THE EFFECTS OF HIGHWAY TRAFFIC POLLUTION ON GLOBAL WARMING IN ABUJA, FEDERAL CAPITAL TERRITORY, NIGERIA

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Abstract

The paper is aimed at evaluating the contributions of highway pollution during traffic congestion, at a local scale, to global warming and was conducted from May to June, 2013 along the three major routes that connect to Abuja the federal capital city. Air quality sampling for gaseous pollutants were carried out Tuesday, Thursday and Fridays for a period of 4 weeks. Concentrations of gaseous pollutants data, CO, SO_2, NO_2 and PM were determined using mobile gas sensors, MSA Orion multiple gas alert and particulate matter sampler. The concentrations of these gaseous pollutants were measured during traffic peak periods i.e. between 7:00am – 10:00am and 4:00pm – 7:00 pm, off peak periods between 1:00-3:00pm. The results show that there is a slight increase in the concentration of these gases during traffic peak periods than off peak periods on Tuesdays and Thursdays while there is an inverse variation on Friday when concentration of SO_2 and NO_2 are higher in off-peak periods while the direct variation is maintained in CO and PM. The concentrations of some of these gases are above maximum permissible limits most especially SO_2 and NO_2. During traffic peak periods for Tuesdays and Thursdays, the concentrations of SO2 for Abuja-Kubwa Road, example, were o.175 pm and 0.125 ppm respectively and the No2 values were 0.275 ppm and 0.175 ppm for Tuesdays and Thursdays respectively. These values are higher than maximum permissible limits and within limits of 0.1 ppm point for SO2 and 0.04-0.06 ppm for NO2 during off peak periods. It is recommended that Government should set up emission standards for vehicles and ensures strict compliance and routine testing; also the Nyanyan-Karu-Abuja road should be expanded to accommodate more traffic flow as this could reduce the emission or pollution level along the road, just as it is done on the Airport-Abuja and Zuba-Kabwa-Abuja roads.

***Keywords:** Highway, Traffic, Congestion, Pollution, Air, Global, Warming.*

INTRODUCTION

In most developing countries of the world vehicular growth has not been checked properly by environmental regulating authorities leading to increased levels of air pollution. According to Okunola *et al.* (2012) them, traffic emissions contribute about 50-80% of NO_2 and CO concentration in developing countries. This situation is alarming and is predicated on the poor economic disposition of developing countries. Poor vehicle maintenance culture and importation of old vehicles, which culminates in an automobile fleet dominated by a class of vehicles known as "super emitters" with high emission of harmful pollutants, has raised high this figure of emission concentration (Ibrahim, 2009).

The fact that the earth is getting warmer is not really in dispute among atmospheric scientists, the concern has rather been on the rate and cause of the continuous global warming, the effects of the warming on climate pattern and change, and consequently on life on earth (Enger and Smith, 2006; Nathanson, 2006).

According to Nathanson (2006) green house effects and climate change are global atmospheric problems associated with air pollution. Nathanson (2006) defined pollution as the presence of certain substances in the air in high enough concentrations and for long enough

duration to cause undesirable effects. In a simple definition, global warming is the increase in the average measured temperature of the earth's near-surface air and oceans and its projected continuation (Royal Society, 2005). Global surface temperature increased by 0.74 ± 0.18°C (1.33 ± 0.32°F) during the 100 years ending in 2005.

Most air pollution comes from one human activity i.e. burning fossil fuels, natural gas, coal and oil to power industrial processes and motor vehicles. Among the harmful chemical compounds this burning puts into the atmosphere are carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and tiny solid particles including lead from gasoline additives called particulates. Between 1900 and 1970, motor vehicle use rapidly expanded, and emissions of nitrogen oxides, some of the most damaging pollutants in vehicle exhaust, increased 690 percent. When fuels are incompletely burned, various chemicals called volatile organic chemicals (VOCs) also enter the air. Pollutants also come from other sources.

