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ENVIRONMENTAL QUALITY OF ENUGU, NIGERIA AS IMPACTED BY THE PRIMARY AIR POLLUTANTS IN THE AREA

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ABSTRACT: *Air pollution activities have increased over the years in urban areas of most developing countries like Nigeria. The same has been experienced in Enugu metropolis. This study therefore examined how environmental quality of Enugu metropolis has been impacted by the polluted air in the environment. The metropolis was classified into different neigbourhoods and then stratified into low, medium and high density areas. Samples were randomly collected from these neighborhoods. In determining the residential environmental quality of the area factor analysis (principal component analysis was used to reduce the various environmental quality variables into single factor known as "Y" variable. This served as dependent variable. Primary air pollutants; particular matter, Nitrogen dioxide, sulfur dioxide and carbon monoxide constituted the independent variables as x1, x2, x3 and x4 respectively. Using multiple regression model a relationship between the dependent and independent variable was established. The coefficient of determination in the result showed that adjusted r^2=.917, indicating that 91.7% variation in the residential environmental quality could be predicted from air pollution. Health challenges of reduced oxygen carrying capacity of blood, chronic bronchitis and worsening respiratory illnesses were identified as some of the effects. Also identified, are acidification of soils, staining of fabrics among others on the environment. Making petroleum products like kerosene available and affordable to all by the federal government of Nigeria, among others have been recommended.*

KEYWORDS: environment, quality, impact, Enugu, Nigeria.

INTRODUCTION

In absence of pollution, our residential environment remains clean and enjoyable. On account of the various activities of man, the composition and complex nature our residential environmental gets changed. Atmospheric pollution is one of the environment male and female populations in the area were used as xi and x2 (independent)al problems confronting growing cities and is currently the challenges faced by many developed and developing countries. The subject of air pollution and its effects on the environment referred to as one of the universal commons that many that many countries and local governments are seeking to address (Puppimde, Oliveira, 2011).

According to Mishra (2003), rapid growth in urban population increasing industrialization and rising demands for energy and motor vehicles are the worsening factors execrating air pollution level. Other factors such as poor environmental regulation, less efficient technology of production congested reads and age and poor maintenance of vehicles add to the problem. The problems associate with atmospheric pollution is continuously on the rise, and this is because of the alarming increase in anthropogenic activities that adversely affect climate environment, and most importantly

the health of individuals worldwide. The according to Akinola et al (2014), the effects on human lives are enormous as it cause disease and chronic illnesses. Apart from the health risk,, it contributes to our changing climatic conditions which are potential sources of threats to local and international communities. In Nigeria, the federal ministry of environment has created different entities to maintain good air quality. With respect to air pollution the agencies employ various air pollution control strategies to reduce, the emission of the pollutants in the atmosphere. Despite the efforts, the problem persists.

The study is therefore aimed at looking into has residential environment quality of Enugu metropolis has been affected by the primary air pollutants in the area.

LITERATURE REVIEW

Hee-sun C. and Mack (2014) assessed the effects of compact urban development on air pollution, taking into account both the spatial distribution of pollutants resulting from increases in inner urban densities and the dispersion of pollutant associated with an increase in outer green open spaces. The analysis was based on a panel data model covering 17 cities in Korea from 1996 to 2009. This approach was used because urban air pollution is influenced by spatial and temporal changes. Estimating the air population level by distance from city centres demonstrated that the spatial concentration of emission sources did not necessarily increase air pollution levels. The two way fixed effects model, employed to control both individual (regional) and time effects showed that SO^2 decreased as the proportion of green area increased. On the other hand, a rise in net density led to an increased inNO^2. Both cases were observed in the case of CO dispersion by green area as well as emission source concentration by high densities. The result indicated a clear relationship between the pollutant specific characteristics and the emission sources, and could not manifest virid impact of compact urban development on air quality in the area.

Mashood and Arsalan (2011) working in the perspective of air pollution, provided the insight view about the effects of environmental pollution on human by diseases and other problems. In the study it was revealed that this kind of pollution is not only seriously affecting the human by disease, it also animals and plants. According to the authors, there is still time left in the hands of global institutions, governments and local bodies to use the advance resources to balance the environment for living and initiate the breathed intellectuals to line friendly with the environment. Sharp and Bromley (1979), however, observed that as effective reply to contamination is largely based on human appraisal of the problem from every age group, contamination control program should be evolved as a nationwide fixed cost sharing effort relying upon voluntary participation.

Kinney (2015) asserted that exposure to residential traffic related air pollution increase the risk of fatal coronary heart disease Nordling(2008) associated exposure to vehicle emissions during the first year of life with persistent wheezing, lower peak expiratory flow and sensitization to pollen at 4years of age. According to him particulate matter exposure associated with oxidative stress resulting in respiratory and systemic inflammatory responses. Araujo (2008) was of the view that this leads to chronic bronchitis, lung cancer asthma and atherosclerosis. A study by Ulfvarson (1987) revealed that exposure to motor vehicle emissions may result in genotoxicity. This was

supported by Lewtas (1983) who opined that extracted diesel and petrol organics from motor vehicle particulates provided strong evidence of mutanenicity in terms of gene mutation, DNA damage and chromosomal aberration. Klinzil (2000) was of the view that air pollution caused 6% of total mortality per annum, half of which is attributed to vehicle emissions. A study by Hock (2002) in the Netherlands revealed that elevated concentration of ultrafine particles may result in pulmonary inflammation and the release of mediators in the blood yielding increase plasma viscosity, which could lead to cardiovascular events including death. This was supported by the health effect institute (2010), holding the view that exposure to motor vehicle air pollution results in premature mortality among exposed population. National security agency (2001) observed that the emission of NO^2 and reactive hydrocarbons are belived to have a significant contribution to ozone and some oxidizing compounds such as hydrogen peroxide and hydroxyl radical known to influence the oxidation of sulphure dioxide to sulphate and NO_2 to nitric acid and nitrate concentration. United States environmental protection agency (2002) advanced that air pollutants such as CO, NO_2, particulate matter are emitted by motor vehicle and that diesel particulate matter, which is made up of elemental Carbone solute organic carbon and trace element are also released.

