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Human Health Implication of the Spatial Distribution of Air Pollution, in Calabar Central Business District (CBD), Calabar, Cross River State, Nigeria

Mrs Patricia Obi, Karang[1], Abobi Domnic Odah[2]

[1]Cross River State College of Education, Akamkpa
Department of Geography Education, Cross River State College of Education– Akamkpa, Nigeria
[2]Cross River State College of Education, Akamkpa. Crs.
Department of Music Education, Cross River State College of Education – Akamkpa, Nigeria

ABSTRACT

This study is spurred by the need to clearly appreciate the air quality status of Calabar metropolis, Cross River State. The investigation is imperative deriving from the recognition that there is absence or dearth of information concerning the air quality status of the area under investigation. The dire necessity of this study derives from the overall health implication of a clean air quality on the health of the people. Historical antecedents of air pollution episodes and their attendant human health impacts have been provided in the background as well as the literature reviewed along similar lines. This goes to buttress the justification of the study which substantiates the inevitability of a study of this nature on grounds of its a utility in urban environmental planning and management, epidemiology essence of the findings and similar other contributions that the study stands to provide. The literature explores the historical anecdotes of the air pollution scenario's in different parts of the world and the human health impact attendant upon them, air quality standards and criteria and the overall paraphernalia of air pollution incidents and health impacts in different parts of the world. The methodology follows such basic themes as description of the study design, the area of study, the study population, the techniques of sampling, basic instruments for data collection, procedure for data collection, data analysis techniques. The decision state that since the F-cal value is greater than the F-critical value at alpha level of 0.05 degree of freedom the null hypothesis is rejected while the alternative hypothesis is accepted in dictating that there is significant variation in the spatial distribution of air pollution in the city of Calabar Nigeria.

INTRODUCTION

Pollution incidence generally and environmental air pollution has been on an alarming increase in recent times caused by the incidence of anthropogenic activities that contribute to environmental dereliction all over the world. Cities and urban centres are more seriously affected due to the magnitude and scope of demographic attrition of the urban landscape. Human activities in different spheres of endeavour such as industries, urban transportation, urban commercial undertakings, so on and so forth are among other precursors of urban air quality deterioration (Montgomery 2000)

Hardoy etal (1992) have reported copiously on urban environmental air quality in cities of developing countries such as Nigeria, the rest of Africa parts Asia, Latin, America and Oceania.

Air pollution incident have been a common feature of urban areas from quite early in the history of civilization. Rahman (2016) provided in sight in the historical prelude of air pollution and their impact on human health in different cities such as muese valley (Belguim 1930), Donora valley (1948) London Smoly (1952)

The meuse valley episode of 1930 was reported to be first major air pollution incidence causing the death of 68 persons and hospitalization of 6000 others. Similarly in Donora valley (1948), the incidence resulted in 14000 people taking ill out of which 20 died. The most grievous tragedy took place in London in 1952 due to the Smog incidence which led to the death over 4000 persons. The poignant Snag in the air pollution health impact incidence is the slurry nature of its impact manifestation. But slowly and insidiously people are liable to fall victims of the pollution incidence.

Following Rahman (2016) air pollution is usually concentrated in densely population urban areas, especially in developing countries where environmental regulation is tax or nonexistent. This situation epitomises the Calabar urban air quality with little or no municipal regulation.

Overall, it has been clearly substantiated that urban air quality has been a major concern throughout the world (Rahman 2016) in the same report by Rahman (op cit) in 2004 urban outdoor air pollution was ranked as the 14th global risk factor for mortality. As human/anthropogenic activities are diverse so are urban sources of air pollution. Urban industries, agricultural sources, urban markets, urban domestic energy sources, urban transportation, urban development and construction industries among others are the media through which pollution are derived in urban centres.

As the sources are diverse, so also are the categories of pollutants. Particulate matter (pm) aerosots, Smog, green house gases (co2, ch4, Nox, sox) among others are the varieties of pollutants that are commonly encountered with their deleterious human effects.