Vehicular pollution refers exclusively to the air pollution caused by the emission of exhausts produced by the combustion of fuels. Most vehicles use petrol, diesel or other derivatives or blends of petroleum as fuels. Fossil fuels provide high energy output upon combustion, but also produce many by-products as wastes. The most notable among these being Particulate matter (PM), Nitrogen oxides, Sulphur dioxide, Carbon Monoxide, Ozone and toxic pollutants. Ground level ozone is produced when vehicular pollutants react with sunlight and form "smog" which irritates the respiratory tract, causes coughing, choking and decreases lung capacity. Particulate matter, of diameter less than 10 micrometer, poses the most harmful threat to humans as they can penetrate very deep into the lungs and cause irritation and abrasion. Carbon Monoxide pollution is extremely dangerous as the presence of CO in the blood prevents the intake and supply of oxygen to the brain and other vital organs, which could be fatal. Sulphur dioxide, produced by burning diesel, is toxic and is extremely harmful for asthmatic patients. Apart from drastically reducing air quality and causing dangers to health, vehicular pollution also majorly contributes to Global warming. This is an immediate concern, as climate change is becoming more and more prominent and rapid. Carbon dioxide is the major contributor to the green house effects and much of CO_2 emissions come from motor vehicles.

This research work is therefore aimed at evaluating the contributions of highway pollution during traffic congestion, at a local scale, to global warming.

MATERIALS AND METHODS

Sampling

This study was conducted from May to June 2013 along the three major routes that connect to Abuja the Federal Capital City. That is the Abuja – Kubwa road, Giri-Airport- Abuja road, and Nyanyan – Karu – Abuja road. Air quality sampling for gaseous pollutants were carried on Tuesday, Thursday and Fridays for a period of 4 weeks. Concentrations of gaseous pollutants data, CO, SO_2, NO_2 and PM were determined using mobile gas sensors, MSA Orion multiple gas alert and particulate matter sampler. The concentrations of these gaseous pollutants

were measured during traffic peak periods, between 7:00–10:00 am and 4:00–7:00 pm, off peak periods between 1:00-3:00 pm. Numerical counts of vehicles plying these routes during traffic peak and off peak periods were also carried out on the same days and period of time to determine the number and density of vehicular traffic.

Statistical Analysis

The raw data obtained was analyzed using simple descriptive statistical of mean values were used to create the multi-bar charts and t-test was performed to verify the existence of relationship between number of vehicles and gaseous pollutants concentration during traffic peak and off peak periods. The comprehensive statistical software (SPSS Version 15) was used in the calculation of the statistical values of the variables investigated.

RESULTS AND DISCUSSION

The concentration of gaseous pollutants SO_2, NO_2, CO and PM along the study routes during traffic peak and off peak periods are presented in Tables 2, 3 and 4 while average numbers of vehicles plying the routes during traffic peak and off peak periods are also presented in Tables 5, 6 and 7.

Specifically the results presented in Table 1 showed the concentration of SO_2, NO_2, CO and PM along Abuja-Kubwa road on Tuesdays, Thursdays and Fridays during traffic peak and off peak periods. The results in Table 1 indicate a slight increase in the concentration of gaseous pollutants during traffic peak periods than off peak periods on Tuesdays and Thursdays while there is an inverse variations in the values of gaseous pollutants on Friday with the concentration of SO_2 and NO_2 being higher in off-peak periods while the direct variation is maintained in CO and PM.

The concentrations of some of these gases are above maximum permissible limits most especially SO_2 and NO_2. During traffic peak periods for Tuesdays and Thursdays, the concentration of SO2 and NO2 are higher than maximum permissible limits and within limits during off peak periods (Table 1).

Table 1: Gaseous pollutants in Abuja-Kubwa Road

Day	SO_2 (ppm)		NO_2(ppm)		CO (ppm)		PM (ug/m^3)	
	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak
Tuesday	0.175	0.1	0.275	0.2	4	3	0.55	0.35
Thursday	0.125	0.075	0.175	0.15	3.75	2.75	0.5	0.3
Friday	0.1	0.15	0.125	0.225	3.5	2.5	0.525	0.3
Maximum Limit	0.1 ppm (26ug/m^3		0.04 ppm-0.06 ppm		10 ppm (11.4 ug/m^3)		250 ug/m^3	