Cohen (2016) was of the opinion that methods available for the measurement of carbon monoxide in ambient air range know fully automated methods using the non-dispersive infrared technique and gas chromatography to simple semi quantitative manual methods using detector tubes. He, however, agreed that several relatively simple methods are also available for determining carbon monoxide by analysis either of the blood or of alveolar air that is in equilibrium with the blood.

Aronow, (2012) stated in his study that internal combustion engines spark ignition engines and that exhaust, concentrations of carbon dioxide increases with lower air to fuel rations and decrease with higher ratios. The decrease in available oxygen with increasing altitude has the effect of enriching the air to fuel mixture and increasing carbon monoxide emission from carbureted engines. Establishing a correlation between total emission of carbons of carbon monoxide in grams per vehicle kilometre; and average route speed, Simonaitus (2015) observed a decrease in emission with increasing average speed. Kuirt (2016) was of the opinion that emission control on new vehicles could be achieved by engine modifications and that substantial reduction in carbon monoxide and other air pollutants result from consideration of design and operating factor.

Advancing that many of the data concerning the combined effects of carbon monoxide and other air pollutants found in the ambient air are based on laboratory animal experiments, Atimay (2011) stressed that only a human studies are available. According to him, early studies in healthy human subjects on common air pollutants such as carbon monoxide, nitrogen dioxide, ozone failed to show any interaction from combined exposure. In the laboratory studies, no interaction was observed following combined exposure to carton monoxide and common ambient air pollutants such as nitrogen dioxide or sulfur, dioxide however, an additive effect was observed following combined exposure to carbon monoxide and nitric oxide and a synergistic effect was observed after combined exposure to carbon monoxide and ozone. Toxicological infractions of combination products, primarily carbon monoxide, carbon dioxide and hydrogen cyanide at levels typically produced by indoor and outdoor fines have shown a synergistic effect following carbon monoxide plus carbon dioxide exposure and an additive effect with hydrogen cyanide. Additive effects were also observed

when carbon monoxide, hydrogen cyanide and low oxygen were combined and adding carbon dioxide to this combination was synergistic. Studies eventually suggested that environmental factors may be important determinants of health effects when combined with exposure to carbon monoxide.

Studying the effects of air pollutant on human health, Anderson,(2013) reported decreased exercise tolerance and worsening of myocardial ischemia in persons with stable angina pectoris following exposure to 50ppm Co for 4 hours sufficient to cause a mean increase in CoHb of 2.9%. Adam 92016) conducted a study focused on the cardiovascular effects of subjects exposure to 100 or 200pmm, Co reaching COHb levels of 6%. Kleinman (2017) demonstrated that at an average COHb level of 2.9% the time to onset of exercise induced inguinal pain was reduced by6% in subjects with stable angina pectoris who were exposed concentration of CO typically found in heavy traffic. In a study of seven U.S Citiers, Morris (2018) found an association between, ambient Co levels and hospital admission for congestive heart failure among elderly people. The relative risk of hospital from 11 in New York to 1.37 in los Ageles Lim (2012) investigated the association between air pollution and daily hospital admission in loss Angeles Co and No_2 showed the strongest relationship with cardiovascular hospital admission in the winter when the range of Co concentration was 11 to 2.2ppm and the increase in cardiovascular was 4% Investigating the major pollutants that induce air pollution, Vaidyanathan et al (2016), identified carbon dioxide as one of the notable primary ones.

According to them carbon dioxide is a natural component of the atmosphere essential for plant life and give of by the human respiratory system. Co_2 currently form about 410parts per million f earths atmosphere compared to about 280ppm in pre industrial times. Kan et al(2010) noted that billion of metric tons of Co_2 are emitted annually by burning of fossil and that its increase in earths atmosphere has been accelerating. Coal and petroleum often contain suphur compound another pollutant and their combustion generates sulfur dioxide, further oxidation of So^2 usually in the presence of a catalyst such as No_2 forms H_2So_4 and thus acid rain. This indeed is one of the causes for concern over the environmental impact of the use of the major pollutant that impair air quality, Mawer (2014) was of the view that human activities such as the burning of fossil fuels in vehicles power plants and various industrious processes also generate significant amount of aerosots combined particulars and gas. According to him, averaged worldwide anthropogenic aerosols those made by human activities currently account for approximately 10percent of our atmosphere. Chi (1994) observed that increased levels of fine particulars in the air are linked to health hazard such as heart disease. Johnson and Keith (2009) noted that carbon-dioxide is a natural component of the atmosphere essential for plant life and given off by the human respiratory system, and that it currently form about 410parts per million of earth's atmosphere compared to about 280ppm min pre-industrial times.

Agreeing that carbon monoxide is one of the air pollutant, the carbon monoxide emitted into the atmosphere was from vehicle traffic and burning one gallon of gas will often emit over 20 pounds of carbon monoxide into the air, however Hewitt and Jackson (2007) their studies sources of air pollution classified these source as of both anthropogrnic and natural action. Harrison (2005) outlined these sources to include; burning different kinds of fuel as well as smoke stacks of power

plants for anthropogenic or man made source, and dust usually from large area of land with few or no vegetation as natural source.

Using Europe and America as case studies Cendreor, Lopez et al (2003) studied the procedure environment quality for sustainability assessment in coastal areas, based on a series of indicators and indices that reflect environmental quality. Three dimension of environmental quality (function, interaction and components were taken into consideration. The procedure, developed within the ELANEM Euro-Latin American project, offered the possibility of expressing environment quality of the coastal areas in numerical form through the use of indices based on clear and replicable method, using indicators that can be measured or objectively determined. This method could provide a useful tool for monitoring environmental quality and therefore offering great assistance in assessing the sustainability of existing police and practices.

In their study of the inequality in the spatial distribution of accessibility and environmental quality in Paris metropolitan Legion, Palma et al (2007) stressed the fact that local amenities the generally capitalized into housing market. In the analysis, data from IAURGP GIS data base and metropolitan computations were used. The empirical analysis of the study showed that considerable inequality existed in the spatial distribution of the local amenities and social indicators. To examine the degree of inequality in these amenities spatial representation and losenz curve were used representation and Losenz curves were used. The study revealed some evidence that some amenities were much more inequitably distribution than others. New sight was provided by the study as to how households in the Paris region trade off amenities against each other and against housing cost by estimating models at both a commune and at a grid cell level. Eventually, the researcher found that the data could be filled better at the smaller scale of the grides cell, using residential location choice model compared to the commune in most countries of the world, GIS/EMIS could be seen to be invaluable for modern environmental studies.

