African Research Review

An International Multi-Disciplinary Journal, Ethiopia

Vol. 5 (3), Serial No. 20, May, 2011

ISSN 1994-9057 (Print) ISSN 2070-0083 (Online)

Environmental Consequences of Volumetric Traffic Flow in Calabar Metropolis, Nigeria *(Pp. 200-211)*

Eja, Eja. I. **-** Department of Geography and Regional Planning, University of Calabar, Nigeria
Email: ejako2007@yahoo.com
GSM: +2348036447566

Otu, Judith. E. **-** Department of Sociology, University of Calabar, Calabar, Cross River State, Nigeria
Email: judithesame@yahoo.co.uk

Eko, JOY, A. **-** Department of Geography and Regional Planning, University of Calabar, Nigeria
Email: joetate@yahoo.com

Etim, Inyang O. **-** Department of Environmental Education University of Calabar –Nigeria. Email: iniobong4goddy@yahoo.com

Abstract

This paper seek to examined the environmental consequences of volumetric traffic flow with respect the relationship between traffic flow concentration and concentration (Mg/L) of pollutants and accident rate in Calabar. The volumetric traffic count was done at three peak-hour periods in each day for nine days for two weeks at ten (10) strategic positions in the study area. The

collection of air samples were done with the aid of absorption filters from 20 sample status within Calabar metropolis. However, the absorption filters were exposed between 6:30am and 7:15pm each day for nine days in the mouth of April, 2010. The readings were analyzed in the laboratory and comparism was carry out with tolerance units for Ambient air pollutants. Findings revealed that, Air pollutant such as carbon dioxide ($C0_2$) nitrogen oxides (N_0) Sulphur dioxide (SO^2), Carbon monoxide (C_0) and particulate concentrations were above threshold level. With this result of analyses, it shows that there is a positive relationship between air pollutants concentration and volumetric traffic flow in the area. Therefore, proper environment management is needed to prevent severe thread on the human ecosystem in Calabar metropolis.

Introduction

Traffic flow in mathematics and engineering is the study of interactions between vehicles, drivers and infrastructure with the aim of understanding and developing an optimal road network with efficient movement of traffic and minimal traffic congestion, pollution and accident rate (Olukaejire, 2008). Stuck in traffic (2004), argues that rush hour traffic **congestion** is inevitable because of the benefits of having a relatively standard work day. In a capitalist economy, goods can be allocated either by pricing (ability to pay) or by queueing (first-come first –serve); congestion is an example of the latter. Instead of the traditional solution of making the "pipe" large enough to accommodate the total demand for peak-hour vehicle travel (a supply-side solution), either by widening roadways or increasing "flow pressure" via automated highway systems, Downs advocates greater use of road pricing to reduce congestion (a demand-side solution, effectively rationing demand), in turn plowing the revenues generated therefrom into public transportation projects. However, the transport sector is a major source of environmental deterioration in developing and developed countries of the world. This is not only true of air but also noise and aesthetic pollution. The sector accounts for virtually all the lead and sulphur oxide emission. The percentage of other pollutant such as Nitrogen oxides, participate matter and nitrous oxide are also high by international standards. Indeed, lead emission in Nigeria's major cities is several times higher than the WHO recommended and acceptable standard. The continued use of gasoline in spite of its hazardous nature and the fact that unleaded gasoline is now the norm in several countries need to be a source of worry (Akpan, 1998). It has been discovered that many of those streets in the large urban centres of Nigeria were created by the colonial

rulers who did not anticipate the present volume of traffic on the streets and as a result many death are recorded at frequent intervals (Kraberger, 2004). In Lagos, over 62 percent of motor accident was recorded in Lagos in 2001. Many of these deaths could have been averted by for multiple factors such as narrowness of the roads in terms of their capacity to accommodate the volume of today and the high rate of pollution (Kraberger, 2004). In Calabar, the situation is not different as the abolition of motor cyclist transport in the metropolis has cause series of environmental crises such as congestion, emission of gases (pollution) and increase in death rate (Eremu, 2000). The increase in taxes as a transportation mode in Calabar has generally increase the amount of gases in the atmosphere such as carbondioxide ($C0_2$) carbonmonoxide (C_0) chloride oxide among others hence resulting to acid rain which is capable of destroying both the natural and human ecosystem. Therefore what role is traffic flow playing in the economy of Cross River State and Calabar in particular? In the light above, this paper seek to examine major issues as regard the environmental consequences of volumetric traffic flow and concentration of pollutants rate, environmental consequences and accident rate in Calabar metropolis.

