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Assessment of Ambient Air Quality with Special Reference to PM_{10} at the Waste Dumpsite Located in Osisioma Ngwa L.G.A., Nigeria

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ABSTRACT

A study of ambient air quality with special reference to Particulate Matter (PM_{10}) at the waste dumpsite located at Osisioma Ngwa, Aba was carried out during the morning and evening hours of the dry season in Nigeria. Sample were collected from six designated areas of the dump sites at Osisioma and were labelled AQSP (1), AQSP (2), AQSP (3), AQSP (4), AQSP (5), and AQSP (6), within the sample spaces, a control point was determined and labelled AQSP (7). The sampling was done with some hard hold air quality monitors to determine and measure the concentration of harmful pollutants in the environment. The mean values of Particulate Matter (PM_{10}) concentration during morning hour at the different location reads: Umuigwe dumpsite (6.32mg/m^3); Umujima dumpsite (13.92mg/m^3); Niger stone dumpsite (16.40mg/m^3); Uratta Amaisa dumpsite (12.60mg/m^3); Eyimba market dumpsite (7.20mg/m^3); Asaeme dumpsite (6.40mg/m^3) and Owerrinta control location (4.30mg/m^3). Values obtained for evening hour reading include: Umuigwe dumpsite (6.32mg/m^3); Umujima dumpsite (18.40mg/m^3); Niger stone dumpsite (60.60mg/m^3); Uratta Amaisa dumpsite (8.80mg/m^3); Eyimba market dumpsite (7.82mg/m^3); Asaeme dumpsite (3.16 mg/m^3) and Owerrinta control location (2.86mg/m^3). The data were analyzed using mixed effect models with random subject effect for repeated measurements. The results indicated that air quality concentrations were unfenced by meteorological factors like temperature, relative humidity and wind speed and the low concentrations obtained within the study area may be due to absence of major road construction.

Keywords: Air pollution, particulate matter, pollutant, contaminant, air monitoring, automobiles, waste dumpsite, Nigeria.

INTRODUCTION

Air pollution is woven throughout the fabric of our modern life. Pollution problems began with the growth of cities and population and their related water, industrial and disposal needs. With the increase of urbanization, man

began to intrude on the beautiful, balanced mechanism of the atmosphere (Dominici *et al*., (2003). Today in our house, in our factories and throughout automobiles and planes, we are recklessly injecting pollutants into our atmosphere. By the use of various thermal power stations in the country, we are reducing the available oxygen in the atmosphere by nearly ten percent every year. The chief pollutants released from such power plants and industries (stone crushers, etc) are fly ash, dust and grit, suspended particulate matter (SPM), other gases and hydrocarbon. Particulate Matter (PM) are discrete mass of any material, except pure water, that exists as liquid or solid in the atmosphere and of microscopic dimensions (Borne, 2000). Particulates can be composed of inert or extremely reactive materials ranging in size from 100um down to 0.1um and less. The inert materials do not react readily with the environment nor do they exhibit any morphological changes as a result of combustion or any other process, whereas the reactive materials could be further oxidised or may react chemically with the environment (Borm (2000). Particles in the size range of 1 – 10um have measurable settling velocities but are readily stirred by air movements, whereas particles of size 0.1 – 1um have small settling velocities. Those below 0.1um are sub-microscopic size and are found in urban air which undergoes random Brownian motion resulting from collisions among individual molecules. Most particulates in urban air have sizes in the range 0.1 – 10um. The finest and the smallest particles are the ones which cause significant damage to health. Air-borne matter results not only from direct emissions of particles but also from emissions of some gases that condense as particles directly or undergo transformations to form particles (Dominici *et al*., (2003). Thus PM may be primary or secondary. Primary PM includes dust, as a result of wind, or smoke particles emitted from some factory like the sawmill factory in Nigeria (Pat-Mbano *et al*., 2012). Atmospheric PM ranges in size from 0.001um to several hundred um. Particulate matter in atmosphere arises from natural as well as man-made sources. Natural sources are soil and rock debris (dust), volcanic emission, sea spray, forest fires and reactions between natural gas emissions Ugwu and Ofomatah, 2011).

