International Journal of
Science Inventions Today
www.ijsit.com
ISSN 2319-5436
Research Article

AIR AND NOISE POLLUTION IN THE UYO METROPOLIS, NIGER DELTA, NIGERIA: SCOPE, CHALLENGES AND MITIGATION

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ABSTRACT

Due to constantly rising air pollution levels as well as an increasing awareness of the hazardousness of air pollutants, new laws and rules have recently been passed. Although there has been a large amount of research on this topic, bibliometric data is still to be collected. Thus this study provides a scientometric approach to the material published on this subject so far.

Keywords: Air and Noise pollution, Uyo, Niger Delta, Evaluation

INTRODUCTION

Air pollution is defined as the emission of particulate toxic elements into the atmosphere by natural or anthropogenic sources these sources can be further differ-entiated into either mobile or stationary sources. Anthropogenic air pollution commenced with human's systematic use of fire. Its historical development has been characterized by steadily increasing amounts of total emissions, the invention of new sources of pollution emission as well as the emission of pollutants that had not formerly been emitted by man-made sources. So far, this development has had the greatest impact on the air quality of so-called Mega-Cities (cities with over 10,000,000inhabitants). Today the major sources of man-made air pollution are motorized street traffic (especially exhaust gases and tire abrasion), the burning of fuels, and larger factory emissions. Depending on the pollutant particles' size, they can be carried for distances of several thousand.

The World Health Organization (WHO) estimates 2.4million fatalities due to air pollution each year . Since the breathing of polluted air may have severe health effects such as asthma, COPD or increased cardiovascular risks. most countries have strengthened laws to control the air quality in the past decade. Further, as polluted air is considered a super-regional problem, international conferences have recently developed different ways to improve and assure air quality employing global strategic perspectives.

Despite such enormous scientific and legislative efforts to measure and improve air quality levels, many people are still exposed to hazardously polluted breathing air on a daily basis hence, the need for this study is necessitated by the fast increase in human population growth, industrial, commercial and private vehicular emission and anthropogenic activities in Uyo.

A further rationale for the study is to close the gap due to lack of regular and comprehensive ambient air monitoring and ineffective regulatory environmental programme awareness, laws and enforcement by government or its agencies.

AIM OF THE STUDY

So with the study that has been carried out, the air quality and noise pollution monitoring would benefit man and the environment in the following ways, among others:

- Identify environmental aspects and impacts in Uyo.
- Identify the impacted locations and the trends by air pollution in Uyo.
- Provide mechanism to evaluate progress in environmental management within the monitoring locations and the immediate environment.
- Provide a focus for improvement and provide a formal approach to mitigation measures.

Scope:

The research was systematically designed to monitor the ambient air quality and noise pollution in Uyo to meet the current trend of rapid population growth and vehicular in-flow in recent time, to broaden the study scope to close the gap and complement some of the previous studies. This study was designed to specifically address the aerodynamic diameters from PM_{10}, PM_7, PM_4, $PM_{2.5}$, PM_1, and TSP in one study and to broaden the scope of this single study by increasing the number of air pollutants to monitor and number of sampling points to cover the large heavy traffic and high density populated areas in Uyo. The study was also designed to generate applicable data that could provide early warning on environmental damage so that control/mitigation measures can be put in place to prevent or reduce risk to human health or deterioration of the environment.

The research basically involved sites selection, field monitoring, data recording, data storage, data analysis and data interpretation. Portable equipment were used, and standard monitoring procedures were strictly adhered to.

Field data was collected in line with standard procedures for air quality monitoring with calibrated portable air quality in-situ meters. Field data collection was carried out in line with recommended procedures for Environmental Data Collection in Nigeria FMENV, (1992)and DPR, (2002) and World Health Organisation's procedures for population density, topography, industrial clusters, and heavy traffic studies. (Efe, 2005).