Based on the identification of certain characteristics, Condrero and Fisher (1999), in florida, worked on the procedures for assessing the environmental quality of coastal area for planning and management. They used certain indicators including numbers of storms per year to propose numerical indices of the indicators that could be used for monitoring environmental change with time. The method can help to determine whether existing management and policy trends move away or towards sustainability. Furthermore, it can facilitate the integration of scientific assessment into the process of coastal planning and management through the application of indices which gives the summary of environmental characteristics in terms that should be significant to planners and managers. Come what may, because of the peculiarities of coastal areas it may not be ideal that the procedure for assessing environmental quality in procedure for assessing environmental quality in coastal areas be generalized to every other environment.

Undertaking a study of the environmental quality of Brazilian Amazon, Perz (2011) emphasized that deforestation is not the only issue of importance concurring changes in environmental quality of the Amazon. Urban environment quality was considered in three dimensions. Data from census and health services statistics were used. Enchanters of environmental quality in urban population of the Amazon were compared in 1980 and 1991 quantitatively, using thirty three environmental

quality indicators. It was shown in the result that environmental quality in the region deteriorated during the 1980s as the production of and exposure to environmental hazards rose while resource to ward off hazards eroded. Besides, it also indicated that environmental quality was particularly poor in more rapidly growth urban centres. This invariably poses a challenge for sustainable development in the Amazon.

In an interesting environmental quality mapping study of Chittagong metropolis in Bangladesh, Majunder Hossain and Islam (2007) endeavoured to analyze both factual statues and perceptual pattern of the environmental quality of Chittagong metropolitan city. The factual data were collected from various sources while the perceptual data were based on questionnaire survey of opinions of 492 respondents at the household level by city ward. Ranking of the wards by environmental groups were used to survey the city's 40wards, and the studies numerous variables were classified into three physical environment neigbourhood environment and social environment. Satisfaction index developed by Hall, Yen and Tan was applied to determine the limit of satisfaction and dissatisfaction of the various environmental variables by respondents. Using chi square, it was tested against three levels of household income high, medium and low income groups. The result revealed the urgent need to address urban environmental quality resulting from high rate of urbanization and urban population in Chittagong metropolitan city. The researchers therefore advocated that the community people be mobilized in such effort since it is often very fruitful when the people are involved in improving their environmental situation.

Taking into account the effects of economic variables, Bernaver and Konbi (2004) assessed the effects of various political variables on environmental quality. Air pollution concentration of sulfur dioxide was used as the dependent variable. Annual observations for the year 1971-1996 from 291 observation sites located in 107 major cities in 42 countries (2,555 observation) constituted the data for sulfur dioxide concentration. Combining the environmental, economic, political and site specific component a statistical model was obtained through regression of sulfur dioxide concentrations on the explanatory variables, the researchers obtained their results. From the findings, there was indication that higher income, higher intensity of economic activity and greater trade openness contribute to lower pollution levels. The study could be useful for monitoring environmental quality. It is not however advice able to generalize the result to other forms of environmental quality as the issues is specific in nature.

Alkay (2009) carried out a study on the relationship between environmental quality level and housing sale prices in Istanbul metropolitan area of Turkey. Carried out in two stages, the environmental quality index was measured in the first stage using principal component analysis after standardizing the different units of measurement with similar indicators. In the second stage, relationship between the environmental quality index and housing sale prices were explored applying equally correlation coefficient and square goodness of fit. It was indicated in the result that the weights of dwelling indicators and satisfaction from housing environmental indicators were positive while the economic, social and accessibility indicators were negative for the casual factor that explained the environmental quality at district level in the metropolitan area. The study therefore concluded that the increasing environmental quality levels depends on the increasing quality of dwelling characteristics and satisfaction from the housing environment. Highlighting the

importance of the result, it could be seen that it guides an insight as to the overview of the environmental quality index at the district level.

Again, it can used to improve the city by both public and private decision makers. However, the fact that the study lacked time series data is a weakness on the other hand.

Investigating the importance of environmental quality to the poor and what the policy makers know about it in Add is Ababa, Ethiopia, Alem and Martinson (2011) asked the citizens and policy makers to rank areas that they think government should focus on. The ranking areas were (a) Better health services, education and housing

(b) Creating environmental opportunity
© Controlling price rise
(d) Improved solid waste disposal
(e) Improved liquid waste disposal.

Although standard determinant of subjective well being in western countries seemed to explain happiness in addis Ababg yet their finding role. On the average, the policy makers had more long term perspective by focusing on health education and housing. On the other part the citizens focused more on short term issue such as controlling prices rice. Consequently, adopting the views of the citizen in this regard, the government of the country went as far as introducing a strict control over price of basic commodities.

Examining the willingness to pay for improved environmental quality among the residents living in close peroximity to two landfill in Olushoshun and Abule Egba Lagos, Nigeria Olorunfemi (2009)used structured questionnaire to collect his primary data. A contingent valuation method was used in the survey technique. This solicited the residents preference through survey technique to state their willingness to pay for the benefit against from an improvement in environmental quality (an improvement in the quality of landfill practices). The results indicated that the presence of the landfills and the associated environment impact was an important factor contributing to respondents in their neigbourhood.

Determining housing and neigbourhood quality for Yenegoa, Bayelsa State of Nigeria, Ede et al (2007) sampled five neighborhoods in the city, using questionnaire and physical observation as instrument. They looked at some of the variables that determine urban housing and neighborhood quality as they relate to Yenegoa. The analysis made use of multiple linear regressions, the dependent variables (Y) in the study was a composite value based on location. The statistical package for social sciences (SPSS) was used to explain the variable. The result indicates that housing developers in Yenegoa did not comply with the existing regular measures to improve the housing and environmental quality. This invariably creates a gap between the present conditions and the target of various policy instruments for regulating the neighbourhood environmental quality in Nigeria. It was indeed, recommended that existing regulatory measures such as urban and regional laws, the National housing policy the urban development policy and the state sanitation edict be vigorously enforced by the government so as to address the situation. Although the study was empirically conducted the independent, variables shown were more of housing than

environmental. Hence, a limited number of environmental quality variables were embedded in the study.

