THE CONCENTRATION AND HEALTH RISK ASSESSMENT OF AIR AND NOISE POLLUTION: A CASE STUDY OF UYO METROPOLIS, NIGER DELTA, NIGERIA

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Abstract: The research evaluated the variations of the air and noise pollution in Uyo Metroplolis It was noted that most of the sampling points recorded air pollutants higher than both international and national acceptable standards/ limits. Fossil fuel burning through exhausts releasing the air pollutants to the atmosphere by the means of generator power plants and transportation, such as private and commercial vehicles, heavy truck movement, high density population were identified as the primary sources of the air and noise pollution. 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.

Key Words: Air and Noise pollution, Fossil fuel, Atmosphere,

INTRODUCTION:

Preservation of the environment is essential for the very existence of the human beings. Proper management of the environment is the only way to ensure sustainable development in the society. It is therefore, essential to make the masses aware of the changes in the quality of our environment and strategies to prevent the situation from worsen further (Bhatia, 2011).

This study was carried out in Uyo Metropolis in accordance to the Federal and State Ministry of Environment and International Best Practice in order to ascertain the degree (if any) of the alteration of fresh/ambient air at the monitoring locations which may to some extent, impact on human life and the environment.

Significance of the Study

Investigating air quality and noise level in the study area entail monitoring and assessment of the presence and concentration of noxious gases in the study area. The gases include Volatile Organic Compounds (VOCs), Nitrogen Dioxide (NO_2), Sulphur Dioxide, (SO_2), Hydrogen Sulphide (H_2S), Carbon Monoxide (CO), Ammonia (NH_3) and Methane (CH_4), including Particulate Matter and Noise level at the selected sampling locations. This is necessary for this study because the noxious gases, particulate matter and noise are dangerous to human health and environment as detail below:

Air Polluted Areas in Nigeria

The main sources of air pollution in Nigeria are the primary sources such as release of the air pollutants from the car exhaust, combustion of fossils fuels and construction operations as well as secondary sources of air pollution when the primary pollutants react chemically. The relatively high concentration of the air pollutants can easily be found in the major cities with high density population, commercial activities, industrial activities, construction works, agricultural activities, oil and gas exploration/ exploitation (Olowoporoku, 2011).

The high dominant commercial with dense population major cities in Nigeria is Lagos, Kano, Onitsha, Ibandan, Aba, Kaduna, Calabar and Markurdi etc. These cities are known for their commercial activities and high numbers vehicular movement, thus there is no doubt of air pollution in these cities.

The Niger Delta region of Nigeria which comprises Akwa Ibom, Delta, Rivers, Bayelsa, Edo, Imo, Abia and Ondo States are highly polluted with air pollutants from oil and gas activities and construction works.

METHODOLOGY:

The sampling of the air quality and noise pollution in Uyo Metrololis was carried out on hourly basis for three (3) hours per sampling station (morning, afternoon and evening – peak, off peak and peak period). This was done in-situ by determining the air pollutants and noise level using a series of hand held (portable) air quality and noise level monitoring equipment of different sensor for each air pollutant Figure.... The sensors were held at a height of about two meters in the direction of the prevailing wind. Short exposure of limits of three minutes were applied per single reading/monitoring of each air pollutant for all the air pollutants that were logged in, and the reading was recorded at stability.

Field Observations and Data collection

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

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.

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 construction operations.

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.

A **B**

Plate A GPSmap Model 76Cx Garmin Global Positioning Systems that was used todetermine geo-references of the sampling points.

Plate.B The Kestrel 4500NV pocket weather Trackerthat was used to determine meteorological data at sampling points.

C

D

Plate. C: The Testo 815 portable noise meter that was used to determine noise level at the sampling points

Plate D: Mass Particle Counter (Aerocet-531S) used for investigation of Particulate Matter

PRESENTATION OF RESULTS:

Air Quality Index of the Study Area for Uyo Metropolis

The air quality index of the sampling points in Uyo metropolis showing the USEPA index interpretation using colour code to describe the concentration of the air pollutants of PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2 with associated health effect statement and cautionary statements so that the sensitive groups would be aware of the quality of air in the sampling study area (See Table 1 and 2)

Table 1: Air Quality Index of the Study Area for Uyo Metropolis, Akwa Ibom State, Nigeria

Sampling Points	PM_{10}	$PM_{2.5}$	CO	SO_x	NO_2	Colours	Sensitive Groups	Health Effects Statements
SP-1	57.4	85.8	6.1	0.2	2.3		People with respiratory disease are the group most at risk.	
SP-2	85.1	118.4	4.2	0.0	1.5			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-3	64.7	117.9	4.9	0.3	2.3			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-4	85.4	100.5	6.1	0.0	3.0			Unusually sensitive people should consider reducing prolonged or heavy exertion.

