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Air Quality Assessment of Specific Air Pollutants along East/West Road, Port-Harcourt, Rivers State

Eunice Nnete Gam[1] and Oliver Chima Amadi[1]
[1]*Department of Agricultural and Environmental Engineering*
Rivers State University of Science and Technology, Port Harcourt, Nigeria

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ABSTRACT:An investigation of air quality from Eleme junction to Rumuokoro axis of Port-Harcourt, Rivers State, Nigeria has been conducted. This was due to the predominance of air pollutants from traffic congestion and industrialization in the study area. Eleme junction, Rumuodara junction and Rumuokoro junction are situated along the Port-Harcourt East/West expressway, major route to other states of the federation and were selected because of the high traffic density usually observed at these junctions. Six criteria pollutants, namely, ground level ozone, carbon monoxide, sulphur dioxide, nitrogen oxide, volatile organic compound and particulate matter were measured respectively, during morning and evening hours; and their mean variation computed and compared with air quality index (AQI) and their limit of exceedance determined and categorized. The MultiRAE Series-detector and the X-AM-5000/5600 multi-gas detector were employed for the survey. The AQI varied between 246µg/m^{3}and 257.5µg/m^3 in the morning hours; and 205.8µg/m^3 and 313.7µg/m^3 in the evening hours. These results exceeded the EPA air quality permissible limit, thus considered unhealthy for dwellers in those regions. Recommendations were proffered.

KEYWORDS: Air Quality, Assessment, Pollutants, Port-Harcourt, Traffic.

I. INTRODUCTION

Man, in his quest to live a comfortable life has inadvertently introduced dangerous gases into the atmosphere, thereby changing the composition of the air around them. The composition of ambient air is 78.1% nitrogen, 20.8% oxygen and 1% of other gases, which includes argon, carbon dioxide, methane and water vapour. The introduction of high levels of foreign elements into the atmosphere has polluted the environment making it injurious to biological communities [1]. Other reports have shown that, air pollution is the major cause of cardiovascular diseases, immune system impairment, allergies, exacerbation of asthma, chronic respiratory diseases, reduced lung function and death. Economic development, urbanization, energy consumption, transportation and rapid population growth, have been identified as the anthropogenic activities that contribute to air pollution. Research has shown that children and the elderly are particularly vulnerable to the health effects of air pollutants such as ozone (O3), particulate matter (PM2.5, 10) and other airborne toxicants. Similarly, exposure to high concentrations of NOx and CO is associated with adverse impacts like premature deaths. The control of airborne toxicants particularly NOx and CO concentrations is a major concern in some developed countries. Many cities in developing countries such as Nigeria have been suffering from increasing air pollution since the discovery of oil. Routine gas flaring continues and the practice gives rise to atmospheric contamination [2]. The worst cases of gas flaring have also posed significant threat on the environment; its impact affect both human and environmental components. Also, the resultant occurrence and impact of acid rain due to the residual activities of some of the flared pollutants are also detrimental to human health as long-term exposure. Numerous human activities which result in the release of potential toxic substances into the atmosphere is predominant.

The primary source of air pollutants today are the waste products released into the air from the exhausts of internal combustion engines, and boilers and furnaces of industries, plants and homes [3]. The case of illegal refineries in the study area cannot be left unturned as it contributes greatly to resultant climatic changes. Vehicular emission has become

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one of the most complicated environmental challenges. In effect, cities which rely on a large number of automobiles for bulk daily transportation, and offering few efficient public mass transportation modes, suffer from effects of automobile emission. As simple as this sounds, it holds true, as researches have highlighted statistical data showing an increase in air pollution as a result of vehicular emission. [4] reported that in Nigeria automobile exhausts accounts for about 80% of the air pollution problem in the urban areas, the remaining 20% are attributed to industrial sources, the burning of refuse and forest and engineering activities. More so, about 15-30% of the emitted led from automobiles is airborne. It is not uncommon to find people eating raw fruits and food hawkers displaying their stuff openly along heavy traffic roads which are apparently contaminated with air pollutants.