Adequate determination of the Calabar urban air quality status in line with WHO and other established standards elsewhere may throw insight into the true perspective of the human health implication of the ambient air quality to which the population is exposed. Epidemiological review/ survey of the morbidity status of the population may also form another basis of adequately ascertaining of the health impact scenario.

STATEMENT OF THE PROBLEM/ JUSTIFICATION

Air pollution incidence has been a subject of numerous investigations by different scholars in cities in different in parts of the world. As earlier stated, in the background to this study air pollutant are of various species and/ or categories and so are the effects enormous and varied.

Generally, air pollution impact on human health has been recognised to be of serious magnitude . In other worlds most pollutants have lethal or deleterious effects. As the pollutants are diverse so equally are the effects and correspondingly so are the rates of susceptibility of individuals due to factors such as age, sex, body morphology and level of exposure.

Hardoy et al (1992) writing about environmental problems in third world cities, noted that one grave in adequacy in third world cities air quality determination is the gross dearth of data. This salutation presents an dreary perspective of the poor knowledge basis of the overall environment which poses serious threat to human health in the present and future state of the society

A situation of uncertainty portends a great danger to all and sundry. Calabar city environment demands prodigious information and data concerning the environmental status and its implication to human health. Presently, there is scarcely reliable or dependable data on the ambient air quality status of the city and its likely import to the health of residents.

Also, there is the dire necessity of reliable data on the air quality standards which may way comparable to the world health of organizations (WHO) acceptable limits of human health sustainability. It is hoped that this study will provide insights into some of the lapses in the air quality assessment and it ability in human health understanding.

OBJECTIVES OF THE STUDY

AIM: The overall objective of the study is an understanding / Assessment of the air quality status of Calabar through determination of concentration of pollutants and how it may possibly or actually impinge on the health of its residents.

OBJCETIVES: From the above aim the following specific objectives have been derived.

I. Determination of the air quality status of the area based on pollutants concentration.

II. Determination of the spatial distribution of pollution in the city of Calabar, Nigeria.

RESEARCH HYPOTHESIS

HO: There is no Significant variation in the spatial distribution of air pollution concentration in Calabar Cross River State.

HI: There is a Significant variation in the spatial distribution of air pollution concentration in Calabar Cross River State.

LITERATURE REVIEW

OVERVIEW

Urban air pollution ranks topmost among urban environmental problems in all cities of the world. Hardoy et al reported that third world cities have high concentration of pollutants in their ambient air environment.

A good number of the pollutants have deleterious effects or are lethal to human wealth. Ubong and Gobo (2000) wrote on certain categories of health effects of some pollutants which they describe as carcinogenous (cancer causing) Teratogenic (causing birth effects) mutagenic (Gene mutation) and /or lethal causing death. The background to the study and the problem statement have alluded to the history of health impacts caused by pollutants in different cities of the world in distant/recent times. One problematic of air pollution study in the cities of developing world areas like Nigeria and Calabar in particular is lack of adequate data on the category and nature of pollutants and their corresponding health effects.

CATEGORIES/ SPECIES OF AIR POLLUTANTS

All pollution categories are as diverse as human cetivities scope. Generally, pollutants of two categories-harmful (nocuos) and non harm (Innocous)

Dantiya (2019) has reported that there are over 3000 anthropogenic air polluting compounds in which most are organic, vehicular emission is reported to contain 500 types of different compounds (WHO 2008)

Anthropogenic Emission from domestic, domestic and automobile sources have increased appreciably in recent times. Among these products of fossil fuels have been reported as the most hazardous (Amraj and Azees 2005) The reporter went further to state that the most hazardous of the air pollutants are products of fossil fuels, which are by products of combustion fuel engines. In most vehicles impacts can be aggravated by water vapour, natural dust and sunlight by activating and producing secondary hazardous pollutants such as ozone, secondary organic aerosols, sulphates and nitrates. That most of those urban air pollutants come from road traffic and comprises a mixture of airborne particulate matter (PM) oxides of sulphur (SOX), oxides of Nitrogen (NOX) carbon monoxides (co) carbon dioxides (co2), volatile organic compounds (vocs) polyaromatic hydrocarbons (PAH) and Ozonel (Turson 2008). Carbon monoxide is said to be produced by incomplete combustion sources that occurs in internal combustion engines, or other devices that use fuel.

