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_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_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^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_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 ^{o} 25 ^{I} N to 12 ^{o} 40 ^{I} N and Longitude 8^{o} 35^{I} E to 8^{o} 45^{I} 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 (KM^2) 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 CO_2 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 Loger CO_2/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	-0.932516	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 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).

Figure 1. Showing Charcoal Deport in Kano Metropolis

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	Coordinates		COPpm
		Northings	Eastings	
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	Tarauni	11.97700	8.56140	006
Indoor	Tarauni	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 Tarauni Local government records is twice the record of Nassarawa local govermnet 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 Nassarawa 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.

Figure 2. Showing Roads and Carbons Sensing in Kano 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	COPpm	CO_2 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	Nasarawo	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		18.9	822	35.6	50.6	008.36437	11.97855
9		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		10.8	1839	37.0	48.0	008.51768	11.94624
12		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, Nassarawo 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 TºC, then station 37 TºC while Station 32 Tº. Tarauni local governmnet area, Carbon Monoxide demonstrates Station B and C are closely in value (18.9 Ppm, 17.6 Ppm). In addition, the carbon mdioxide 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 (ºC) then Station C with 36.5ºC. 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 additionStation 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 (37.0ºC, 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 Mkt Junct)		Location: DaLa (Gidam Mal. Junct)		Location: Gwale (Tal'udu Junct.)		Location: Kumbot (Sharada 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	011	Average	014	Average	014	Average	012

The field survey indicates that Tarauni local goveernmnet 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. Nsassrawa 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 (Dnagi Junction)	1299	1873	962	1389	1873	962	1389	1873	976	13774	1530
Nasarawa (K/N Junctions)	3072	2373	1752	3072	2373	1754	3072	2373	1754	18957	2106
Fagge (K/K Junction)	296	1689	401	296	1689	401	296	1689	401	10534	1170
KMC (Rimi Markt Junction)	1618	8261	1958	1618	3861	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 Trauni 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 considerderd.The resutl reveals that Tricycles (KEKE NAPEP) is the most pupular and common means of transportation within the metropolis. This is because of its confort, economy and convient. The result also shows that car is only popular in governemnt researve areas (GRA) and low density lay-out, high income earners only but motor cycles is most popular within the old town (Ancient Ganuwa) , this is because of the below urban planning standard roads with the traditional old town. In addition, Nasarawa local governemnt maintain the most traffic flow with 18957 vehicles records within the study days. This is because it links high commercial areas with residentail 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 (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 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 that Outdoor which is due to plots sizes and conjestion 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 ^oC. 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 governemnt 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 environmnetal impacts that required in-depth study to be conducted so as to achieved sustainable development.

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