Statement of problem:

Due to the rapid increase in immune system damage, neurological and reproductive damage including infant mortality and low birth weight have been reported to be common among Uyo residents.
Other health effects include developmental and respiratory disorder such as acute lower respiratory infection, upper respiratory and otitis media. Chronic pulmonary disease and cataract are alarming amongst Uyo residents (Udotong, 2015; Oguntoyinbo, 1978; Okecha, 2000)

It may be pertinent to note that most residents of Uyo may not be aware of the level of air pollutants in the atmosphere in uyo, their effects on human life and the environment. Therefore, they show little or no concern about the quality of air they inhale.

Moreover, many residents of Uyo depend on incomplete combustion power generators, which also contribute great percentage of noxious gases and particulate pollutants to the natural air quality.

The need for this study is necessitated by the fast increase in human population growth, industrial, commercial and private vehicular emission and anthropogenic activities in Uyo, which can be the primary sources of ambient air pollution, with the ignorance of the people towards the polluted fresh air the inhabitants of Uyo metropolis inhale. A further rationale for the study is to close the gap due to lack of regular and comprehensive ambient air monitoring and ineffective regulatory environmental programme

awareness, laws and enforcement by government or its agencies.

Geology of the study area:

The Niger Delta Basin (wherein the project area is located) evolved in the tertiary level following the deposition of the Imo shale during the Palaeocene-transgression, and the subsequent seaward build-up of a delta complex in the Eocene. Later there was a tripartite division of the major lithofacies units into the diachronous Akata-marine, Agbada-paralic and Benin continental-fluvial formations. From time to time on the delta flanks, channels were cut and were subsequently clay filled. The major progradational sequences associated with deltaic settings consists of numerous repetitive cycles, each one being characterized by an erosive surface followed by the shallowest facies, then a deepening commonly leading to a condensed horizon. This is usually followed by the most shallowing sequence either prograding or aggrading depending on several factors. Generally, eustatic sea level fall and/or increased sediment supply cause delta progradation out unto the mud prone shelf. At such times, loading on shale platforms initiate or reactivate growth fault movement, thus creating extra accommodation space in the hanging wall, and a lateral shift in the facies type across the fault is experienced, and aggradations sets in.

Empirical review:

Air pollution is primarily a product of man's own activities. Man's activities generate the pollutants that cause the natural and pure air polluted, and thus bring both man and his environment under threats of health and environmental degradation. Air pollutants may be from natural sources such as, forest fire and dust storm and volcanic eruption. The anthropogenic sources of air pollution include automobile combustion of fossils fuels, household cooking and burning of firewood and thermal power plants. There can also be primary air pollutants from atmospheric chemical reactions that result in secondary air pollutants such as smog. These air pollutants can be in the form of particulate matters or in the gaseous form. The negative impacts and health hazard of the air pollutants on environment and man have prompted several researches on this field of study.

It requires proper and regular monitoring of the assumed natural and pure air to investigate the presence of the pollutants constituents and their level in the air. These can be done via selection of sampling locations of the study area by standard methods as outlined by WHO and other national standards for sampling site selections. The best available technology or the best practical technology and techniques should be employed. The standard and recommended methodologies for field data gathering should be used. Data analyzing, data interpretation and presentation should be in the simpler form like air quality index of the study area for public understanding and consumption.

(a) The review aims to look at different researches that were carried out by various scholars in air quality in different cities in Nigeria and other countries, putting into consideration the air quality parameters, sampling / equipment techniques and methodologies. Also to be considered are challenges in air quality monitoring, interpretation and presentation of air quality data.