Globally, there are regulations or limit set on the maximum concentration in the exhaust of combustion device. To have an adverse effect of reducing the oxygen concentration in the red blood cell (RBC). Oxides of nitrogen, (No, and No2) are equally said to be produced by internal combustion engines. There are said to be derived from vehicles that use diesel and gasoline. Oxides of sulphur are also said to come from combustion sources which are by products of fuels containing sulphuric substances. There are also said to be derived from petrochemical sources. Ozone (o3) is another pollutant in the higher elevation. In the atmosphere ozone reacts with chlorine to produce chlorothorocarbon (CFC) (Montgomery) 2000). It is also reported that of all pollutants, particulate matter (pm) is the most complex and the most hazardous. Fuel sources are said to produce smaller particles that are most harmful (Dantiya 2019)

INDOOR AIR POLLUTANTS

So far attention has been devolved to outdoor air pollution of different categories. Indoor air pollution is equally another source of concern in environmental health.

The imperative of devoting attention to issues of indoor air pollution effects derive from the recognition that most people spend long times in the indoor area than the outdoor and (Mendes et al 2013) among issues of concern in indoor air pollution are environmental Tobacco smoke (ETS)

Meckler (1991) reported that indoor air pollutants are not homogenous as reported from indoor air quality assessment.

Factors that affect indoor air pollution concentrations include inefficient air filtration worker productivity demand, out-gassed products from buildings and consumer materials and increased percentage of time spent indoor by residents (Baughman et al 1994). The threat to serious health burden in the developing regions of the world is the most grievous concern due to the reliance on traditional fuel for cooking and heating (Oguntok et al 2010) following a world reported, indoor pollution in developing countries is designated as one of the four most critical environmental problems (Carter 1998, Mac. 2009).

Biomas in the form of solid fuel burning causes the production of large amounts of smoke and other pollutants in the confined space of the home. It is reported that all the pollutants which are found alongside with carbon dioxide have been identified as mutagenic compounds (causing gene mutation) or carcinogenous (cancer causing effects)WHO 1997).

Radon another colourless, odourless and tasteless gas has been discovered to be an important indoor air pollutant. It is said to be radioactive and carcinegenous. It is also said to decay into other radioactive isotopes of lead, bismuth and other metals, that stuck to dust particles which in turn may be inhaled and sometimes cause lung cancer (Mongemery 2000) It is equally reported that when radon is diluted in the atmosphere its hazards are lower than when it concentrated in the walls of buildings the hazards are increased. Tightly sealed homes may have radon Levels 200times more than the levels found in Uramium mines. Several other sources of indoor air pollution include asbestos, particulate matter/aerosols, deodorants and emulsifiers such as paints and disinfectants.

AIR QUALITY STANDARDS/ INDICES

In consideration of the magnitude of the health effects of pollutant, National and international standards are set to regulate levels of pollution by industries and other anthropogenic activities. National standards are set by countries in consonance with their monitoring and regulatory agencies. International standards are set by WHO, UNEP, GEM and other environmental agencies. These standards or indices specify the permissible allowable pollution levels for different categories of pollutants. There are also regulatory measures which prescribe penalties for industries such as the 'polluter pay pays principle' (PPP) which was enunciated following the Kyoto protocol 1997 (Law and Smith 2003).