Source: Fieldwork, 2013

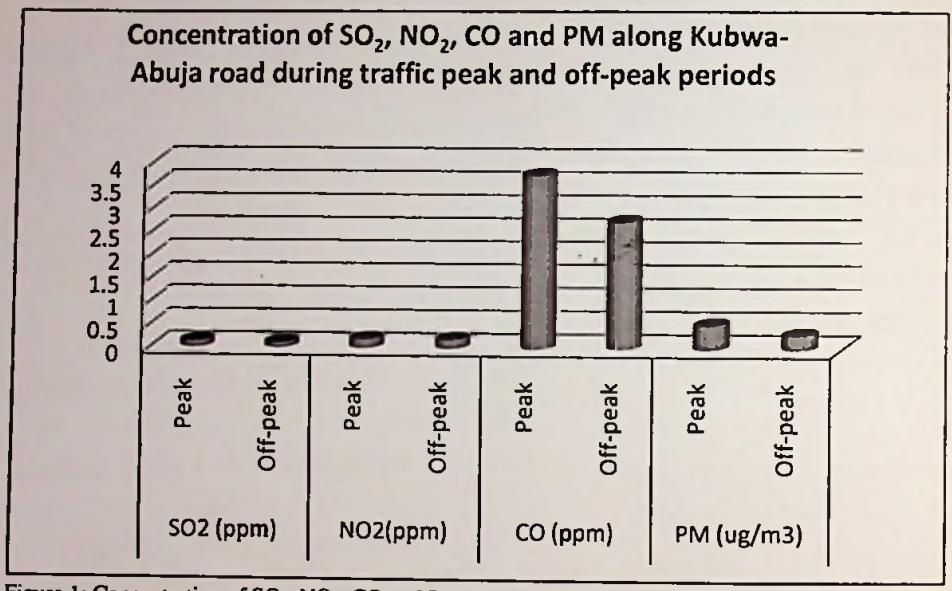


Figure 1: Concentration of SO_2, NO_2, CO and PM along Kubwa-Abuja road during traffic peak and off-peak periods

Figure 1 shows that carbon monoxide has the highest concentration (4ppm) of all pollutants measured but not beyond maximum permissible limit (10ppm). However, longer exposure to it is not safe for human health. There is also slight difference in the concentration of these pollutants during traffic peak and off-peak periods.

The concentration of gaseous pollutants along Giri-Airport –Abuja road as presented in Table 2 shows slight variation between traffic peak and off-peak periods. CO and PM were higher during peak periods than off-peak periods except on Fridays when the time of the day regarded as peak period recorded lower concentration of SO_2 and NO_2

Table 2: Gaseous pollutants along Giri- Airport-Abuja road

Day	SO_2 (ppm)		NO_2 (ppm)		CO (ppm)		PM (ug/m^3)	
	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak
Tuesday	0.125	0.1	0.125	0.1	3.75	2	0.45	0.25
Thursday	0.125	0.1	0.275	0.15	3.5	2.25	0.4	0.3
Friday	0.1	0.175	0.125	0.2	4.25	3	0.5	0.35
Maximum Limit	0.1 ppm (26 g/m^3		0.04 ppm-0.06 ppm		10 ppm (11.4 ug/m^3)		250 ug/m^3	

Source: Fieldwork, 2013

The lower concentrations of SO2 and NO2 during traffic peak period can be attributed to increased traffic on Friday afternoon as many people are on the road to go to mosques for prayers. The average concentration of SO_2 (0.125 ppm) and NO_2 (0.275 ppm) during traffic peak periods were higher than daily maximum permissible limits of 0.1 ppm and 0.06 ppm for SO_2 and NO_2 respectively. While off peak periods is within or slightly above limits. However, CO and particulate matter are below permissible limit.