Studies shows that the types of sources of PM which include fuel combustion and industrial

operations (mining, smelting, polishing, furnaces and textiles, pesticides, fertilisers and chemical production); industrial fugitive processes (material handling, loading and transfer operations); non-industrial fugitive processes (roadway dust, agricultural operations, construction, fires); transport sources (vehicles exhaust and related particles from fire, clutch and break wear) all contribute to the emission of PM at rates higher than the natural sources (Adinna, 2001). Of all the different types of particulates in the atmosphere, the presence of trace elements such as cadmium, lead, nickel and mercury may constitute the greatest health hazard. Many of the trace metals are toxic and are concentrated in the finest of particulate matter in a variety of combined forms such as oxides, hydroxides, sulphates and nitrates (Allen *et al*., 2009). The chemical composition of particulate pollutants varies over a wide range, which actual composition is very much dependent upon the origin of the particulate. Particles from soils and minerals primarily contain calcium, aluminium and silicon compounds. Smoke from combustion of coal, oil, wood and solid waste contains many organic compounds (Ubuoh *et al*., 2016). Insecticide dusts and certain fumes released from chemical plants also contain organic compounds. In addition to the above there are also many kinds of biological particulate matter that remains suspended in atmosphere. These are bacterial cells, spores, fungal spores and pollen grains (Vallero, 2001).

Particulate matter is injurious to health. Soot, lead particles from exhaust, asbestos, fly ash, volcanic emission, pesticides, H_2SO_4, mist, metallic dust, cotton and cement dust, etc., when inhaled by man cause respiratory diseases such as tuberculosis and cancer, bronchial disorders, allergy and many other diseases in man, animals and plants (Dietert *et al*., 2002). Particulate matter inhaled may be deposited in various regions of the respiratory system depending on particle size. Particles above 10um are almost wholly retained in the nose. Those below 10um escape entrapment and generally pass through the upper respiratory system. Reports shows that fine particles in the size range 0.5 to 5um are deposited as far as bronchioles, but few reach the alveoli (Lin *et al*., 2002). Some PM interfere with the clearing mechanisms of the respiratory tract, while some act as carriers of absorbed toxic gases such as SO_2 and produce synergistic effects

which can accelerate the corrosion of steel, copper, zinc and other metals (Ajadike (2001). Most are intrinsically toxic because of their physical and chemical characteristics. The fine particles emitted by automobiles are retained within the lungs and are absorbed by body with an efficiency of about 40% (Ramsey *et al*., 2003). Extensive measurements of the size of CO_2 in automobile exhaust have shown extremely small mean concentrations besides the highways in busy urban areas like Aba (Nwakanma *et al*., 2016). In addition, due to the fact that not much systematic work seems to have been done on the study of ambient air quality at Osisioma Ngwa waste dumpsite located at Aba. Hence the present work was undertaken to determine the ambient air quality with special reference to the release of PM_{10} in the study area.

MATERIALS AND METHOD

Multiple sampling points were carried out to ensure adequate coverage of the dump sites in the study area as shown in Fig.1. Sample were collected from six designated areas of the dump sites at Osisioma and were labelled AQSP (1), AQSP (2), AQSP (3), AQSP (4), AQSP (5), and AQSP (6), within the sample spaces, a control point was determined and labelled AQSP (7). The sampling was done with some hard hold air quality monitors to determine and measure the concentration of harmful pollutants in the environment. The sampling was done for a period of three hours in the morning and two hours in the evening to get a comparative result which showed the amount of activities at the location points. The pollutant studied was Particulate Matter (PM_{10}). Muto Gas Analyzer was used to monitor seven criteria pollutants Model, 2002, with the electrochemical measuring principles and complete gas conditioning systems. For the purpose of understanding of the status of air quality within the selected dump site, descriptive statistics was employed to present data in graph. Data in numerical and tabular form were presented and analyzed using mixed effect models with random subject effect for repeated measurements. In the first level of analysis, linear and logistic models were applied for the pollutants gas combined to know whether associations exist. The test homogeneity in mean variance of the concentration levels of monitored gas across the sampling station was conducted with analysis of variance (ANOVA).