(b) Assessment of air quality and noise around Okrika communities in Rivers State, was carried out by Gobo *et al.,*(2012), using hand held air monitors for air pollutants and anemometer for meteorological parameters. The parameters measured were suspended particulate matter, nitrogen dioxide, sulphur dioxide, hydrogen sulphide, ammonia, carbon monoxide, methane and volatile organic carbon, temperature, wind speed, wind direction and relative humidity. The results showed the highest concentration values of 0.007mg/m^3 ($PM_{1,}$ dry), 0.036mg/m^3 ($PM_{2.5}$) 0.286mg/m^3 ($PM_{7,}$ dry), 0.378mg/m^3 ($PM_{10\ dry}$), 0.503mg/m^3 (TSP dry), 1.7ppm (NO_2 dry), 3.0ppm (CH_4 dry), 0.2ppm(H_2S dry), 12.7ppm (CO dry), 2.7 (NH_3 dry) and 7.0ppm (VOC rainy). The dry season concentrations of air pollutants were higher than the rainy season concentration. The observed difference in mean concentration of the air pollutants between the two seasons were not significant in case of TSP ($p<0.05$) but were significant ($p<0.05$) in other pollutants. The highest mean concentrations of the gaseous pollutants exceeded permissible limits and therefore pose environmental and health concern for the inhabitants of the area. The quality of the air in the area is poor and need to be regularly monitored. Also, it will help to make proper policies in preventing effects of air pollution in the area.

(c) Spatio – Temporal Variation in Urban Vehicular Emission in Uyo city was carried by Mmom *et al.,* (2014) from selected six major traffic and congested locations . The study investigated pollution from automobiles during traffic peak periods at intersections on some selected roads monitoring hourly in the morning, afternoon and evening, of some selected air pollutants which are largely the products of internal combustion in motor vehicle engines such as nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2), hydrogen sulphite (H_2S). The study revealed that concentration CO monitored was higher during the peak period due to traffic congestion especially at intersections, where long waiting time for vehicles were observed exceeded Federal Ministry of Environment Limits / Standard.CO recorded highest at Oron road by Nwaniba with the value of 17.6ppm and least value 2.6ppm was monitored at Aka road by plaza during off peak period. It was also observed that the concentration of sulphur dioxide (SO_2) ranged from 0.014ppm -0.071ppm which was alarmingly high, especially in location C (Ekpo Obot by Dominic Utuk Aveue). It was also observed that levels of nitrogen dioxide (NO_2) and hydrogen sulphite (H_2S) concentrations monitored varied in time and space but were above recommended municipal and international standards in all the six locations during the peak traffic period. The findings revealed the potential health implication in the area of study, if these air pollutants are not controlled.

(d) Air Quality Assessment at Traffic Control Points in Uyo Metropolis, Nigeria by Udotong, (2015), the study showed the contributions of toxic gases into the atmosphere from motor cycles, tricycles, motor cars and

trucks. Ten sampling points were chosen and two control locations and portable digital air quality monitors (Gasman, UK) were used. The air pollutants that were monitored include carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ammonia, hydrogen sulphite (H_2S) and chlorine gas (Cl_2). Also monitored were Noise level and meteorological parameters. All the field data gathered were compared with the U. S. National Ambient Air Quality Standards (US NAAQS), Nigerian Ambient Air Quality Standards and the instruments alarm/precision levels. The mean concentrations of CO (35ppm), SO_2 (0.3ppm), NO_2 (0.4ppm), NH_3 (5ppm), H_2S (0.7ppm), HCN (2ppm), and Cl_2 (0.9ppm) were observed highest in locations with heavy traffic as against the mean values of CO (11ppm), SO_2 (<0.1ppm), NO_2 (<0.1ppm), NH_3 (2ppm), H_2S (0.4pmm), HCN (<1ppm), and Cl_2 (0.2ppm) with lowest reading at locations where the operation of these traffic were reduced . The noise level (66.6-110.6 dB(A)), radiation (0.41mR/hr), and heat (542-544 Rad) were also recorded highest at heavy traffic monitoring locations. The air quality assessment revealed most of the air pollutants monitored were above the US NAAQS at some of the monitoring heavy traffic points but below the instruments alarm levels. It was observed that the data generated from this monitoring , revealed that the various transport operations contributed significantly to high levels of gaseous air pollutants at traffic control points in Uyo metropolis. The gaseous air pollutants emissions levels monitored were compared to statutory limits and the associated human health consequences were noted.