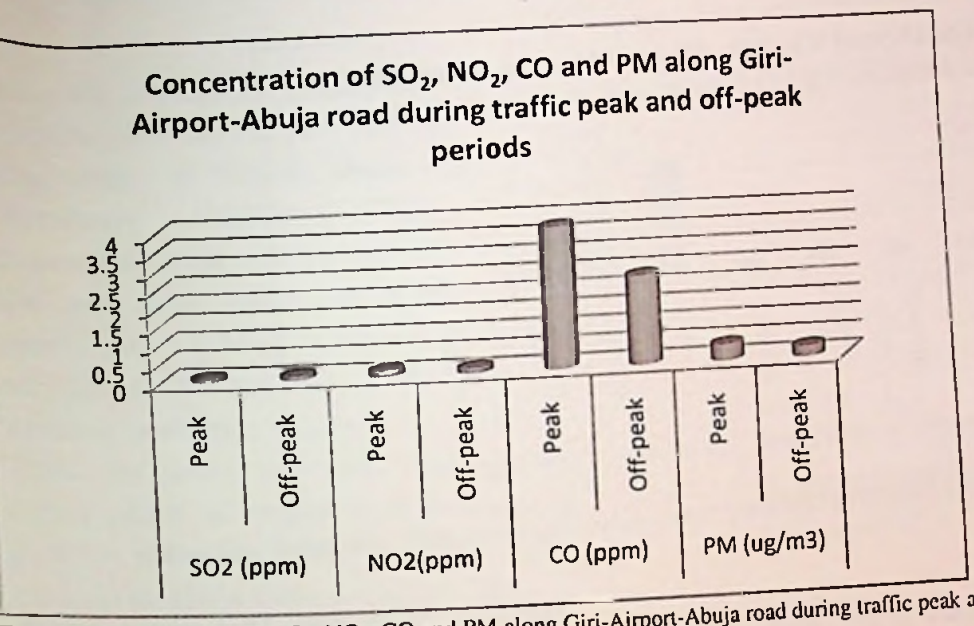


Figure 2: Concentration of SO_2, NO_2, CO and PM along Giri-Airport-Abuja road during traffic peak and off-peak periods

Like Kubwa-Abuja road, the general concentration of gaseous pollutants measured along Giri-Airport-Abuja road is higher during traffic peak periods than off-peak periods.The trend observed in Kubwa-Abuja road and Giri-Airport-Abuja road is somewhat different from Nyanyan-Karu-Abuja road. The difference in the concentration of these gaseous pollutants is more significant than what was recorded in other routes (Table 3).

Table 3: Gaseous pollutants along Nyanyan-Karu-Abuja road

Day	SO_2 (ppm)		NO_2(ppm)		CO (ppm)		PM (ug/m^3)	
	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak
Tuesday	0.175	0.1	0.275	0.15	3.75	2.25	0.5	0.375
Thursday	0.175	0.1	0.25	0.125	3.75	2.75	0.4	0.32
Friday	0.125	0.125	0.2	0.125	4	3.25	0.475	0.325
Maximum Limit	0.1 ppm (26 g/m^3		0.04 ppm-0.06 ppm		10 ppm (11.4 ug/m^3)		250 ug/m^3	

Source: Fieldwork, 2013

The difference in the significant of gaseous pollutants between Table 3 and Tables 1 and 2 is largely due to the fact that traffic gridlock during peak periods is more than what is experienced in the remaining two routes. The inverse variation observed on Fridays on other routes also does not exists along Nyanyan-Karu-Abuja road as the road is almost busy all through the day. The concentration of SO_2 and NO_2 for traffic peak periods on Tuesdays, Thursdays and Fridays were above permissible limits while the concentration of SO_2 during off peak is within limit for Tuesdays and Thursdays while slightly higher on Fridays.