SP-5	94.2	140.5	6.1	0.3	2.3			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-6	81.7	106.0	4.2	0.0	1.9			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-7	98.4	98.5	8.7	0.4	5.7		People with respiratory disease are the group most at risk.	
SP-8	77.6	41.6	6.8	0.3	6.1		People with respiratory disease are the group most at risk.	
SP-9	84.5	93.3	3.8	0.2	2.3		People with respiratory disease are the group most at risk.	
SP-10	51.5	68.7	3.4	0.2	4.5		People with respiratory disease are the group most at risk.	
SP-11	113.3	112.0	7.6	0.4	6.4			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-12	108.9	117.3	8.0	0.2	4.5			Unusually sensitive people should consider reducing prolonged or heavy exertion.
SP-13	58.7	73.3	4.2	0.0	1.9		People with respiratory disease are the group most at risk.	
SP-14	145.1	102.7	2.7	0.1	2.7			Unusually sensitive people should consider reducing prolonged or heavy exertion.
CTR	47.0	63.8	0.8	0.0	0.4		People with respiratory disease are the group most at risk.	

Table 2: USEPA AQI Colour Chart

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...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

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

Number of Tricycles and Vehicles at Traffic Points

The number of vehicles and tricycles at heavy traffic and road intersection where long vehicles waiting was observed for about 10 minutes interval and counted at the time of monitoring during morning, afternoon and evening (peak, off peak and peak) periods which could be attributed to be the primary source of air pollution in this study area as shown in Table 4.2.

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

$CO = -1.291 + 0.092(T) – 0.194(W/S) – 0.010(H)$

$R=0.746$, $R^2 = 0.557$ (55.7%), $Adj.R^2 = 0.436$ (43.6%), p-value = 0.025.

Because the calculated p-value (0.025) is less than the critical p-value (0.05), i.e. $p_{cal}(0.025)<p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) has significant effect on VOC.

Effects of Temperature (^oC), Wind speed (m/s) and Humidity (%) on NH_3

$NH_3 = 10.850 + 0.072(T) – 0.361(W/S) – 0.145(H)$

$R=0.444$, $R^2 = 0.197$ (19.7%), $Adj.R^2 = -0.022$ (-2.2%), p-value = 0.573.

Because the calculated p-value (0.113) is greater than the critical p-value (0.472), i.e. $p_{cal}(0.472)>p_{crit}(0.05)$, it is concluded that the meteorological variables (temperature, wind speed and humidity) do not have significant effect on NH_3..