AFON (1998) made use of twenty variables and identified ten environmental quality indicators to examine the housing improvement of core residential environmental quality of Ogbomoshe town in Nigeria. The relationship existing between pairs of the variables was determined comparing the correlation metric, and correlation of the proved positive., Emphasizing the importance of the result, the researcher asserted that it was of no use for planners to impose their ideas on the public because people are better planned for when they are allowed to make input into policy and programme that can affect their present or future.

Attempting to shed some high on compliance that ensure high attaching of environmental quality to housing, Ekurekong (1998) linked his study to housing estate in Uyo, Nigeria. The study revealed that the housing estate by all indicators was deficient in facilities and service provision. It also showed that more tahn70% of the total area of the estate had been used for residential development, leaving less than 10%forteh provision of facilities and services. These services were completely lacking in the estate. Hence, it was clear that existing facilities were undoubly inadequate to support the huge population in the estate. Thus, to monitor and control quality of the environment in the estate, it was recommended that an environmental quality unit be established.

Umeakuka and Mba (1999) observed that blockage of storm water drainage paths in Onitsha with solid wastes which in turn induced flooding can not enhance the quality of the area. Okeke (2002) noted that the extensive use of temporary structure in the high density neigbourhoods of Nigerian urban centres has constituted the forerunner of squatter settlement development in these areas. This is invariably impacted negatively on the environmental quality of the areas. Olarenwaju and Fadairo (2003) emphasized that poor state of streets even in Urban areas constitute a major problem in that it does not give room for efficient evacuation of solid waste. Hence, constant littering of these wastes within the vicinity tends to obviously impair the environmental quality of the area.

Nwafor, (2008) examined the causes of urban solid waste management problems and the attendant economic, social and health costs, as well as environmental and aesthetic costs. He identified the inertia factor, the demographic factor, institutional factor as well as absence public participation as being responsible. According to him the force of inertia operates from three angles; difficulty in enrolling pubic involvement for change, the perceptional aspect and the response aspect. Considering the demographic factor, rapid urban population increase the accelerated rate of urbanization, while lack of inter-sectoral communication and coordination to manage the environment are the major institutional constraints. Consequently, solid waste management problems have resulted in critical environmental, economic, social and human health crises in the metropolis, impairing seriously the environmental quality of the area.

Although various authors have discussed or carried out researches on environmental quality studies have so far primarily concentrated on the effects of economic and social demographic variable on environmental quality as observed by Benaur and Loubi (2004). Besides, the available studies on

measuring environmental quality focused mainly on peculiar areas a sin the case of Cendvero and Fisher (1999). Again, a good number of the studies were on an aspect of environmental quality especially pollution such as in Olorunfemi (2009) furthermore, public perception based studies were very common as exemplified in Afon (1998). It is therefore essential that a study of detailed environmental quality indicators is timely in Nigeria. This will aid in the measuring and ascertain the environmental quality of an area, especially now that Nigeria and the rest of the world are gearing towards sustainable environment

MATERIALS AND METHOD

The study Area

Enugu metropolis is located in Enugu State capital in South Eastern past of Nigeria. It lies within 221 meters to 317 metres above sea level and is found between latitudes 60 23N and 6029 N and longitudes 70 29'E the and 70 32E the area is easily accessible through the Onitsha-Enugu express way; the metropolis ascends from the Garki road end to the Uwani Ogbete road and runs towards Asata Areas. It is surrounded by predominantly rural areas with Nkanu Local government to the East and South and Udi Local Government to the North and West. Enugu was founded as a result of the discovery of coal in the later part of1909. As the metropolis grew in commerce and industry so did its population. In 1917 Enugu attained township status and by 1939 it became the headquarters of the tem southern province it became a regional capital and the important administrative centre in then Eastern region with the creation of the three region in Nigeria in 1961.presently,it is the capital of Enugu State of Nigeria, with a population of 722,664(NPC).

The metropolis is mostly underlain by the Enugu state, with the outcrops occurring in the plains east of the North –South trending escarpment. Having been subject to weathering and erosion for long periods, the characteristics landscape of the areas is extensively level plains interrupted by steep valleys and low hills. The national vegetation, which is tropical rainforest, is reduced to Guinea savanna type as a result of human activities except along river stream channels where remnants of original vegetation can still be observed.

The study area lies within the tropical rainforest climate zone and the climate is humid tropical characterized by day time temperature of 27-32^{o}c and night time temperature of 17-28^{o}c. two district season primarily determine the climate of the areas dry season and rainy season. The dry season lasts from November to March, while the rainy season last from April to October, but a times extending to between March and November, having July as the peak period. The annual rainfall of the area is usually over 1240mm. the relative humidity fluctuates between 40 and 80percent. The prevailing winds are the local monsoons; the North East Trade wind and the South west trade wind the North East trade wind blows from across Sahara desert, with dry and dusty air over the area resulting in dry season. The South West Trade wind blows from across the Atlantic oceans, brining about the rainy season.

METHOD

In the analysis, a relationship between the environmental quality of the area and the primary indicators of air pollution was established. Survey design was adopted in which the metropolis was classified into 30neigbourhood, stratified into high, medium and low-density areas. From these areas sample were selected randomly, primary data were mainly collected using questionnaire. Closed form was largely used in which choices of possible answer to open questions were provided and direct contact method of reaching the respondents was adopted one thousand, five hundred and twenty copies of the questionnaires were used in the analysis. Also field tests were equally carried out to determine the magnitude of the pullants in the areas.

21 residential environmental quality variables were used in the study made up of11dwellign unit quality variable(floor condition, wall condition, window condition, ceiling condition, rood condition lighting, structural condition landscaping, nuisance, poor condition, and neighborhood problem), 5 parcel quality variables (condition of drive, fair condition, sanitary condition, drainages and noise level) and 5 basic residential quality variables (crowdedness, good condition of housing units, air quality of the areas, waste disposal and domestic water supply). Primary indicators of air pollution variables used in the study include particulate matters of air pollution variables used in the study include particulate matters of air, carbon II oxide, sulphure IV oxide as well as nitrogen IV oxide.