Study Area

The study area is Calabar metropolis which lies between latitude 50^0 32^1 and 40^0 22^1 North and longitude 70^0 50^1 and 90^0 28^1 East it is about 21, 481sqkm in size. It is situated within the tropics sharing a common boundary with the Republic of Cameroon in the East, Odukpani Local Government Area in the North, while Akwa Ibom in the south. The perninsular of Calabar is moderately undulating with land descending rather abruptly to Calabar River at the Western boundary while the slope is gradually towards the Kwa River to the east. However, the scope of this research is limited to the hotel industry as sub system of the hospitality industry and the tourism potentials within the area. The climate of the study area is of the semi-equatorial (monsoonal) type with normal heavy downpours. The rainfall regime is divided into types-dry and wet season. The movement of our mass northward and southward determines the beginning and end of dry and wet season in the study area. Rainy season starts in March and ends in November, while the dry season sets in December and ends in February. Annual rainfall ranges from 2500mm to 3000mm. The variations in the intensity and reliability of rainfall coupled with high temperature throughout the year affect the influence of tourist and visitors in the area. The vegetation of the study area was typical tropical rainforest, and it was characterized by three layer canopy with the

emergent trees. It is a closed canopy forest and made up of layer of broad leaf evergreen tree species (60-100 species per sq km) with 3- 4 layers. The canopy height of this forest was between 25-50m tall with emergent trees up to 100m high. The trees had buttress smooth bark and columnar boles. Thick-stemmed woody climbing plants (Lianas) were common as well as epiphytes and other herbs.

However, due to the nature of the forest, there is a reasonable presence of wild animals and birds, these animals include reptiles such as crocodile, alligator, snake-python, and iguana, bush fowls, birds such as parrots, hawks and kites. The tree species found in this region are achy, opepe, cedar etc.

Methodology

This Information on the analysis of this study was based on traffic flow along ten (10) major and minor routes such as Ekpo Abasi, Inyang, Bassey Duke, Edimotop, old Ikang, Mount Zion, Mayne Avenue, Marian, Etta Agbor and Yellow Duke. Traffic count was carried out in the morning session 7am - 11am, afternoon session 12pm -3pm and evening session 4pm – 7pm for nine days within the month of January and Febraury, 2010. Average traffic concentration was obtained as a ratio of the total number of vehicles and the paved road surface area within the hours of survey. The accident rates between 2003 and 2009 were obtained from field survey in the Calabar General Hospital records. The air samples were obtained using absorption filter papers in the hours of 6am and 7:3pm each day for nine days. The absorption filter papers were taken to the laboratories each day for analysis. Sulphur dioxide (SO^2) was oxidized to sulphate using dilute nitric acid which was determined by turbidimetric method at 42mm using UNICAM 8700 Spcetrophoto metre. For H_2S, the samples were treated, after collection with zinc, acetate solution (1-0) and sodium hydroxide solution (6pm). The sulphate concentration was obtained using the formula, total sulphide (Mgl) = (A and B) – (XD) x 1600. Chloride level in samples was measure with $NgNO_3$ titration using potassium chromate as indicator. Lml of $AgNO_3$ solution was taken as equivalent to 10ppm of chloride 100ml of sample. The particulate matter sampled was filtered using whotman filter paper. The resultant residue was measured on weighing balance. Moreso, the sampled for $C0_2$ was determined with filtration against a standard hydrochloric acid using methyl orange as an indicator: In order to analyze the relationship between volumetric traffic flow and pollutant concentration in air of Calabar metropolis, the sample arithmetic means was used to present the average of

volumetric traffic flow. This was however, tested using the linear regression. Formular which is mathematically presented as: y = a +b x e, Where, y = Dependent variables, x = Independence variables, a = The y intercept, b = The shop of regression and e = Residual error term. The T-test was adopted to assess the relationship between volumetric traffic flow and air pollution concentration. The tolerance limit for Ambient air pollutants were used to compared the laboratory results.

Literature Review

Transportation involves the movement of persons and / or goods from one point in space to another usually to satisfy a need, which could be economic, social or cultural. Transportation and development are intricately interwoven in a harmonious relationship. According to Ikya (1993), this relationship is more glaring in urban centers where the nature and characteristics of transport system largely influence the level and rate of the development of cities. This presupposes that the development of most urban centers in recent times is influenced partly by the contribution from the transport sector.