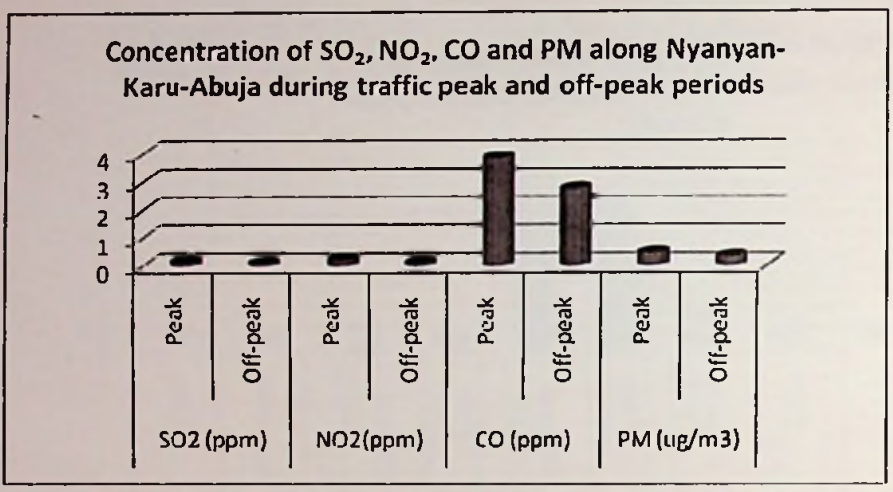


Figure 3: Concentration of SO_2, CO and PM along Nyanya-Karu-Abuja during traffic peak and off-peak periods.

Vehicular count

Numbers of vehicles plying each of the three sampled routes were manually counted during the study on the same days when concentrations of gaseous pollutants were measured. The results of vehicular counts are presented in Tables 5, 6 and 7 below. The total number of vehicles plying Kubwa-Abuja road during traffic peak and off-peak period as shown in Table 5 above depicts a high variance in the total number of vehicles. People coming from Suleja in Niger state, Zuba, Deidei, Kagini and Kubwa all combine to use this road during morning and evening hours to get to and from work. The Giri-Airport-Abuja road connects people staying in Gwagwalada, Giri and Lugbe to the city centre while those coming to Abuja through the airport also make use of this road. However, the ratio of vehicles plying the road during traffic peak and off-peak periods is 3:1 (Table 5). The highest number of traffic flow into the city centre comes from Nyanyan-Karu-Abuja road. This is largely because many people who work in the capital city stays in some parts of Nasarawa State from Mararaba to Keffi. This is because life is more affordable in these places than in the FCT. (Table 6).

Table 4: Number of Vehicles along Kubwa-Abuja road during traffic peak and off peak periods

Day	Peak	Off-peak
Tuesday	11,472	1,844
Thursday	11,060	2,105
Friday	10,868	1,806

Source: Fieldwork, 2013

Table 5: Number of Vehicles plying Giri-Airport-Abuja road during traffic peak and off peak periods

Day	Peak	Off-peak
Tuesday	6,628	2,184
Thursday	6,893	2,203
Friday	6,982	2,314

Source: Fieldwork, 2013

Table 6: Number of Vehicles plying Nyanyan-Karu- Abuja road during traffic peak and off peak periods

Day	Peak	Off-peak
Tuesday	15,984	2,950
Thursday	16,596	3,091
Friday	15,825	2,767

Source: Fieldwork, 2013

It is very obvious from the results in Tables 1, 2 and 3 that the concentration of gaseous pollutants like NO_2, SO_2, CO and PM are generally higher during traffic peak periods than off-peak periods. This is basically because the amount emitted from

vehicles contributes greatly to the total concentration in the air. This has serious implication to human health ,especially respiratory conditions. The higher concentration of gaseous pollutants along the three study routes during traffic peak period shows a direct relationship between number of cars and total concentration of gaseous pollutants (figures 1, 2, and 3). Thus, the dense vehicular traffic is the direct cause of higher concentration of gaseous pollutants along the three major entrants to Abuja Federal Capital City.

CONCLUSION

The study showed a direct relationship between traffic flow and concentration of gaseous pollutants. The three major routes are relatively wide with Kubwa-Abuja and Airport-Abuja having up to six lanes and Mararaba-Abuja with four lanes, both ways, through the dense traffic flow creates serious traffic gridlock. At times vehicles are not in motion for five minutes creating the necessary conditions for the concentration of gaseous pollutants. The more flowing the traffic is, the less the emissions while the slower the traffic is the more the emissions. This explains why concentration along Nyanyan-Karu-Abuja road is higher that the remaining two roads. It is argued that the reduction in the concentration of the gaseous pollutants can only be achieved with the vehicle moving fast, which entails the expansion of the roads beyond what we see.

Recommendations:

Government should set up emission.

i. standards for vehicles and ensure strict compliance and routine testing.
ii. Nyanyan-Karu-Abuja road should be expanded to increase traffic flow and reduce emission level along the road.
iii. Furthermore, government attention is needed on anthropogenic causes of air pollution.

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