To reduce the various residential environmental quality variables to component, factor analysis (principal components analysis) was first used. Varimax rotation was carried out to constantly rotate so as to further reduce the components into factor score. The eignen values of the factors were introduced and a combination of the factors scores formed the single "Y" variable. The pollutants; particulate matters of the air, carbon II oxide, sulphure IV oxide and nitrogen IV oxide constituted the x1, x2, x3 and x4 variables respectively. While the residential environment quality (Y) constituted the dependents variable the pollutants (x1, x2x3 and x4 variables respectively. While the residential environmental quality (Y) constituted the dependents variables the pollutants (x1, x2,x3 and x4) became the independent variable.

Multiple regressions were then involved to establish the relationship between the dependent and the independents variable hypothesis was used to test the relationship at 0.05level of significance.

Data Presentation

The results of air quality measurement carried out in the neigbourhood of the study areas turned out the following;

Table I: Result of air quality measurement carried out in the study area in Nov. 2019.

Fed. Min of Env. Limit Nigeria	Total particles (250)	Nitrogen IV (0.035)	Sulfur IV oxide (0.5)	Carbon II oxide (5)
Limit				
Low density Area				
Independence layout	188	0	0	1.3
G.R.A	194	0	0	1.1
Republic layout	208	0	0	1.4
New G.R.A	201	0	0	1.6
Golf	197	0	0	1.4
Medium Density Area				
Trans Ekulu	231	0		.1
Corridor layout	211	0		0
Federal Housing	246	0		0
Thinkers corner	261	0		.1
City layout	241	0		0
Maryland	257	0		-1
Aria Road	236	0		0
New road	240	0		0
New Era	231	0		0
Second Avenue	224	0		0
Real Easte				
High density Area				**3.2**
Ogui layout	242	0	0	3.8
Astat layout	243	0	0	3.6
Achara layout	241	0	0	3.2
Uwani	238	0	0	3.6
Iva valley	248	0	.6	5.2
Awkunanaw	247	-05	0	0
Abakpa nike	258	.01	0	5.2
State housing	254	0	0	4.8
Emene	261	.09	0	5.4
Riverside	244	0	0	3.6
New haven East	236	0	0	3.1
New Haven West	236	0	0	3.0
Astata Camp	241	0	0	2.8
Ogbete	261	.088	0	5.6
Idaw River	242	0	0	2.4

Source: Researchers field work,2019

Table 1 indicates the results of air quality measurement carried out in the study area. Also indicated are the limits by the Federal ministry of environment in Nigeria for air quality indicators of total particle, nitrogen IV oxide, sulfur IV oxide and carbon II oxide.

Table II component matrix of environmental quality variables

Variable	**Components**		
	1	2	3
Floor	.804	-076	064
Wall	.917	.011	231
Window	-946	.013	208
Ceiling	-918	.148	152
Roof	-891	.178	149
Lighting	.889	.127	284
Structural condition	.851	.113	298
Landscape	.802	.102	198
Nuisance	.819	.191	137
Condition of Drives	.825	.299	013
Crowdedness	.419	.634	299
Poor condition	.912	.028	019
Fair condition	.608	.461	239
Good condition	.824	.309	059
Sanitary condition	.682	.501	232
Drainage	.801	.308	011
Neighborhood problem	.887	.049	132
Air quality	.609	.178	191
Noise level	.828	.079	189
Waste disposal	.764	.128	448
Dom. Water supply	.802	.106	299

Extraction: principal component analysis

Principle component analysis has reduced the 21 environmental quality variables to 3 underlying components in table II

Components I, has significant loading on21 variables and they include; floor, condition, wall condition, window condition, ceiling condition, of roof, lighting, structural condition, landscaping, nuisance, condition of drives, poor condition, fair condition, good condition, sanitary condition, drainage, neighborhood problem, our quality noise level , waste disposal and sources of domestic water supply.

Component II has significant loading only, one variable; which is crowdedness of the housing units while components II has no significant loading on any variable

Table III: Varimax Rotated component matrix of environmental quality

Variable	**Factor scores**		
	1	2	3
Floor	-681	-418	398
Wall	-804	-403	.191
Window	-791	-411	.319
Ceiling	.801	-294	.408
Roof	.771	249	.441
Lighting	.859	238	.307
Structural condition	.821	276	.189
Landscape	.701	248	-309
Nuisance	.644	459	-192
Condition of Drives	.581	658	-951
Crowdedness	.179	111	-804
Poor condition	.663	463	-461
Fair condition	.213	776	-103
Good condition	.601	192	-661
Sanitary condition	.279	814	-102
Drainage	.484	691	181
Neighborhood problem	.731	439	-291
Air quality	.341	272	-521
Noise level	.345	631	-504
Waste disposal	.262	489	-706
Dom. Water supply	.356	491	-602

Rotation method. Varimax with Kaiser Normalization

Table II shows the varimax rotated components matrix of the environmental quality variables. After constant rotation, the result eventually turned out 3 factors;

Factor I is significantly loaded on II variables and they are; floor condition, wall condition, window condition ceiling condition, condition of rood, lighting, structural condition landscaping, nuisance, poor condition and neighborhood problem. These variables impinge on the environmental quality by stressing primarily the variables of the environment which hinge squarely on the dwelling unit component. Thus, the underlay factor identified could be regarded as the dwelling unit impact on the environmental quality of the study areas.

Factor has significant loading on five variables which are condition of drives, fair condition, sanitary condition, drainages and noise level. They constitute the most pronounced and conspicuous imprints on the adjacent structures and the parcel. This describes the extent to which quality of the units and surrounding within the same vicinity is affected. The common focus within these variables is that they hinge on the parcels of the areas. Hence, the underlying factor could be identified as the percent environmental quality.

Factors III is loaded significantly on 5variables. They include; crowdedness of the housing units, good condition of the housing units, air quality of the areas, waste disposal in the study areas as well as domestic water supply in the areas. In other words, the index appears to measures the overall quality of the exterior physical environment. For this reason, it is referred to as basic residential quality.