Maria (2004) observes that adequate, efficient, reliable and affordable transport service in essential for national development. It is also observed that population and economic factors are central in explaining the evolution of transport in Nigeria on the one hand while changing attitude and rise in urban population affect the choice of transport mode used by man (Ikya, 1993). In his work on "motorcycle in public passenger transport service", Ikya traced the history of taxis as being the contemporary mode of transport in most Nigerian cities. The emergence of taxis and bus as a mode of transport is invariably associated with negative socio-economic and environmental impacts. Maria (2004), Kayode (2004), Adeimila (1981) and Adenie (1981) have identified the negative impacts in the form of traffic congestion, urban pollution and increasing rate of accidents. They attributed these problems to inadequate road design and maintenance, lack of adequate control device, wider car ownership and inadequate public transport, and examined those causal factors under social, economic, road, vehicle, human and accident factors.

In contemporary urban scene, it is argued that as long as industrial, commercial, administration and recreational activities concentrate in urban areas, there will always be transportation crises. Others have argued that non-motorized mode of urban transport is best for intra-city mobility. Ikechukwu

(2001) argued in favor of the use of taxis for urban mobility but it could be argued that increased use of bicycles in urban centers could increase accident risk besides road traffic congestion. Thus, a sustainable transport system is that which meet the mobility and accessibility needs of people by providing safe and environmentally friendly modes of transportation. Thus, both the motorized and non-motorized modes of urban transportation have their relative merits and demerits. Apart from the negative socio-economic implications for the use of motorcycle as intra-urban mobility means, its evolution has brought some relieves to the problems of contemporary urban transportation generally.

Findings

Volumetric Traffic Flow in Calabar Metropolis

From table1, it was observed that there is a variation in the level of volumetric traffic flow between the major and minor roads in Calabar metropolis with a higher density concentration within major arterial than the minor collectors except in few exceptions. However, the density of volumetric traffic concentration along the major roads according to Akpan (2001) is compounded by convergence of commercial and private volumetric traffic which converge at a single point to form the centre of attraction to them. They also attract 80% of commercial, financed and business establishment to themselves.

Volumetric Traffic Flow and Concentration of Pollutants Rate in Calabar Metropolis

The result from the analysis of the relationship between traffic flow and concentration od pollutants rate in Calabar metropolis shows that SO^2 falls below detectable limits in most locations particularly in areas with low traffic flow. The concentration lies between 0.74Mg/L, and 0.5Mg/L respectively. The highest concentration values of 1.35Mg/L and 9.1Mg/L as presented in table 3. With this result it can be said that SO^2 concentrate constitute great danger to the environment of Calabar metropolis. Carbonmonoxide (CO) in the analysis indicates minimum concentration of 2.35gm/1. These values when compared with the Ambient and quality limit of 0.1Mg/L falls above the threshold limit value of 0.05Mg/L. This result indicates that residents in Calabar metropolis are subject to serious heath problems. The analysis of H_2S shows a concentration value of 0.27Mg/L, 0.35Mg/L with the highest values of 1.25Mg/L and 1.05Mg/L respectively. However, this concentration is capable of threatening the environment of Calabar metropolis judging from

the ambient air quality limit of 0.05Mg/L. From the analysis, carbondioxide ($C0_2$) was detected in all locations with the highest concentration value of 37.10Mg/L and the minimum concentration 9.01Mg/L. However, one can not generalized the result due to the fact that no standard was given in the national ambient quality limit standard. The result of the analysis of Cl_2 shows that the concentration of Cl_2 remain almost the same but with a highest value of 30.50Mg/L and minimum value of 29.61Mg/L respectively. The value as indicated by the analysis is above the ambient quality limit of 0.63Mg/L. Therefore, it constitutes a serious health hazard on the people residing in Calabar metropolis. With respect to the analysis of particulate matter, the highest concentration was 6411Mg/L and a maximum value of 3145Mg/L which is relatively high compared to the ambient quality limit of 25Mg/L. This result shows that particulate matter constitute a nuisance to the inhabitant and it environment.

However, at 0.05 level of significance, the tabulated value was 3.54, which was less than all the computed values. This result indicates a strong relationship between volumetric traffic flow and air pollution concentration on the one hand, and vehicular traffic concentration and atmosphere pollution on the hand. The relationship between volumetric traffic flow, volumetric traffic concentration and air pollution in Calabar, Cross River State was confirmed. However, respect to sulphur dioxide the relationship between volumetric traffic flows, concentration was not found to be significant as table, values higher than calculated values. This relationship conforms to the findings of Bolade (1986) in study carried out in Lagos metropolis on the consequences of urbanization and pollution rate in the area.

