctions inorder to save time. The study indicates that interaction of traffic flow in the metropolis significantly increases the air pollution.

5. Finding

Carbon Sensing results reveals that Fagge local government area recorded the highest out door 012Ppm. On the other hand, the indoor CO sense data depicts Gwale local government is the top is the record with 10Ppm. The field survey indicates that Tarauni local Dangi Junction’s average daily carbon sensed records is the highest 19.5 Ppm. Air quality indicators data demonstrates that, the coefficient of determination (R²) reveals that relatively 84% of the changes in the dependent variable (DV) environmental impact was fully captured therefore the changes within the explanatory variables increases the air pollution.
6. Conclusion
The study unveiled that the 84% of the changes in the dependent variable (DV) environmental impact was fully captured in coefficient of determination ($R^2$). Indoor emission is slightly higher than outdoor which is due to plots sizes and congestion within compounds especially in the traditional unplanned aged settlement the energy sources used (generator, woodfuel and charcoal). Temperature across the study area ranges between 23-40°C. Carbon monoxide sense outdoor along seven selected junctions in Kano metropolis states Sharada Junction has the significant records of 25PPm. Traffic count result shows that, Nasarawa local government maintain the most traffic flow of 18957 vehicles.

7. Recommendations
The study unveiled that carbon emission is higher in Kano Municipal (1577Ppm) and Kumbotso (1839Ppm) local governments. These records are within United Nation standards poor air quality. Nassarawo local government recorded the highest Temperature of 40 Degree Celsius, Tarauni local government maintains 39 Degree Celsius. The results could be compared with [23] work conducted in Kaduna Metropolitan area Nigeria, Ezema, Opoko and Oluwatayo (2016) in housing sector in Nigeria and the work of [24] carried out in Ibadan Nigeria. The study shows that Rapid urban growth metropolis has long term environmental impacts that required in-depth study to be conducted so as to achieved sustainable development.

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