Following Rhahman (2016) air quality standards are few. That the standards define clean air and tell how much of a substance can be in the air without causing harm. That in Canada, the criterion of air quality Health index (AQHI) is applied. The index is said to be a protection tool used to make decision to reduce short-term exposures to air pollution by adjusting activity levels during increased levels of air pollution. The index ranges from 1-10 to indicate level air pollution in the ambient air. The ranges are 1-1(Low), 4-6 (Moderate, 7-10 (High) 10^{+} (very high) (Environment Canada 2008). The AQHI provides a local air quality current value as well as local air quality maximum forecast for 'today',' tonight', 'tomorrow' and provides associated Health risk (Rhahman 2016).

In Malaysia, the Air pollution index (API) system, follows closely the United states pollution standards index (ASI) system to measure air quality. The API stipulates the maxim index among particulate matter (PM_{10}), Nitrogen dioxide (No_2) Sulphur 2 oxide (So_2) and carbon monoxide (Co.). The index ranges as follows (0-50 Good), 51-100 (moderate) 101-200 (unhealthy), 201-500 (Hazardous) and 500^{+} (Emergency). The World Health Organization has its air quality (criteria that it set for pollution levels of different categories of pollutions. Such criteria pollutants are listed to include (Co, So_2, No_2, No, O_z, PM_{10}. World Wide WHO ranked Mexico city as worst most polluted city, with concentration of ozon (03) ranking quite high above the tolerance level (WHO 2008) Nigeria under the mandate granted the Federal Ministry of Environment to have pollution standards and air quality criteria set for different aspects of human environmental activities (FME 2004)

HEALTH EFFECTS OF AIR POLLUTION

Health effects of air pollution impact on human health have been documented severally in the literature. Rahman (2016) reported on epidemiological accounts of the effects particulate matter implicated in large death tolls in early history of air pollution in such areas as Donora valley (Pensylvania 1948) London (1952) and New York in 1940s, 1950's and 1960's. Accordingly, the report stated that the particulate level in a 4 week pollution disaster in London in 1955 were more 50 times higher than that of California standard.

Also that over the years the incidence of a number of diseases increased greatly by asthma has been recognised as the most important disease incidence (Kleinman 2000). Several factors are considered in connection with the effect of air pollution on health. These include pollution concentration, the chemical properties of the pollutants, the persons age and general state of health, the duration of exposure, weather condition and the distance from the source of the pollutant among others.

In line with a WHO (2008) air quality data, the estimated mortality attributable to outdoor air pollution in cities amount 1.34 million premature deaths. That also, the number deaths attributable air pollution in cities has increased from the former estimate of 1.15 million deaths in 2004 (WHO 2011). Following the report it is at once evident that air pollution is a major environmental problem.

In many cases, air pollution incidents are followed by physical discomfort disruption of day-to-today living, wide spread public apprehension, morbidity and even death.

CONCLUSION

The review has so far encapsulated a number of issues related to air pollution and its human health implication. The historical antecedence of air pollution impact damage on human society was brought out in the introduction to the review. The perspectives of air quality assessment at national/is international quality standards were brought to bear. Finally, the basic human health implication of the air scenario was clearly substantiated in the literature.

METHODOLOGY OF THE STUDY

RESEARCH DESIGN

This research design is a descriptive epidemiology survey design aimed at evaluating case incidents of air pollution impact scenario's. Incidents evaluation and assessment was conducted using pollution scenarios to explain etiology of disease.

AREA OF STUDY

The area of study is Calabar metropolis Cross River State. Calabar is in a maritime costal location. To the south it is bordered by the Atlantic ocean in the Gulf of Guinea and the Bight of Biafra. The coastal location confers on it an ameliorate temperate environment. Inland in the hinterland to the North it enjoys the effect of continentality with pronounced diurnal range of temperature.

Unlike most other secondary urban hierarchy settlement, it has less presence of large scale industry in the form of estate. Pollution sources are mostly caused by vehicular traffic, domestic source power generation, commercial energy source pollutants and others. Indoor air pollution is certainly ubiquitous and correspondingly impending.