Environmental Consequences of the Air Analysis Result

The values identify during the analysis shows that concentration of all the pollutants exceeds the threshold values of the ambient air quality limits. The effect of the concentration of SO^2 as shown in the result manifest in materials, visibility, building and their roofs, vegetation, deterioration of electric equipment among others. Beside, SO^2 has the potential of disturbing the activities of air flights, which solely depend on clear sight. The sulphuric acid produce from automobile exhaust with other gases and aerosols in the atmosphere result in the formation acid rain which is very distructure to aquatic life, especially salmons, and reduce specie diversity in aquatic ecosystem, damage food crops and trees and leach plant nutrients from plant and the soil. The effect of sulphuric acid droplets and ammonium sulphate

particles is considered the most serious air pollutant threat to human health (Eramu, 2001). The high concentration of carbondioxide when inhaled to the body affect the haemoglobin of the red blood cell, hence leading to severe headache, fatigue, impaired judgement and also create greater workload on the heart. Carbondioxide can also cause automobile accidents by causing driver fatigue and poor judgement (Miller, 2000). Nevertheless, atmospheric pollutant according to Imoh (2009) lead to ozone layer depletion, acidification, weather modification, damage to building nervous disorders and respiratory diseases. However, the ambient air pollutants which shows the threshole limit of pollutants observed in the field as a result of traffic was presented in table 3.

Accident rate in Calabar Metropolis

Table 4, revealed a monthly variation in accident rate in Calabar which according to Sule (2010) is a functions of urbanization and rapid growth of urban cities. The table shows that 2009 and 2003 recorded a high accident rate in Calabar with values of 17.00% and 15.21% respectively. This was confirmed in an empirical works of Mabogunje (1976) who contribute accident rate to traffic congestion in cities. It was observed in table 4 that accident rate in May, 2003, June 2003 and April 2009 and recorded the same accident rate with value of one thousand and thirteen (113) cases. Moreso, it was noticed that the month of February recorded the least accident rate with the years under investigation with value of six hundred and fifteen (615) cases with a corresponding yearly decrease of 12.76% cases (accident rate) in 2008.

Conclusion and Recommendation

The high rate of traffic flow in Calabar has become of great concern which has resulted to series of environmental catastrophe in the area. From the result obtained, it is crystal clear that volumetric traffic flow constitutes health implication in Calabar metropolis. In the light of the dangers which this phenomenon is associated unit, there is urgent need for all stakeholders to provide a workable mechanism to cushion these adverse effects of volumetric traffic flow. Secondly, more roads should be constructed to help decongest most of the area with high traffic flow and effective measures should be put in place to decongest urban social and commercial services. This will help planners to effectively plan the transportation routes and improved traffic management.

References

Adedimila A. S. (1981) "Towards Improving Traffic Flow in Lagos" in *Transportation in Nigerian National Development*. Edited by S. 0. Onakomaiya, N.I.S.E.R. Ibadan.

Adefolalu, A.A. (1977) "Traffic Congestion in the city of Lagos" *Nigerian Geographical Journal Vol. 20. No. 2.*

Adeniji, K. (1985). Public Transportation in Nigeria: Basic needs research Project (September 1985). Paper presented at a National Seminar on Meeting the Basic needs of the People of Nigeria, Conference center, University of Ibadan, 4-8May, 1986

Akpan, R.A. (2001). 'Noise Pollution as an urban management issue in Uyo Metropolis" in *Geography and the Nigerian Environment*, Afahaida and Bros. Publishing Company

Bolade, A. (1986). Transport in Lagos metropolis Lagos: *Transport Review 6,* 1-30.

Eke, N. (2003). "Road Traffic accidents in the Developing World: Who are Liable?" Department of Surgery, University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria. www-google search.corn.

Eremu, R.O. (2001). *Urban Environmental Pollution. Critically: Synopsis* Calabar: Baaj International

Faulks, R. W (1990). *Principles of Transportation*. 4th-Edition. London: McGraw-Hill Book Company.

Hassel, J. S. (1982). How Effective has urban Transportation Been? In Levinson, H. S. and Weant, R. A. (eds), *Urban Transportation: Perspectives and Prospects*. Eno Foundation for Transportation, Westport.

Imoh, I.A. (2003). Industrial pollution and environmental degradation in Nigeria. *Geography and the Nigerian environment* pp 75-79

Kraberger, B. (2004). "Transportation and the movement of people in Nigeria: some tentative notes". www.googlesearch.com

Rosenbloom M. S. (1982); Peak-period Traffic Congestion: a State of the art Analysis and Evaluation of Effective Solutions. In Levinson, H. S.

and Weant, R. A. (eds). *Urban Transportation: Perspectives and Prospects*. Eno Foundation for Transportation, Westport.

