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Research Article

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Assessment of Air and Noise Pollution in Uyo Metropolis, Akwa Ibom State, Nigeria

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Abstract Industrialization is highly desirable for the sustenance of a nation's economy and the enhancement of the citizenry's well being. However the negative impact precipitated by introduction of its unwanted by–products into environment may be catastrophic if allowed to build up and uncontrolled. Urban Air pollution due to activities of process industries is one of the main problems faced by the industrial area of the world. Environmental assessment was carried out to determine the extent of air pollution the Uyo. Results obtained revealed that the concentration of pollutants are unacceptable compare to the Federal Environmental protection Agency set limit.

Keywords Air and Noise Pollution, Uyo Metropolis

Introduction

Man's environment is under constant threat from his own activities. Man's expanding population, industrialization and intensive agriculture have caused tremendous damage to our environment. Man's ignorance of laws of nature and his over- exploitation of natural resources have further aggravated the problem [1].

Humans need a continuous supply of food, air and water to exist. Changes in the environment have put the survival of man in danger. Air pollution is woven throughout our modern life. Air pollutant is a chemical, physical (e.g. particulate matter), or biological agent that modifies the natural characteristics of the atmosphere is a complex, dynamic and natural gaseous system that is essential to support life on planet earth. Its pollutants constitute various kinds of gases, droplets and particles that reduce the quality of the air.

Objectives of Present Study

The objectives of the study is to monitor and mitigate changes in existing physical and chemical characteristics of the air resources in Uyo and its environs

Study Research Questions

i. What are the environmental aspects in Uyo?
ii. What are the environmental impacts of air pollution in Uyo?
iii. Which locations are impacted by air pollution in Uyo?
iv. What are the mitigation parameters to control the pollution?

Location area and the pollution parameters studied

Uyo, the state capital of Akwa Ibom State of Nigeria, is one the cities in South –South geo-political zone of the predominantly oil and gas producing area of Niger Delta. Uyo was a small town in Cross River State of Nigeria until 23rd September 1987. Uyo has really been experiencing rapid influx of people of different works of life since its creation as a State Capital of Akwa Ibom State. This results in a fast growing population with commercial activities, private and commercial vehicles for transportation, road and housing construction activities including heavy equipment and truck movement, urbanization, industrialization, deforestation and road traffic. Rapid development and urbanization in Uyo would no doubt create some environmental impacts in the city of such magnitude as to arise the concern that required the present study.

Investigating air quality and noise level in this research work entail monitoring and assessment of the presence and concentration of noxious gases in the study area and some of these gases are discussed below;

Volatile Organic Compounds (VOCs)

The presences of Volatile Organic Compounds (VOCs) in the area are ozone precursor and may also cause a wide range of health effects. VOCs are also powerful infrared absorbers thus contribute to the greenhouse problem. Some are known to be toxic or carcinogenic and also contribute to smog problem.

Nitrogen Dioxide (NO_2)

Nitrogen Dioxide is as the result of the chemical reaction between Nitrogen and Oxygen. Their primary sources are natural and anthropogenic. Anthropogenic emissions account for only 8% of naturally produced Nitrogen Oxide [2]. The major man-made sources of Nitrogen Dioxide are burning of fossil fuel via automobile. Nitrogen emitted from gasoline and diesel engines of automobile into the atmosphere and under very high temperature Nitrogen is also produced [2].

The two oxides of Nitrogen that are usually of primary concern in air pollution are nitrogen oxide (NO) and nitrogen dioxide (NO_2). Nitrogen Dioxide, NO_2, contributes to acidity because it reacts with rainwater to form nitric acid, which in turn reacts with ammonia in the atmosphere to for a plant nutrient (ammonium nitrate). In human beings, Nitrogen Dioxide irritates the alveoli of the lungs. It also induces corrosion and rusting of materials including roofing sheets and textiles [3]. NO_2 results when fuel is combusted at high temperatures and occurs mainly from motor exhaust and stationary sources such as electric utilities and industrial boilers [4-5]. It is the only oxide of Nitrogen that has been shown to have significant human health effects, with exposure to concentrations higher than 0.5ppm ($1mg/m^3$) triggering changes in pulmonary function in healthy people [5].

Limitation of the Study

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. The fear of community attack.
iii. The study is limited to selected high vehicular traffics locations and congestion areas and aforementioned air and noise pollutants in Uyo metropolis.
iv. Limited time was a constraint.