ANALYSIS AND RESULT

In the analysis of the entire data, SPSS was used and the output (Regression outputs) are;
Model summary

Model	R	R square	Adjusted R square	Std error of the estimate
	.934	.917	.905	8.01216

a. Predictors (constant) participate matter, Nitrogen dioxide, sulfur dioxide, carbon monoxide.
ANOVA b

Model	Sum of square	Df	Means square	F	Sig
Regression	3968.548	4	141. 116	121.211 46.826	0.03
Residual	482.864	25	54. 361		
Total		29			

a. Predictors (constant) particulate matter, Nitrogen dioxide, sulfur dioxide, carbon monoxide
b. Dependent variable; aggregate score

Coefficient

	Unstandardised Coefficient		Standardized Coefficient		
Model	B	Std Error	Beta	t	Sig.
1 constant	26,468	12.72		3.412	.051
P.M	-2948	2.4492	-172	3.483	.041
Nit Diox	-0892	0.6891	- 112	2.124	.028
Sul Diox	-2402	2.1921	- 131	2.862	.034
Carb. mon	-2662	2.2261	-156	3.081	.036

a. Dependent variable: aggregate score

DISCUSSION

From the results, there is an indication that there is strong significant relationship between particulate matters, nitrogen dioxide, sulfur dioxide carbon monoxide and the environmental quality of the study area $r^2 = .917$. This shows that 91.7% of the variation in the dependent variable can be predicted from the independent variables.

To generalize the finding to the population beyond the sample, adjusted r^2 was employed Adjusted $r^2 = .905$, indicating that the best coefficient of determination is 90.5%. Thus, 905% (explained variance) of the variable is capable of predicting the value of environmental quality in the area,

leaving 9.5% of the variation unexplained. Furthermore, D significance = .03 and P <.05level of significance, all the independent variables have significant levels at less than .05. The coefficient table indicates the relative impacts of each independent variable on the dependent variable, it is pertinent, however to note that particulate matter variable impact more on the environmental quality of the area than any other variables in the relationship however, there are instance where some of the variables are manifested in greater magnitude in certain neigbourhood than the others.

From the analysis of the concentration of particulate matters in each of the neighborhoods, the results show that the concentration is higher in neighbourhoods; the results show that the concentration is higher in neighborhoods like Maryland, thinkers corner, Ogbete state housing and Emene than the stipulated limit by Federal ministry of environment in Nigeria. Industrial dust plant pollen, combustion and gas particle conversions were deemed as the possible sources of the increase in this pollutant. The presence of different industrial outfits in Emene and Thinkers corner has specifically been identified as contaminating the air in theirs neigbourhoods. Also, the extensive agricultural activities within Emene and Abakpa could be likened to the manifold presence of increased plant pollen in these neigbourhood. Besides in Maryland behind Lomalina Estate, massive construction work is presently going on there in forms of residential property development and the associated services. The developers (primarily private developers), who in many instance are not guided by the code of development for new areas, tend to turn a lot of particulate matters into the atmosphere. This, in effect, is likely to account for the increase in particulate matters as being experienced in the area. At Ogbete which harbours the biggest market in Enugu capital territory effective waste management at Ogbete market seems to be an illusive venture. Heaps of waste materials, particularly food stuff are seen in different parts of the market. The situation is worsened when scavengers and the likes go to these heaps, up turning them scouting for one item or the other they could sell to fend for themselves; hence, polluting the vicinity as these decayed debris fume into the air. Since particulate matters are carcinogenic and are also associated with pulmonary effects, people who do their business around such areas are particularly susceptible. On the physical environment, it has been observed that particulate matters stain fabrics, paint surfaces and building as well as reduce like of materials and surface finishing.

In Emene, Abakpa, Ogbete neighbourhood, high level of carbon II oxide was observed sources of this pollutant were not unconnected with porter-governed motor vehicles, diesel engines and fuel wood oxidation of hydrocarbons. As a result of having one major road linking old Emene with the city of Enugu and the road being in a state of disrepair, committers find it difficult to fly through this road particularly around Oye Emene during peak periods. Hence, a lot of vehicles are trapped in hold up around Oye Emene all emitting carbon monoxide within the same vicinity thereby polluting the air in the neighborhood. Besides, the presence of Nigeria National Petroleum Corporation depot at Emene attracts a large number of heavy duty vehicles that come to lift petroleum products. Emissions from such vehicles tend to pollute the air in the surrounding neighborhood. Furthermore, in Enugu metropolis, Emene us regarded as the industrial of the area. These industrial uncontrollably emit carbon monoxide into the atmosphere, putting the environment. In Ogbete neigbourhood, the hold up being experienced in front of Ogbete market between Ogui junction and Okapra Avenue is nothing to be desired as a result, the vehicles involved equally emit carbon monoxide to pollute the immediate environment. It has, however, been known

that presence of carbon monoxide in an environment exceeding its limit brings about reduced oxygen carrying captivity of blood by formation of carboxyhaemoglabin instead of oxyhaemoglobin formation.

Sulfur IV oxide was noticed to be on the high side in Emene and Iva valley increases in petroleum products in recent time has caused many families in Emene even industrial outfit to resort to the use of coal for their domestic as well as industrial purposes. This is evident as lots of people are seen in Oye Emene on any Oye market day marketing coal products. Also the activities in Okpara as well as Onyeama coalmines seem to have had devastating effects on the environment around Iva valley neigbourhood. The mining activities of coal has indeed branded the city coal city because of the abeyance of coal deposits in the area hence, the combustion of coals is the major source of sulfur IV oxide pollutant in the metropolis and the exceeding limited of it in any environment could negatively affect the health of peoples living around the area. This brings about worsening respiratory illness from short-term exposure and increased respiratory symptoms including chronic bronchitis from long term exposures. The environmental effects often manifest in the acidification of soils, lakes and rivers, damages to plants and crops, corrosion of building and the likes.

Nitrogen IV oxide exists in a higher level than that stipulate by the federal ministry of Environment in Abakpa and Emene. Forest fires, vehicular emission as well as nitrate based fertilizers could be traced to be the sources of this pollutant. Lack of adequate residential housing units in the core city has caused many residents in Enugu particularly the low income earners to move out of the town to suburbs, and some of the suburbs are presently being over stretched. Abakpa being one of the suburbs is harboring both human and vehicular traffics more than its carrying capacity. The vehicular emission in this neibourhood tends to impair the air quality particularly during the peak periods. Furthermore, many farmers are known to be residing in Amorji Nike, Iji Nik, as well as other places surrounding Abakpa and Emene, cultivating vegetable primarily in both rain and dry season. These farmers often make use of nitrate based fertilizer to boost yield and this invariably contributes towards the impairment of the environment.