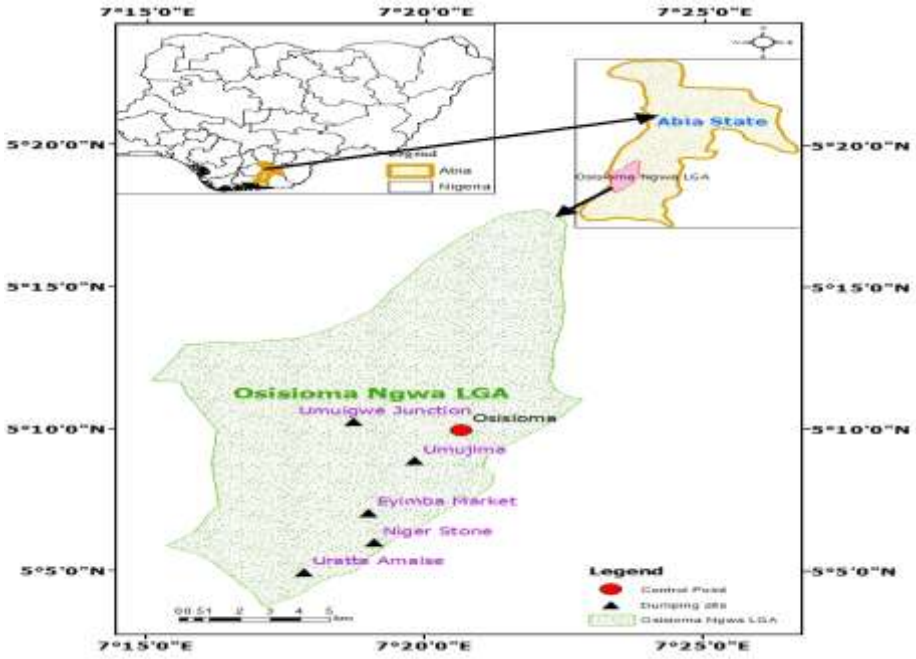

Figure 1: Map of Osisioma Ngwa LGA showing the dumping sites

RESULTS AND DISCUSSION

The mean values of Particulate Matter (PM_{10}) concentration during morning and evening hours in the dry season are presented in Table 1 and below

Table 1: Result of PM_{10} during Morning Hour in Dry Season

LONG	LAT.	STATION/LOCATION	PM_{10} mg/m^3
E007^{0}19.718	N05^{0}10.239	Umuigwe dumpsite	6.32
E007^{0}19.810	N05^{0}08.486	Umujima dumpsite	13.92
E007^{0}19.717	N05^{0}05.894	Niger stone dumpsite	16.40
E007^{0}19.659	N05^{0}05.320	Uratta Amaise dumpsite	12.60
E007^{0}18.694	N05^{0}06.981	Eyimba market dumpsite	7.20
E007^{0}16.913	N05^{0}18.928	Owerinta control location	4.30
E007^{0}19.686	N05^{0}04.414	Asaeme dumpsite	6.40

Table 2: Result of PM_{10} during Evening Hour in Dry Season

LONG	LAT.	STATION	PM_{10} mg/m^3
E007^{0}19.718	N05^{0}10.239	Umuigwe dumpsite	6.82
E007^{0}19.810	N05^{0}08.486	Umujima dumpsite	18.40
E007^{0}19.717	N05^{0}05.894	Niger stone dumpsite	60.60
E007^{0}19.659	N05^{0}05.320	Uratta Amaise dumpsite	8.80
E007^{0}18.694	N05^{0}06.981	Eyimba market dumpsite	7.82
E007^{0}16.913	N05^{0}18.928	Owerinta control location	2.86
E007^{0}19.686	N05^{0}04.414	Asaeme dumpsite	3.16

From Table 1, the result shows PM_{10} ranged between 4.30-16.40mg/m^3, with a mean value of 9.591mg/m^3 Owerrinta has the lowest value and Niger Stone dump site has the highest value. This high concentration of PM_{10} is due to agitation of dust particles by moving vehicles and other remote factors. No such conditions at Owerrinta. Table 2 also shows that PM_{10} varies between 2.86-60.60mg/m^3 at Owerrinta and Niger Stone respectively. It has a mean value of 15.494mg/m^3.

Table 3: Comparison of maximum air pollutant in the morning and evening during dry season with Federal Ministry of Environment (FMENV) standard for clean air

Max. for air pollutants	Morning PPM	Evening PPM	Range	Mean value	FMENV STD
PM_{10} (mg/m^3)	16.40	60.60	-44.20	38.50	150

Table 3 results indicate maximum air pollutant values for PM_{10} to be higher in the evening (60.60mg/m^3) and lower in the morning with values of 16.40mg/m^3. However, values obtained for PM_{10} were lower than FMENV standard for clean air. This was in line with reports by Borne (2000) on measurement of Particulate Matter in relation to Health and the Composition level of PM $_{2.5}$ at Baltimore, Washington DC.

Meteorological factors such as wind speed, wind direction, temperature and relative humidity (RH) had effects on concentrations of air pollutants as shown in Fig. 2 to Fig. 5 below.