Description of the Study Area

Uyo is a city and local government area. The city is a capital of Akwa Ibom State in South – South (Niger Delta) of Nigeria. The town became the capital of Akwa Ibom state on September 23rd 1987 following the creation of Akwa Ibom state from erstwhile Cross River state. The population according to the 2006 Nigeria census which comprise of Uyo and Itu is 436,606 while the urban area including Uraun is 554,906. The city has witnessed some infrastructural growth in the years since it became Akwa Ibom State capital [6].

Climate and Meteorology

Uyo is the capital city of Akwa Ibom State which is the primary area of focus. It is situated in the southern part of Nigeria and more particularly in the South-South region of Nigeria. Uyo has Tropical Climate conditions governed by the movement of the Inter-Tropical Conveyance Zone (ITCZ) or Inter-Tropical Discontinuity Zone

(ITDZ), that is, the boundary between the South-Westerly (or the Tropical Air Mass) and the North-Easterly trade wind.

The area being within the Niger Delta area experiences the prevalence of tropical air mass almost all year round with little seasonal change in wind direction [7]. It is located under the Tropical monsoon climate, with rainfall having bimodal peaks in June and September/October. The weather is hot and humid for most of the year. The wet season on the other hand, starts early around March. The meteorological conditions of the area are greatly influenced by Tropical Maritime air mass. The dry season is thus short, not more than three (3) months, from December when rain-bearing winds are sometimes replaced by the harmattan wind. Even within the three dry months, there are three (3) short rains that are so consistent in occurrence and timing that it is always expected annually. The current climate change has affected the timing of these rains that residents of AkwaIbom State could before now predict to the date.

Table 1: Mean monthly Rainfall (mm) rainy days in Uyo-Akwa Ibom State (30 years Period)

Month	Mean rainfall(MM)	Nos. of Days
January	39	3
February	90	6
March	187	12
April	232	13
May	375	13
June	685	21
July	733	21
August	514	22
September	529	23
October	377	20
November	197	11
December	52	5
Annual	4010	170

Source: The analyses were based on records obtained in University of Uyo and reported in some Literatures (Soils and Landscape Survey of Akwa Ibom State, 1989)

Sources of Air Pollution

Since air pollution is as a result of concentration increase in hazardous substances via natural and man's activities. There are natural and anthropogenic sources of air pollutants:

i. Natural sources: This is as a result of the natural processes that occurs which emanate air pollutants without man interventions. Such air pollutants sources include among others; dust storm, volcanoes eruption, forest fire, pollen, spore and sea -salt spray.

ii. Anthropogenic Sources: These sources of air pollution are known as man – made sources. It is due to evolution of industrialization. It emanate from combustion of fossil fuels. Rapid changes in technology for development to meet man's needs increases the rate of combustion.

Methodology

Research Design

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. 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.

Sample and Sampling Techniques

The research basically involved sites selection, field monitoring, data recording, data storage, data analysis and data interpretation. Portable equipments 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 Organization's procedures for population density, topography, industrial clusters, and heavy traffic studies [8-9].

Table 2: AQI and index interpretation

Index Values	Levels of Health Concern	Cautionary Statements
0 - 50	Good	None
51 - 100*	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
101 - 150	Unhealthy for Sensitive Groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
151 - 200	Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
201 - 300	Very Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.
301 - 500	Hazardous	Everyone should avoid all physical activity outdoors.

*An AQI of 100 for ozone corresponds to an ozone level of 0.08 parts per million (averaged over 8 hours)

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

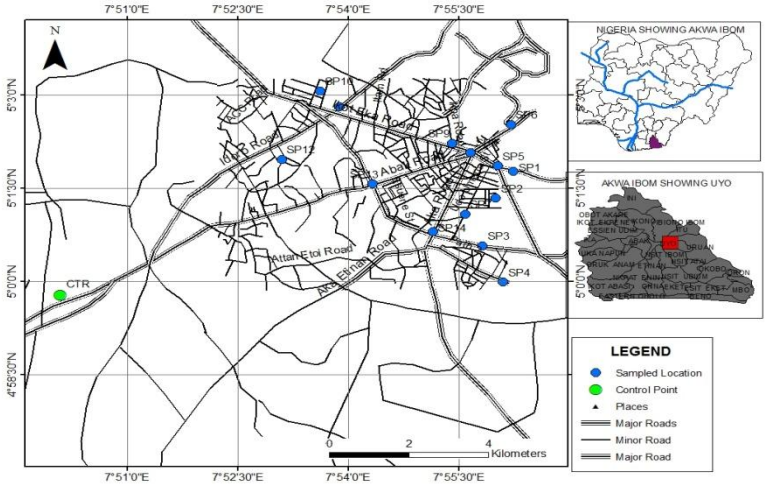

Figure 1: Map of Uyo showing Sampling Point

Site Selections

Fourteen (14) sampling locations were selected in the study area using World Health Organization 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.