Also forest fires mainly during dry season often impacting regulively on the air quality of the areas. This follows' the activities of hunters who often set forests in the areas on fire during dry season for easy catch of their preys. Nitrogen IV oxide affects lung function in Ashatics from short term exposure, causing chest tightness, burning of the eyes and headaches. On the physical environment, nitrogen IV oxide can absorb infrared radiation and can enhance global warming and destruction of the earth. It can also bring about distortion in ozone layers.

CONCLUSION

In the study, it has clearly shown that there is a strong relationship existing between the air quality and the entire environmental quality of the study area. This could be seen through the interaction of the air quality indicators particulate matter sulfur dioxide, nitrogen dioxide and carbon monoxide with the environmental quality of Enugu Metropolis.

The relationship exhibited negative impacts on the environment, these imapcst were manifested in different neigbourhoods. In Maryland thinker's corner, Ogbete, Emene, State housing, the concentration of particulate matters was high. High level of carbon monoxide was observed in Abakpa, Ogbete as well as Emene. Sulfur dioxide concentration manifested high in Iva valley and Emene while high concentration of nitrogen dioxide was experienced in Abakpa Emene and Ogbete. The effects of high concentrations of these pollutants were seen in different areas of life. Particulate matters were observed to be carcinogenic and are likely to be associated with pulmonary effects in the area. The physical environment is affected through the staining fabrics, effects on paint surfaces and buildings. The exceeding limit of carbon monoxide brings about reduced oxygen carrying capacity of blood in man. High sulfur concentration of sulfur dioxide results to worsen respiratory illness from short term exposure and increased respiratory symptoms including chronic bronchitis from long term exposures. It can also lead to acidification of solid, lakes and rivers, damages to plants as well as causing corrosion to building. Exceeding limit of nitrogen dioxide affected lung functioning in Asthmatics from short term exposure, causing chest tightness and burning of the eyes it can also absorb infrared radiation and can enhance global warming and destruction of the earth.
It could be deemed an Irony of circumstance that the environmental quality of the study area is deteroririating, even now that the global attention is focusing on sustainable environment. It is therefore imperative that adequate attention is shown by all concerned so as to salvage the situation.

Recommendation

It is clear that the land use pattern in parts of Emene and Thinkers corner is that of mixed developments of residential housing units and industrial outfits. Hence, it is therefore very essential that residential areas be totally separated from industrial areas so as to avoid the effects of industrial dust and other emissions from industries in the area which elicit negative impacts on the residents in these areas. Besides, in parts of Abakpa and Emene land is being used for both agricultural and development of residential housing units. As a result, the areas are being contained with plant pollen as well as contamination from nitrate based fertilizers. It is equally recommended that the residential areas be totally distanced from agricultural area. Area like Amorji, Iji and Ogwogo Nike where much property development has not taken places could be deliberately reserved for agricultural purposes while Abakpa Nike and Oye Emene areas with housing development could be divulged of commercial agricultural activities. This will go a long way to separate the resident's in these neigbourhoods from the harmful effects of these activities.

There is urgent need for special intervention in the state of some of the major roads in the metropolis by the state government. These roads include the major road linking Okpara Avenue and Ogui road through Ogbete main market, the old Emene road connecting rehabitiationroad at Oye Emene as well as the road linking the densely populated Abakpa area with Enugu /Onitsha express way at Army barracks. Furthermore, it is essential that the Nigeria National Petroleum Corporation Depot at Emene be related outside the metropolis as residential development has engulfed the area these measures will tend to ease the vehicular movement in the areas affected and concentrated emission of carbon monoxide avoided. The residents residing within these areas are saved from the chance of being faced with the health problem of reduced oxygen carrying capacity in the blood.
The metropolis is known as being rich in coal deposit. The exploitation of this mineral and usage by individual industrialist at a very rapid rate tend to negatively impact on human health and

physical environment. The recent economic melt down as it affects prices of petroleum product is nothing to write home about. The prices of petroleum product are nothing to write home about. The price of kerosene used by majority of the people within the metropolis has gone up recently in an astronomical manner, beyond the reach of the common man. Many people have therefore resorted to the use of coal. The combustion of coal has indeed instilled a major air pollutant sulfur dioxide into the environment. This exposes the residents in the metropolis to danger of respiratory illness like chronic bronchitis the Federal government of Nigeria is therefore implored to speedily intervene in the availability and price of kerosene product so that the common man and indeed, majority of the residents in the area will be able to have access and can afford to purchase the product. This will make residents of the area using coal as their sources of power to desist from such and go back to the cheaper alternative kerosene. This will help in sanitizing the environment as less combustion of coal and of course less pollution in the concerned environment will be experienced.

Nitrogen dioxide, the pollutant that brings about chest tightness burning of eyes and which equally affects long functioning in asthmatics could be avoided of peasant farmers within the metropolis will totally desist from the use of nitrate base artificial manure and go for the natural manure that can easily be accessed through the composting of materials within the area and from other sources. As bush burning elicits nitrogen oxide into the atmosphere, adequate measures should be taken by both the state and local government officials in the area to curb the activities of the self centred hunters who often set bushes on fire in the metropolis for the mere easy catching of their prey rodents.

Furthermore, it is advocate that Enugu North Local government Authority liases with Enugu State waste management authority to tackle the problem of waste management in Ogbete market. The market association executives should be incorporated in the forum, who will invariably reach out to their colleagues to effectively maintain good sanitation in the market, and avoid incidence of air pollution there.