(e) Otti *et al.,* (2011), state the air pollution sources, the composition of the atmospheric air and structure, air pollution effects and the best practical method and best available technique to control air pollution. Some recommendations were made by them that FEPA should be responsible for the enforcement of the ambient air quality statement concerning the emission standard for stationary source and mobile source. They also stated that the state government should be delegated with some power for an effective monitoring and control. They also recommended that minimizing the rate of production of pollutant should be the first option to be considered the most effective method of ambient air pollution control.

Air pollutants	**Emission Limits**
Particulates	250 (µg/m^3)
SO_2	0.1 (ppm)
Non methane hydrocarbon	160 (µg/m^3)
CO	11-4 (µg/m^3) or 10ppm
NO_x	0.04-0.06(ppm)
Photochemical oxidant	0.06(ppm)

Table 1: Nigerian Ambient Air Quality Standard

Source: FME 1991

Air Quality Index (AQI) Values *When the AQI is in this range:*	Levels of Health Concern *...air quality conditions are:*	Colors *...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Table 2: USEPA AQI Colour Chart

Source: USEPA (Air Quality Index Guidelines for the reporting of daily air quality)

METHODOLOGY

Site Selections:

Fourteen (14) sampling locations were selected in the study area using World Health Organisation standard for site selection studies for 'population density, topography, industrial clusters, heavy traffic' and one sample location for control point.

The GPS map Model 76Cx Garmin Global Positioning Systems was used to determine geo-references of the sampling locations in accordance with the above stated criteria.

Nature/ Sources of Data:

The data was from primary sources of the air pollution in Uyo, direct release of gaseous air pollutants from vehicular and power generating plant exhausts via combustion of fossil fuels and particulate pollutants arising from traffic congestion and non construction operations.

RESULTS AND DISCUSSION

A. Effects of Temperature (^oC), Wind speed (m/s) and Humidity (%) on PM_1

$PM_1 = -29.398 + 1.890(T) - 4.573(W/S) + 0.014(H)$

$R=0.462$, $R^2 = 0.214$ (21.4%), $Adj.R^2 = 0.00$ (0%), p-value = 0.430.

Because the calculated p-value (0.430) is greater than the critical p-value (0.05), i.e. p_{cal} (0.430)>p_{crit} (0.05), it is concluded that the meteorological variables (temperature, wind speed and humidity) do not have significant effect on PM_1.

B. Effects of Temperature (^oC), Wind speed (m/s) and Humidity (%) on TSP

$TSP= 2919.037 + 13.977(T) - 113.520(W/S) - 38.831(H)$

$R=0.709$, $R^2 = 0.503$ (50.3%), $Adj.R^2 = 0.367$ (36.7%), p-value = 0.046.

Because the calculated p-value (0.046) is less than the critical p-value (0.05), i.e. $p_{cal}(0.046)<p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) has significant effect on TSP.

C. Effects of Temperature (^oC), Wind speed (m/s) and Humidity (%) on CH_4

$CH_4= 16.413 + 0.057(T) - 0.173(W/S) - 0.206(H)$

$R=0.211$, $R^2 = 0.045$ (4.5%), $Adj.R^2 = -0.216$ (-21.6%), p-value = 0.913.

Because the calculated p-value (0.913) is greater than the critical p-value (0.05), i.e. $p_{cal}(0.913)>p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) do not have significant effect on CH_4.