POPULATION OF THE STUDY

The population of the study comprises the entire residents of the metropolis both young and old, males and females. Transit groups such as visitors or others in business undertaking are not in the list of the population.

SAMPLING TECHNIQUE.

Multistage sampling approach was employed such as:

i. **PURPOSIVE SAMPLING**: This involved delineation the entire area into city blocks or clusters using human quality profile domain based on population agglomeration, nature activity such traffic flow pattern, domestic energy consumption pattern and others.

ii. **STRATIFIED SAMPLING**: This involved consideration of pollution sites based on location e.g. Coastal vs Hinterland, overcrowded vs. Sparsely settled areas, commercial centres/ institutional domains.

iii. Finally random sampling was used to select the representative group for the study.

INSTRUMENTS FOR DATA COLLECTIONS.

The basic instruments employed for data collection included. (i) Questionnaires/ checklists, and Air samplers.

METHOD OF DATA COLLECTION.

Air quality assessment to determine the acceptable air standard analysis was achieved using air samplers for recording air pollution status of ambient air over the area for outdoor air pollutants.

Questionnaire/ checklist was administered to elicit responses concerning morbidity or disease prevalence episodes among the residents to enable inferences to be appropriately made concerning air quality assessments.

DATA ANALYSIS

Table below is a checklist of pollution assessment conducted over the area using air pollution samplers with values averaged over a number of reading. The crowman gas detectore was employed in detecting the ambient air quality of areas. The values obtained are speciated into four categories such as; 0 – 3 (low), 4 – 6 (Moderate), 7 – 10 high and 10+ (Very high) [- *see table 1]*

Table 1: Spatial Distribution of Pollution in Calabar, Nigeria

S/NO	POLLUTION TYPE/SOURCE	RATING				
		0 – 3	4 – 6	7 – 10	10+	**Total**
1.	Particulate Matter (Pm)	4	2	6	1	**13**
2.	Automobile Pollution	3	6	10	12	**31**
3.	Point Source (Plant)	2	6	8	14	**30**
4.	Biodegradable waste	1	2	5	3	**11**
5.	Indoor Air	2	4	6	8	**20**
6.	Cottage Industries	4	6	6	19	**26**
7.	Domestic Waste	2	3	1	4	**10**
8.	Biomes/Firewood	4	6	8	12	**30**
9.	Demolition Waste	10	12	14	15	**51**
10.	Thermal Heat	4	8	12	12	**36**

The checklist is transposed for amputation of the analysis of variance on the spatial distribution of Pollution in the area. Parametric statistics of the one way analysis of variance was employed in the determination of the spatial and temporal variation in disease incidents.

TABLE 2. SUMMARY

Pollution type/source	*Count*	*Sum*	*Average*	*Variance*
Particular Matter	4	13	3.25	4.916667
Automobile Pollution	4	31	7.75	16.25
Point Source (plant)	4	30	7.5	25
Biodegradable Waste	4	11	2.75	2.916667
indoor Air	4	20	5	6.666667
Cottage Industries	4	35	8.75	47.58333
Domestic Waste	4	10	2.5	1.666667
Biomes/Firewood	4	30	7.5	11.66667
Demolition waste	4	51	12.75	4.916667
Thermal heat	4	36	9	14.66667

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	386.025	9	42.89167	3.148012	0.008617	2.210697
Within Groups	408.75	30	DE13.625			
Total	794.775	39				

DECISION RULE

Here, we can see that the F-value is greater than the F-critical value for the alpha level selected (0.05). Therefore, we have evidence to reject the null hypothesis and accept the alternative hypothesis to say there is a significant variation in the pollution concentration in Calabar Cross River State

RESULTS/FINDINGS

In line with the hypothesis tested using the technique of one-way analysis of variance, the F-calculator value is higher than the F-critical value at alpha level of 0.05 degree of freedom. This result indicates that the null hypothesis is rejected while the alternative hypothesis is accepted. Therefore, there is significant variation in the air pollution distribution in different areas in Calabar.