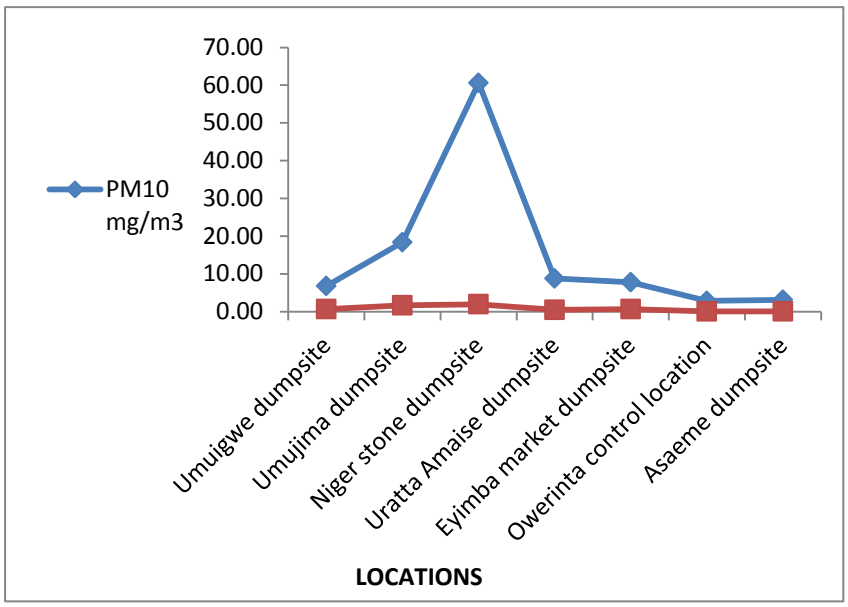

Fig 2: The effect of wind speed on PM_{10} concentration

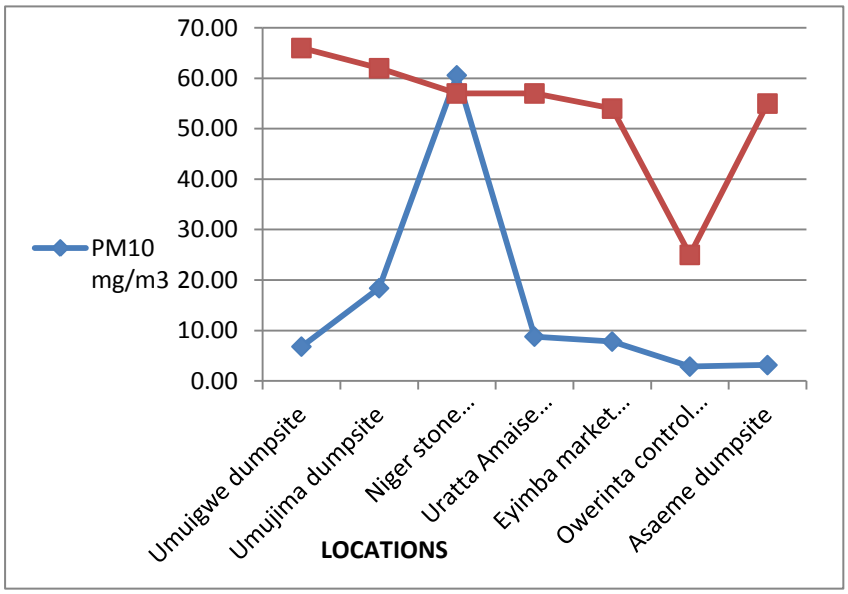

Fig 3: The Effect of Elevation on PM_{10} Concentration

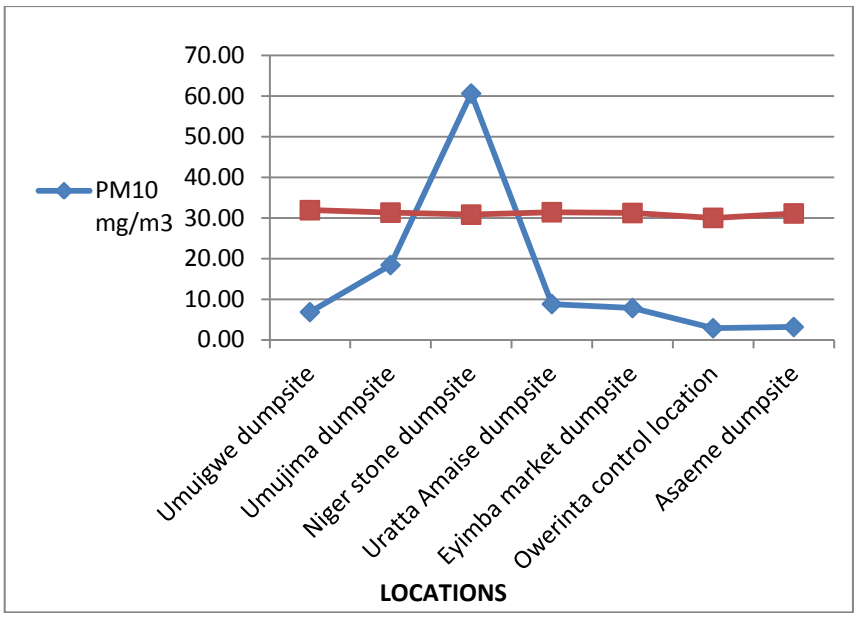

Fig 4: The Effect Temperature on PM_{10} Concentration

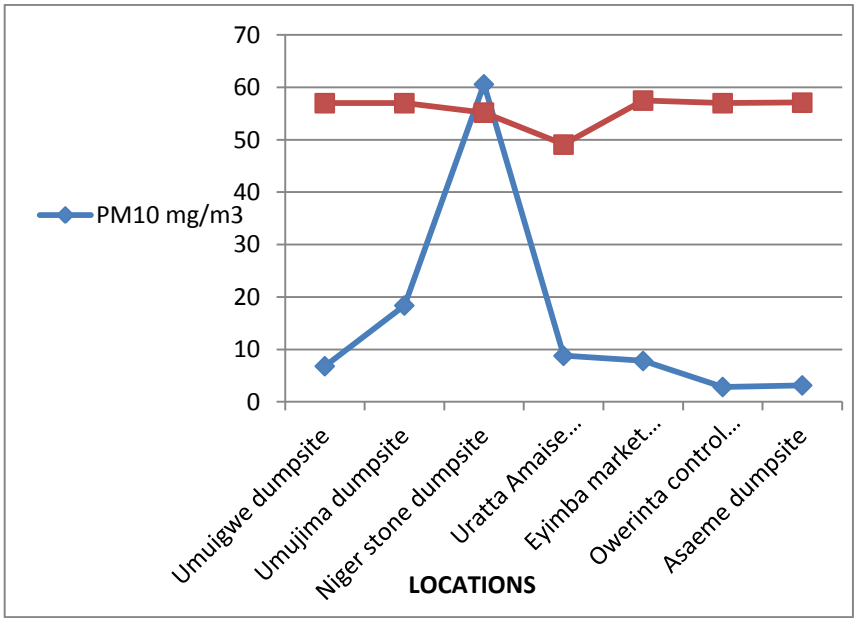

Fig 5: The Effect Relative Humidity on PM_{10} Concentration

Table 4: Comparison of Sampled Air Quality (dry season) with AQI Pollutant

Location	Time	PM_{10}	Average AQI	Descriptive Remark
Umuigwe	Morning	6.32	86.588*	Moderate
	Evening	6.82	81.166	Moderate
Umujima	Morning	13.92	89.598*	Moderate
	Evening	18.40	91.038	Moderate
Niger Stone	Morning	16.40	89.838*	Moderate
	Evening	8.80	87.024	Moderate
Uratta Amaise	Morning	12.60	86.894*	Moderate
	Evening	8.80	87.024	Moderate
Eyimba market	Morning	7.20	79.999*	Moderate
	Evening	7.82	80.933	Moderate
Owerrinta	Morning	4.30	12.36*	Good
	Evening	2.86	13.988	Good
Asaeme	Morning	6.40	81.580*	Moderate
	Evening	3.16	77.656	Moderate

The air quality during dry season reading was compared with air quality index for pollutant (AQI). Result obtained from Table 4 indicates that for morning average reading, Niger Stone location had higher value of PM_{10} at 16.40mg/m^3 followed by Umujima location (13.92mg/m^3). However, lower value for morning reading was at Owerrinta control location which recorded a value of 4.30mg/m^3. The variation in the evening was highest with the Umujima location (18.40mg/m^3). The variation in the evening was highest with the Umujima location (18.40mg/m^3), and the lowest value of 2.86mg/m3 was recorded for Owerrinta location. The high value recorded for the evening against morning reading indicates that the contributory meteorological factors may have favoured the building up of the pollutant (PM_{10}) in the study area. Comparing the values with pollutant standard index (PSI), indicates "good" with no risk associated to health which is in line with recommended standards by WHO (2000). Results revealed that quality is initiated by various activities outside indiscriminate waste dumpsites in the study area, which is in relation to the findings of Nwakanma *et al*., (2016). These have led to air quality varying from one location to another in the study area which reflected in the variability of the morning and evening results. Also, the results

indicated that air quality concentrations were unfenced by meteorological factors like temperature, relative humidity and wind speed (Vallero, 2001). Apart from climatic factors that influenced the concentrations of the parameters, elevation also played a key role.

In conclusion, low concentrations obtained within the study area may be due to absence of major road construction, the target road network, and high relative humidity during the time of sample collection.

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