Field Observations

Field observations were made visually and documented in field notebooks. Photographs were taken to show important features appropriately and activities that may be the sources of the air pollutants.

Validity/ Reliability of Instrument

Prior to mobilization, the portable air quality and noise equipment were certified calibrated. Quality assurance/control measures were done appropriately as per the equipment manufacturer directive and batteries were fully charged while PPEs and field notebook were in order. The guidelines and field work plan to cover sampling activities were designed and documented.

Figure 2: Gas monitor (Aeroqual series 500) used for investigation of all the gaseous pollutants monitored

Results and Discussion

Presentation of Data (in Table, Graph)

The results of respirable particulate matter (RPM) $PM_{10,}$ $PM_{7,}$ $PM_{4,}$ $PM_{2.5}$and $PM_{1,}$ Total Suspended Particulate (TSP) including gaseous air pollutants and noise level that were monitored in Uyo metropolis are presented below.

Suspended Particulate Matter (SPM)($PM_{10,}$ $PM_{7,}$ $PM_{4,}$ $PM_{2.5}$,PM_1 and TSP)

i. Respirable Particulate Matter (RPM) ($PM_{10,}$ $PM_{7,}$ $PM_{4,}$ $PM_{2.5}$ and PM_1)

(PM_{10}) mean value ranges from 56.0-279.7 µg/m^3 at all the study sites. PM_{10} was recorded at all the sampling sites. The peak period (morning and evening) recorded relatively higher values than off peak period (afternoon).The individual site data range from 35.0 – 520.7 µg/m^3 with the highest value being recorded at the Itam Market by Goodluck Jonathan Flyover.

PM_7 mean data varied across the monitoring sites from 45.0-182.4 µg/m^3while the individual data was from 28.9 – 323.4µg/m^3. Ekomiman Junction (IkotOkuIkono) was a predominant source, which recorded the highest mean observed values.

Levels of mean of PM_4 data varied from 29.4-82.9 µg/$m^3$and the individual values were found to be between 22.5 – 129.7 µg/m^3. The highest mean data was also observed at the Ekomiman Junction (IkotOkuIkono).

Mean variation of $PM_{2.5}$ was between 20.5-51.5 µg/m^3 while the individual data ranged from 14.2 – 79.6µg/m^3. Nwaniba Roundabout by Oron Road was the observed dominant source of $PM_{2.5}$.

Mean variation of PM_1 was between 13.8-34.8 µg/m while the individual data ranged from 7.8 – 55.3µg/m^3. Nwaniba Roundabout by Oron Road was the observed dominant source of PM_1.

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

VOC= -744.399 + 27.692(T) – 39.00(W/S) + 4.436(H)

R=0.437, R^2 = 0.191 (19.1%), Adj.R^2 = -0.030 (-3.0%), p-value = 0.489.

Because the calculated p-value (0.113) is greater than the critical p-value (0.05), i.e. $p_{cal}(0.489)>p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) do not have significant effect on VOC.