This result agrees with existing studies carried out on air pollution characteristics in different cities of the World. Specifically, Dantiya (2019) reported that there are over 3000 anthropogenic compounds in which most are organic while vehicular emissions alone are said to contain 500 types of different compounds. The armorphous nature of pollutants is a vivid indication of the nature of human activities carried out in different areas across every city domain.

Accordingly Amrai and Azeeze (2005) have reported based on the health implication of the pollutants that the most hazardous of them are products of combustion of fuel engines. The implication here is that the temporal impact of air pollution will peak during the day and especially during traffic rush hours which period in human activities cycles such as early morning, office hours, midday, break periods and/or late evening home runs. In this sense the daily and diurnal flux of pollution incident over the Central Business Areas will oscillate between high and low respectively in line with the activity cycles of over each twenty-four hour duration. This conjecture is strongly supported by findings reported in the literature by Turson (2008), which state that vehicular pollution impacts can be aggravated by water vapour, natural dust and sunlight by activating and producing secondary pollutants such as Ozone, secondary organic aerosols, Sulphates and Nitrates. It was further added that those urban pollutants come from road traffic and comprises a mixture of air borne Particulate Matter, Oxides of Sulphur (SOX), Oxides of Nitrogen (NOX), Carbon Monoxide (C0), Volatile organic compounds (VOCs), Poly Aromatic hydro Carbons (PAH) and Ozone.

Most of these amorphous constituents fall within the categories of Photo-chemical Oxidants, which are commonly active in the day. This clearly stipulates the human health implication of the pollutants due to their amorphous compositions.

Montgomerry (2005), reported concerning "Ozone alert" in connection with vehicular traffic movement during a hot sunny day which is considered to be a great risk for transport operators. The artificial Ozone produced by oinization of natural Ozone to bio molecular Oxygen can cause the destruction of vehicle tyres and cause accident on such occasions.

Air pollution concentrations generally is variegated over the entire city space in line with the activity tempo and type. While commercial activity areas and especially industrial locations produce enormous qunatities of pollutants, domestic areas produce less quantities of out door air pollutants but a relatively higher amounts of indoor pollution depending on the energy type used. Calabar generally has less presence of large scale industrial activities. Indoor air pollution may be more ubiquitous except from vehicular traffic sources. The sprawling residential areas, high prevalence of hospitality industries and recreation centres have the likelihood of predominance of indoor air pollution in homes and such other centres.

Following Baughman *et al* (1994) "factors that affect indoor air pollution concentration include inefficient air filtration, workers productivity demand, out gassed products from buildings, consumer materials and increased percentage of time spent indoor by residents. Considering the conditions listed above, Calabar city indoor assessment deriving from the field report may implicate a good number as can be gleaned from one or two parameters on table 1.

Accordingly item 5 (Indoor Air Parameter) strongly support the fact that indoor air pollution is very high. This point is further strengthened by the report on item 8 (Biome/Fuelwood use) which is equally high caused by the heterogonous nature of residents. Grossly going by total store rating for all the parameters explored, demolition waste ranks highest which may be explained based on the rate of construction activities going on based on institutional and private property development. Next in ranking is the incidence of thermal heat which is a glaring scenario of most urban cities caused by the Urban Heat Island Phenomenon. Automobile pollution ranks next due to the intensity of city traffic movement by the city burgeoning population and particulate matter ranks list due to less prevalence of major industries. In keeping with the results provided above, the health implications on residents can be gleaned.

In consideration of the spatial distribution of air pollution assessed over the city the air quality status on the average is moderate to high. Less incidence of particulate matter will imply that prevalence of respiratory and other pulmonary disease will be less rampant in some areas but high concentration of indoor air pollutants due to activities of hospitality industries and recreation activities have the likelihood of susceptibility of residents to diseases prevalent in indoor polluted areas.

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