Mabogunje, A.C. (1976). *Cities and Africa Development studies in Development of African resources 3*, Ibadan: Ibadan University Press

Mathew O.A. (2002). *Tranportation and the rural-urban environment*. London: Macmillan.

Miller, A.S. (1992). Stratospheric ozone depletion: Can we save the sky? In Green Club year book 1992: Oxford: University Press, 83-91

Olukaejire, S.O. (2003). Land use and trafic generation. *The Tide newspaper* 9th November, 2010

Sule, R.A. (2000). *Paradigms of Regional Development Planning in Africa: Theory and Practice*. Calabar: Calabar practical.

Table 1: Volumetric traffic flow in selected streets in Calabar metropolis

S/n	Street/ Road	Street Area (M^2)	Traffic flow			Number of vehicles concentration. Per unit hour
			Morning session	Afternoon session	Evening session	
1.	Ekpo Abasi	3.5	7578	964	6949	545
2.	Inyang	2.3	6345	751	3423	310
3.	Bassey Duke	2.1	4512	142	2145	211
4.	Edimotop	2.4	3094	105	954	201
5.	Old Ikang	1.9	1984	176	1134	91
6.	Mount Zion	2.7	9345	954	8945	694
7.	Mayne Avenue	3.7	6410	745	5241	431
8.	Marian	6.5	9984	12454	9341	721
9.	Etta Agbor	3.1	7569	1445	8411	524
10	Yellow Duke	2.6	5234	1651	4954	303

Source: Field survey (2010)

Table 2: The relationship between traffic flow concentration and the concentration (Mg/L) of pollutants in Calabar metropolis

S/N	Street	Streets Area (KM2)	Traffic Flow per hour	No. of vehicular concentration per unit area per hour	SO^2	CO_2	CO	Cl^2	PM	H_2S
1.	Ekpo Abasi	3.50	545	16036	1.35	19.49	3.09	30.50	5011	ND*
2.	Inyang	2.30	310	10829	0.74	37.10	5.44	30.41	6351	1.25
3.	Bassey Duke	2.10	211	7013	ND	18.58	3.07	31.40	3145	0.27
4.	Edimotop	2.40	201	4354	ND	22.4	3.85	31.40	6411	ND*
5.	Old Ikang	1.90	91	3385	ND	9.01	2.41	31.50	6213	ND*
6.	Mount Zion	2.70	694	19938	ND	24.5	2.35	31.50	6410	1.05
7.	Mayne Avenue	3.70	431	12827	ND	13.1	2.40	31.50	3201	ND*
8.	Marian	6.50	721	21291	ND	14.2	2.40	31.50	6117	0.35
9.	Etta Agbor	3.10	524	8935	7.1	14.2	2.40	29.61	5510	ND*
10.	Yellow Duke	2.60	303	12142	1.5	11.3	2.35	29.61	4564	ND*

ND= Not detected

Source: Laboratory result of air samples analysis (2010)

Table 3: Tolerance limits for Ambient air pollutants

Pollutants	Permissible (Hours)
Carbon monoxide	1.0mg3 per day
Particulates	250mg3 per day
Sulphurdioxide	0.05 mg3 per day
Hydrogen sulphide	0.005 mg3 per day
Chloride	0.03 mg3 per day

Source: FEPA (1991)

Table 4: Estimated yearly accident rate in Calabar metropo lis

Month	2003	2004	2005	2006	2007	2008	2009	Total
Jan	125	98	215	314	135	101	245	1233
Feb	75	121	57	94	65	95	108	615
Mar	113	99	198	113	75	105	214	917
April	210	117	218	204	207	138	113	1206
May	195	87	113	156	158	213	36	1008
June	113	141	208	83	204	198	226	1173
July	154	138	88	129	171	159	169	1008
Aug	212	194	134	204	241	96	205	1286
Sept	215	114	201	145	196	168	361	1400
Oct	225	301	184	105	49	175	203	1242
Nov	189	198	109	95	132	62	95	880
Dec	95	112	75	89	59	101	116	647
Total	1921	1730	1800	1731	1692	1611	2140	12625
Acc. % rate	15.21 %	13.70 %	14.26 %	13.71 %	13.40 %	12.76 %	17.00 %	

Source: Field survey (2010)