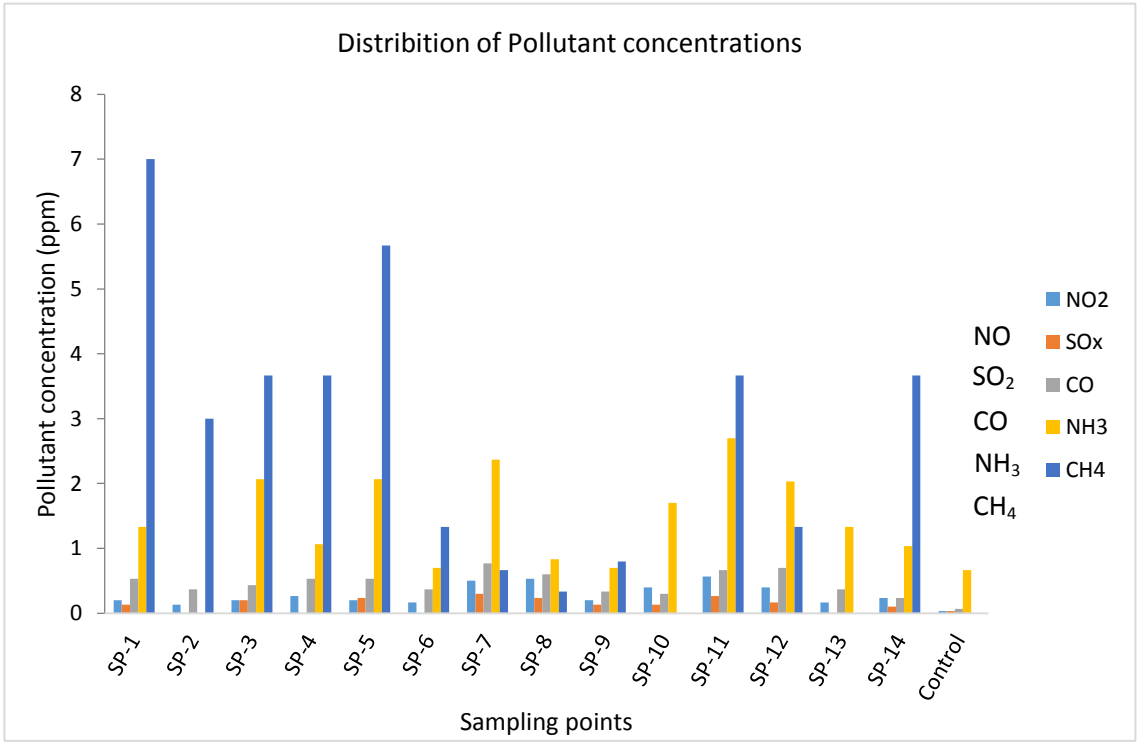

Fig 1.: Morning, Afternoon and Evening Mean Values of NO_2, SO_2, CO, $NH_3$and CH_4 of the Study Area

DISCUSSION OF RESULTS:

This research was carried out to monitor the air quality and noise pollution in Uyo, Akwa Ibom State. 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 mean 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.

The following values were obtained for gaseous pollutants; VOCs mean values ranged from 308.2 - 514.5ppm, NO_2 mean data recorded was between 0.13 - 0.56ppm, while SO_2 mean data was from <0.01 - 0.3ppm. H_2S mean value was <0.01ppm, the CO mean values was between 0.23 - 0.76ppm. The mean data obtained for NH_3 was between <0.01 - 2.7ppm, while CH_4 mean values ranged from <1.0 – 7.0ppm and mean noise level ranged from 68.8-84.9dB. All these values recorded at the monitoring points for the air pollutants and noise pollution in the study area were higher than all the values recorded at the control point which are 50.73µg/$m^3$for PM_{10}, 30.4µg/m^3 for PM_7, 26.8µg/m^3 for PM_4, 18.7µg/$m^3$for $PM_{2.5}$, 9.2µg/m^3 for PM_1, 59.87µg/m^3 for TSP, 192.37ppmfor VOCs, 0.03ppm for NO_2, 0.03ppm for SO_2, <0.01ppm for H_2S, 0.66ppm for CO, 0.66ppm for NH_3, <1.0ppm for CH_4 and 52.13dB for Noise level. The highest values of $PM_{10}$was recorded at Itam Market by Goodluck Jonathan Flyover,PM_7 and PM_4 highest values were at Ekomiman Junction (Ikot Oku Ikono) while $PM_{2.5}$ and PM_1highest values were recorded at Nwaniba Roundabout by Oron Road. TSP highest data was recorded at Itam Market by Goodluck Jonathan Flyover.

The VOCs recorded the highest value at Nwaniba Roundabout by Oron Road, NO_2 highest value was at Itam Market by Goodluck Jonathan Flyover, SO_2 mean highest value was recorded at Akpan Andem Market by Udoumana. The H_2S value was less than instrument detection limit of 0.01ppm while CO recorded the highest value atAkpan Andem Market by Udoumana. The NH_3 highest value recorded was at Itam Market by Goodluck Jonathan Flyover, the highest value for CH_4 was obtained at Four Lane Roundabout by Nwaniba Road, while Itam Market by Goodluck Jonathan Flyover recorded the highest noise level. The heavy traffic, congestion, dense population, road intersection, generator power plants, rotten wastes, agricultural and urban runoff could be attributed to the sources of the air and noise pollution.

CONCLUSIONS:

It was noted that most of the sampling points recorded air pollutants higher than both international and national acceptable standards/ limits. Fossil fuel burning through exhausts releasing the air pollutants to the atmosphere by the means of generator power plants and transportation, such as private and commercial vehicles, heavy truck movement, high density population were identified as the primary sources of the air and noise pollution.

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.

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