S/N	Sampling Points Concentrations d B	Noise
1.	SP1	76.6
2.	SP2	70.8
3.	SP3	73.0
4.	SP4	78.5
5.	SP5	79.9
6.	SP6	75.8
7.	SP7	84.6
8.	SP8	75.8
9.	SP9	78.9
10.	SP10	68.8
11.	SP11	84.9
12.	SP12	81.1
13.	SP13	81.5
14.	SP14	81.6
15.	CTR	52.13

Table 3: Morning, afternoon and evening mean data of Noise Level

Key:	Description of Sampling Points	Coordinates	Frequency of Monitoring/hourly
SP1	Four Lane Roundabout by Nwaniba Road	N 05° 01'.668'' E 007° 57'.113''	Morning, Afternoon and Evening
SP2	Ultra Fit Roundabout Ewet Housing Estate	N 05° 01'.254'' E 007 56'. 543'	Morning, Afternoon and Evening
SP3	MbiaobongEtoi Park, Uyo	N 04°59' .762'' E007°57' .621''	Morning, Afternoon and Evening
SP4	SheltaAfrique Junction by Oron Road	N 04° 59'. 454'' E 007 57'. 979''	Morning, Afternoon and Evening
SP5	Nwaniba Roundabout by Oron Road	N 05° 01' .854'' E 007° 56'.032''	Morning, Afternoon and Evening
SP6	Play-ground by Dominic Utuk Avenue	N 05°02'.090'' E007 56'.253''	Morning, Afternoon and Evening
SP7	Akpan Andem Market by Udoumana	N 05°02'.090'' E007 56'.253''	Morning, Afternoon and Evening
SP8	Ibom Plaza Roundabout	N 05° 02'.075'' E007° 55'.673''	Morning, Afternoon and Evening
SP9	Uniuyo Roundabout by Uniuyo Town Campus	N 05° 02'.224'' E007° 55'.410''	Morning, Afternoon and Evening
SP10	Itam Main Park, Uyo	N 05° 03'.064'' E007° 53 .622''	Morning, Afternoon and Evening
SP11	Itam Market by Goodluck Jonathan Flyover	N 05° 02'. 805'' E 007° 53'. 888'	Morning, Afternoon and Evening
SP12	Ekomiman Junction (Ikot Oku Ikono)	N 05° 00'. 351'' E 007° 51'. 309'	Morning, Afternoon and Evening
SP13	State Secretariat Roundabout Close to Mechanic Village	N 05° 01'. 568'' E007° 54'.330''	Morning, Afternoon and Evening
SP14	NsikakEduok/ IBB Roundabout by Aka Round	N 05° 00'.797'' E 007° 55'.154'	Morning, Afternoon and Evening
CTR	Control	N 04° 58'.694'' E 007° 47'.689'	Morning, Afternoon and Evening

Table 4: Sampling Points Key, Description of Sampling points, Coordinate and Frequency of Monitoring

Noise values monitored during the study were relatively high in all the sampling locations as expected due to mechanical, vehicular movement, generator power plants, dense population and other noise associated activities. Itam Market by Goodluck Jonathan Flyover recorded the highest noise level. Heavy traffic with long waited vehicles and market activities could be the reason for the highest value of noise at this location. Various researches including Udotong, (2015) and Ewona *et al.,* (2013) also reported the same high values of noise during peak period. Hence, the findings are in agreement the noise level recorded is as a result of heavy traffic with high densely clustered people with commercial activities around the study location. This was observed during the peak periods (morning and evening) when many people were going and coming back from offices and other businesses.