REFERENCES

Adams, S(2016) Mapping micro urban heat Islands using landsat TM and Agis comput Geotech 1995:21:965-979

Afon, A.O (1998) “use of residential environmental quality indicator in ogbomosha care residential housing improvement” FUTA environmental forum. Vol xi. No 1pp60-6

Akinola, A.K Suleiman A Adeleye Y, Francis O and Dauda R. (2014) air pollution and climate change in Lagos, Nigeria, need for practice approaches to risk management and adaption Journal of environmental science 10(4) 42-423

Akinola, A.K, Suleiman A,Adeleye Y, Francis O and danba R (2014) Air pollution and climate change in Lagos, Nigeria, Need for proactive approaches to Risk management and adaption Journal of environment sciences 10 (4) 412-423

Alkay, E. (2009) The relationship Between Environmental Quality level and Housing sale prices in the Istanbul metropolitan Area. Istanbul Technical University publication vol. 6 No. 1pp 60-76

Altem, Y and P Martinson (2011) How important is environmental quality for the poor and what Do Policy Makers know about it" A study on subjective and well being in Addis Ababa" SAE working paper services

Anderson, (2013) The union carbide disaster in Bhopal: A review of health effect. Arch environ. health (9)242

Aronow (2012) Decadal charge in summer mortality in U.S cities Int. J biometeol 47:116-175

Atimay, U (2011) The changing chicken chooks, cooks and culinary culture Sydney University of new South wales press

Bernaur, T and K. Koubi (2004) "On political Determination of Environmental quality CIS UNI/ETH Zurich working paper no 2

Cendrero A and W.M Fisher (1999) A procedure for assessment the environmental quality of coastal areas for planning and management *Journal of coastal research v*ol. 13 No3 pp6-8

Cendrero L Lopez and Adriana G (2003) "Indicators and indices of environmental quality for sustainable Assessment in coastal Area" *Journal of coastal research coastal education and coastal foundation Inc*. vol 19No4pp 919-933

Chi, C.C(1994) Growth with pollution unsustainable Development I Taiwan and its consequence. Stud.Comp.Int. Dev. 1994:29:23-47

Cohen, N (2018) Handbook of urban health New York Spinger.

Edo, N, F Ebakpa and C Chukwuigwe (2007)"Determination of Housing and neigbourhood Quality for yenegoa" Journal of Nigerian Institute of Town planner vol. xx No 1p.107

Harrison, RM (2005) Sources of air pollution, Air Quality guideline global update copenhagen Denmark: *World Health organization regional office for Europe*

Hewitt and Jackson A.V (2007) Sources of Air pollution in Jackson, AV, editor, Handbook of Atmospheric science; principles and application 2nd ed maiden MA USA Blackwell Science Ltd pp 24-55

Jonson W and C Keith (2009) "How carbon dioxide become a pollutant wall street journal (9) 48-59

Kan, H, Chen B, Zhao N (2010) A time series study of Ambient Air pollution and daily mortality in shanghai, China. Res. Rep. Health eff Inst:154:17-78

Kleinman, N (2017) Framework for the Development of Environmental Health Indicators. World Health StateQ1995:48:144-154

Kust,T (20016) Occupational health boston. Little brown and co.

Lim, N(2012) meat compensation trends and health: casting wider Risk Assessment net public health Nutri.2005:8:341-343

Majunder, A E Hossain, EIslan and M. Sarwa (2007)"urban environmental quality mapping. A perspective study of chittagans metropolis Bangladesh" *Kathnandu University Journal of Science and technology* vol. 1 No4pp10-11

Mawer, C (2014) Air pollution in Iran BMJ 348:g1586

Mihrea, V. (2003) Health effects of air pollution. Background paper for population Environment research network. Cyber seminer Dec. 1-5 retrieved from http/www.mnforsustain org/climate health effects of air pollution mishra pern.htm \

Mishrea, V. (2003)Health effects of air pollution background paper for population environment research network cyber seminar Dec. 1-5Retrieved from http/www. Mnforsustain. Org/climate health effects on air pollution mishra pern htm

Molina M and L Molina (2004) Megacities and Atmospheric pollution J. Air waste Management Asso. 2004:54:644-80

Morris, S(2018) urbanization and slum formation. Journal urban health 2007.11524-007.9167-5

Nwafor, J.C (2008) "Integrating Environmental impact assessment into planning and Development at local govt. and state levels. A case study of Enugu" paper presented during A 3 day workshop of centre for environmental management and control (CEMAC) at zodiac hotel Enugu March 21-24

Nwafor, J.C (2008). "integrating environmental impact assessment into planning and development at local government and state levels. A case study of Enugu" paper presented during A 3day workshop of centre for environmental management and control (CEMAC) at Zodiac hotel Enugu. March 21-24

Okeke O.C (2002) "Urban Landuse planning and informal sector syndrome. A case study of Enugu" Journal of the Nigerian institute of town planners Vol. xiii pp 56-64

Okeke O.C(2002) "Urban landuse planning and informal sector syndrome. A case study of Enugu" Journal of the Nigerian, Institute of town planners; vol xiii pp 56-64

Olarenwaju, Dand G. Fadairo (2003) "Flooding as an induced environmental problem . a case study of Ala River,Akure Nigeria" *Journal of Nigerian Institute of Town planners vol. xvi No 4 pp 85-95*

Olaronwaju, D AND g. Fadaira (2003) "flooding as an induced environmental problem. A case study of Ala River, Akure, Nigeria" journal of Nigerian institute of Town planners vol. xvi no 4pp85-95

Olorunfemi F. (2009) Willingness to pay for improved environmental quality among residents living in close proximity to landfills in Lagos metropolis, Nigeria". Ethiopian *Journal of Environmental studies and management* vol. 2 No 3 pp 21-22

Palma D and A Anndre (2007)" Accessibility and Environmental inequality in the Paris Housing Marketing" *European Transport publication* No36 pp47-74

Perz, S.A (2011) "The quality of urban environment in the Brazilian Amazon *Journal of social Indicators Research.* Vol.49 No 2 pp 181 -212

Puppim de Olieria J.A (2011) Why an air pollution a cleover lags on climate policy. The case of local policy implementation in Mire Japan Environ. Plan. A 43:1894-1901.DoI:10.1068/a43240

Puppim de OLIVEIRA J.A (2011) why an air pollution a cleaver Lagos on climate policy: the case of local policy implementation in mire, Japan. Environ. Plan. A 43:1894-1909.Doi 10.1068/a43240

Simonaitis , S.(2015) Air Quality Guideline for particulate matter Ozone, nitrogen dioxide and sulphur dioxide global update 2005Geneva.world health organization

Umeakuka I. J.M and H.C Mba (1999) Waste Management Practices, A case study of Anambra state *Journal of the Nigerian institute of Town planners* vol, xii.pp14-25

United States Environmental Protection Agency(2003)Carbon monoxide poisoning: A review for clinician . The Journal of emergency me. 17 89-93

Vaidyanathan, climate wire and Gayathri (2016)"The worst climate pollution is carbon dioxide" scientific American.