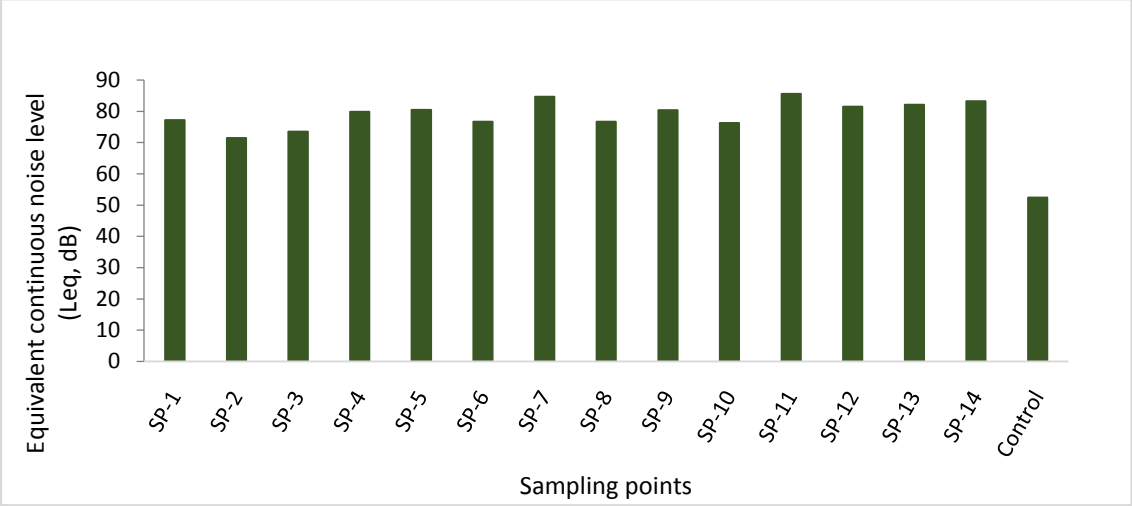

Figure 3: Morning, Afternoon and Evening Mean Values of Noise of the Study Area

iii. Effects of Temperature (^oC), Wind speed (m/s) and Humidity (%) on NO_2

$NO_2 = 0.371 + 0.072(T) – 0.128(W/S) – 0.026(H)$

$R=0.759$, $R^2 = 0.576$ (57.6%), $Adj.R^2 = 0.461$(46.1%), p-value = 0.020.

Because the calculated p-value (0.033) is less than the critical p-value (0.05), i.e. $p_{cal}(0.020)<p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) has significant effect on NO_2.

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

$SOx = 0.150 + 0.026(T) – 0.008(W/S) – 0.010(H)$

$R=0.400$, $R^2 = 0.160$ (16.0%), $Adj.R^2 = -0.069$ (-6.9%), p-value = 0.573.

Because the calculated p-value (0.113) is greater than the critical p-value (0.05), i.e. $p_{cal}(0.573)>p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) do not have significant effect on SO_2.

Table 3: Daily mean values of atmospheric parameters

SO_2 (ppm)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
SP-1	3	0.1333	0.05774	0.03333	-0.0101	0.2768	0.10	0.20
SP-2	3	0.0000	0.00000	0.00000	0.0000	0.0000	0.00	0.00
SP-3	3	0.2000	0.10000	0.05774	-0.0484	0.4484	0.10	0.30
SP-4	3	0.0000	0.00000	0.00000	0.0000	0.0000	0.00	0.00
SP-5	3	0.2333	0.05774	0.03333	0.0899	0.3768	0.20	0.30
SP-6	3	0.0000	0.00000	0.00000	0.0000	0.0000	0.00	0.00
SP-7	3	0.3000	0.10000	0.05774	0.0516	0.5484	0.20	0.40
SP-8	3	0.2333	0.05774	0.03333	0.0899	0.3768	0.20	0.30
SP-9	3	0.1333	0.05774	0.03333	-0.0101	0.2768	0.10	0.20
SP-10	3	0.1333	0.05774	0.03333	-0.0101	0.2768	0.10	0.20
SP-11	3	0.2667	0.05774	0.03333	0.1232	0.4101	0.20	0.30
SP-12	3	0.1667	0.05774	0.03333	0.0232	0.3101	0.10	0.20
SP-13	3	0.0000	0.00000	0.00000	0.0000	0.0000	0.00	0.00
SP-14	3	0.1000	0.00000	0.00000	0.1000	0.1000	0.10	0.10
CTR	3	0.0333	0.05774	0.03333	-0.1101	0.1768	0.00	0.10
Total	45	0.1289	0.11205	0.01670	0.0952	0.1626	0.00	0.40