This research was carried out to monitor the air quality and noise pollution in Uyo, Akwa Ibom State, Nigeria, from 22nd – 24th October, 2015. The air pollutants monitored were PM_{10}, PM_7, PM_4, $PM_{2.5}$, PM_1, TSP, VOCs, NO_2, SO_2, H_2S, CO, NH_3 and CH_4, and also Noise level. Fourteen (14) sampling points and one (1) control location were chosen for this study. WHO and FMENV Standard/Criteria were strictly followed for the choice of sampling sites selection. Aerocet-531S Mass Particle Counter, Aeroqual series 500 gas monitor, GPSmap 76Cx, Testo 815 noise meter and Kestrel 4500NV Pocket Weather Tracker were the portable in-situ meters used for the field data gathering. The above air pollutants under study were sampled three times daily for each sampling point (Morning, Afternoon and Evening). Morning and Evening were the peak periods while Afternoon was the off peak period. Descriptive and Regression methods were used to analyze the data and the mean value of the three sampling times (Morning, Afternoon and Evening) was calculated for each sampling station. The calculated three times monitoring mean values of each sampling point was observed that PM_{10} mean values ranged from 56.0-279.7µg/m^3, PM_7mean values varied from 45.0-182.4µg/m^3, the mean values for PM_4 were between 29.4-82.9µg/m^3, while $PM_{2.5}$ mean values varied from 20.5-51.5µg/m^3 and the mean values recorded for PM_1 ranged 13.8-34.8µg/m^3, while TSP mean data was between 74.5-

443.0 µg/m^3.

CHALLENGES

Air Quality Monitoring Programme in Nigeria:

From the research and the environmental studies history in Nigeria, there is no proper Air Quality Impact Assessment (AQIA) or Air Quality Baseline data for all our cities and local areas by the regulatory agencies such as Federal Ministry of Environment (FMENV), National Environmental Standard Regulatory Enforcement Agency (NESREA), etc. However, some of the air quality monitoring that has been carrying out in most cases in our country Nigeria are projects specific and of course it is not for public consumption because the data are not always accessible by the public. The inability of these regulatory agencies that cannot afford the high cost of modern technology, equipment, instrument, calibration, maintenance and training program for their personnel are the big challenges the agencies are facing. Because the approved budget for these agencies by the Government is very low.

Nigeria environmental laws and policies are another big problem in environmental management in the country.

The limitations of the monitoring of ambient air quality and noise pollution include among others:

i. Lack of comprehensive ambient air quality and noise pollution baseline study data in Uyo.
ii. Lack of fund and grant for the study.
iii. The fear of community attack.
iv. The study is limited to selected high vehicular traffics locations and congestion areas and aforementioned air and noise pollutants in Uyo metropolis.
v. Limited time was a constraint.

MITIGATION

In Nigeria, to show evidence of Best Available Techniques (BAT), the principle which implies that anyone creating an environmental impact of either pollution or resources depletion should employ state of the art processes, facilities or methods of operation to either minimize the likelihood of occurrence or ensure appropriate control and mitigation, the NESREA Act and its subsidiary regulations prohibit the discharge of hazardous substances into the air. No industry or individual can release any gaseous waste into the atmosphere without proper monitoring and authorization from the relevant government agencies responsible for environmental protection. These industries must install anti-pollution equipment for detoxification of their gaseous effluent and chemical discharges and the anti – pollution equipment installed must meet the best available technology (BAT), or best practical technology (BPT) or the uniform effluent standard (UES) (Okere, 2015). The polluter pay principle of the article 16 of the Rio declaration which provides that states “should endeavour to promote the internalization of environmental costs and the use of economic instruments. This principle which takes into the account the approach that the polluter should, in principle bear the cost of pollution with due regard to the public interest and without unduly distorting

international trade and investment", is also the basis for the Nigeria National Policy on the Environment (1999).

This air quality assessment study has uncovered the trend of the rapid air pollutions in relationship to the rapid population explosion of the Uyo City due to rural-urban migration and resulting increase in anthropogenic activities, which require frequent and regular air quality and noise pollution monitoring.

The following mitigation measures are proposed based on the findings of this research:

1. Policy should be made by government for traffic control.
2. Traffic personnel training programme should be frequent.
3. Traffic awareness campaign should be carried out.
4. Environmental awareness programme should be organized for the public.
5. Policies to ban used/old automobile engines and power generating plants should be made by the relevant authority.
6. Regular and frequent air quality and noise pollution monitoring should be carried out.
7. Relevant regulatory agencies should effectively enforce the environmental laws and policies.

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