Table 4: Daily mean values of atmospheric parameters

CO (ppm)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
SP-1	3	0.5333	0.05774	0.03333	0.3899	0.6768	0.50	0.60
SP-2	3	0.3667	0.05774	0.03333	0.2232	0.5101	0.30	0.40
SP-3	3	0.4333	0.05774	0.03333	0.2899	0.5768	0.40	0.50
SP-4	3	0.5333	0.05774	0.03333	0.3899	0.6768	0.50	0.60
SP-5	3	0.5333	0.05774	0.03333	0.3899	0.6768	0.50	0.60
SP-6	3	0.3667	0.05774	0.03333	0.2232	0.5101	0.30	0.40
SP-7	3	0.7667	0.05774	0.03333	0.6232	0.9101	0.70	0.80
SP-8	3	0.6000	0.10000	0.05774	0.3516	0.8484	0.50	0.70
SP-9	3	0.3333	0.05774	0.03333	0.1899	0.4768	0.30	0.40
SP-10	3	0.3000	0.10000	0.05774	0.0516	0.5484	0.20	0.40
SP-11	3	0.6667	0.20817	0.12019	0.1496	1.1838	0.50	0.90
SP-12	3	0.7000	0.10000	0.05774	0.4516	0.9484	0.60	0.80
SP-13	3	0.3667	0.11547	0.06667	0.0798	0.6535	0.30	0.50
SP-14	3	0.2333	0.05774	0.03333	0.0899	0.3768	0.20	0.30
CTR	3	0.0667	0.11547	0.06667	-0.2202	0.3535	0.00	0.20
Total	45	0.4533	0.20068	0.02992	0.3930	0.5136	0.00	0.90

Discussion of Findings

The discussion of the results of respirable particulate matter $PM_{10,}$ $PM_{7,}$ $PM_{4,}$ $PM_{2.5}$ and PM_1. Total Suspended Particulate (TSP) including gaseous air pollutants and noise level that were monitored in Uyo metropolis are presented.

Suspended Particulate Matter (SPM) $PM_{10,}$ $PM_{7,}$ $PM_{4,}$ $PM_{2.5}$, PM_1 and TSP)

i. Respirable Particulates Matter (RPM) ($PM_{10,}$ $PM_{7,}$$PM_{4,}$ $PM_{2.5}$ and PM_1)

The predominant source of PM_{10} was Itam Market by Goodluck Jonathan Flyover. This trend can be attributed to high densely people clustered and commercial activities in the market that produced such value of particulates. The reason for the high value recorded could also be attributed to heavy traffic congestion and road intersection where long vehicular waiting was observed at the time of monitoring. The trend of relatively high values was recorded during the peak periods (morning and evening) where many residents were going and returning from works and different businesses. Various studies by Efe, (2006), Akpan, (2014) and Gobo *et al.*, (2012) also reported the same high values of PM_{10} during peak period. Hence, the findings of this study are in agreement that high concentration levels of PM_{10} are as a result of heavy traffic with high densely clustered people with commercial activities around the study location [10-12].

The highest concentration of PM $_{2.5}$ and PM_1 observed at the Nwaniba Roundabout by Oron Road is attributed to concentration of organic carbon (OC) and elemental Carbon (EC). This carbonaceous species in air could be attributed to the household burning of firewood for cooking, burning coals used to roast suya and corn, diesel exhaust, gasoline powered motor exhaust around the sampling site and paved road dust including the consistent traffic emitting of gaseous pollutants. These could be the attributing sources of the presence of the high values of $PM_{2.5}$ and PM_1 at the time of monitoring .Various studies by Gobo *et al.*, (2012), Efe, (2006) and Akpan, (2014) also reported the same high values of $PM_{2.5}$ and PM_1 during peak periods. Thus, the findings of this study

are in line with several literatures that have reported the same trend. This trend of relatively high values was observed during the peak periods (morning and evening) when many people were going and coming back from offices and other businesses [10-12].

Noise

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 [13-14].

Plate 1 – State Secretariat Roundabout Close to Mechanic Village (N050 01'.568", E0070 54' .330")

Findings

The survey revealed that people near and around particulate matter air pollution had an increased risk of pulmonary exacerbations and decrease in lung function. Patients were examined before the study for amounts of Specific pollutants like *Pseudomonas aeruginosa* and; they exhibited more severe respiratory symptoms (including cough, phlegm and dypsena) and increased sputum production and purulence. So it was concluded that air pollution was the most likely cause of the observed respiratory functions. It is believed that much like cystic fibrosis, by living in a more urban environment serious health hazards become more apparent. Studies

have shown that in urban areas patients suffer mucus hyper secretion, lower levels of lung function and more - diagnosis of chronic bronchitis and emphysema.

Conclusion

The paper has enable us to understand the magnitude of the effects of air pollution on people in Uyo. As environmental manager, we think that the effects of air pollution are being underestimated; hence we propose that maintaining air quality should be added to the Millennium Development Goals (MDGs) so that we can fully grasp its importance. Although the Air Pollution Control Agencies face numerous challenges; it is imperative that all the agencies push through the issues and try to improve indoor and outdoor air quality.

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