[4] conducted a study on air pollutants within Aluu and Igwuruta axis of Obio-Akpor, Rivers State and they identified four dominant air pollutants namely, nitrogen dioxide (NO2), sulphur dioxide (SO2), ammonia (NH3) and methane (CH4). These raises concern on possible health risks on community dwellers within the region. [5] in their air pollution research in Okrika communities in Rivers State, identified high concentrations of particulate matter (PM), hydrogen sulphide (H2S), trisodium phosphate (TSP), nitrogen dioxide (NO2), methane (CH4), ammonia (NH4), carbon monoxide (CO) and volatile organic compounds (VOC). There dry season concentrations were also found to be higher than during the wet season. Research result of [6] on Roadside Air Pollution Assessment in Port-Harcourt, revealed that the amount of CO, NOx and PM10 in the atmosphere brought the AQI index to fall between 267.17 and 14.71, showing that the health of people who spend long hours along the roadside are at risk. In their study on the impct of vehicular emission on air pollution in Ojo local government area of Lagos State, Nigeria, [7] concluded that the reason for high concentration of CO at Okokomaiko was due to vehicular traffic. They also identified NO2, SO2 and PM as pollutants whose concentrations were above the world health organization's (WHO) standards for ambient air quality. The study also revealed that measured gaseous pollutants in the air, directly or indirectly threaten the environment and lives of inhabitants of the location. It was discovered in Rivers State University Campus, following monitored parameters, that the shopping complex air shed had the highest concentration of Particulate Matter (PM1-10 and TSP). While PM1 and TSP did not exceed allowable limits, however, PM2.5, PM7 and PM10 showed exceedances over internationally allowable limits. The PM2.5/PM10 ratio showed that 87.5% of the data had particulate matter in the size fractions of 10 microns whereas 12.5% were in the size fractions of 2.5 microns. Exceedances were obtained for NH3, NO2, SOx and H2S in the RSU Campus air basin [8].

II. MATERIALS AND METHODS

This paper is a review of the present waste management practices in Port-Harcourt municipality. Sources of information include personal observation, journal articles, questionnaire survey and one-on-one interaction with waste management professionals and residents.

Description of Study Area

Port-Harcourt is the capital of and largest city in Rivers State, Nigeria. The municipality lies between longitude 6°55′ and 7°10′ east of Greenwich meridian and latitude of 4°47′ north of the equator housing, and is bounded by an area of about 2600km with a population of 1,850,020 [14]. It also lies along the Bonny River and is located in the Niger-Delta region. As of 2016, the Port Harcourt urban area had an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006 [15]. Port-Harcourt is comprised of several towns and localities inclusive of Azuabie Town, Abuloma, Amadi Ama, Borokiri, D-line, Diobu, Eagle Island, Elekahia, New GRA, Nkpogu, Nkpolu Oroworukwo, Ogbunabali, Old GRA, Old Port Harcourt Township, Oroabali, Oroada, Orochiri, Orogbum, Orolozu, Oromeruezimgbu, Oroworukwo, Oromineke, Rebisi, Rumukalagbor, Rumuobiekwe, Rumuwoji, Tere-Ama and Okuru-Ama (Figure 1).

Port-Harcourt was created in 1912 by the British colonial administration and was a port for coal export and agricultural produce. Initially Port-Harcourt was just 30,000 acres (121.41km^2), but with the discovery of oil in 1950 Port Harcourt expanded quickly beyond its original boundaries (which was about 470km^2), mainly towards the northern sides, as the eastern, western and southern sides of Port Harcourt are bounded by swamps, creeks and rivers. Access to potential energy from oil and natural gas, in addition to good communication with the outside world through its international air and sea ports, created favourable conditions for Port Harcourt to become one of Nigeria's most important industrial towns, and the economy of the small town rapidly upgraded. This economic change brought in a steady stream of oil and gas companies such as Royal Dutch Shell, Mobil, Chevron Texaco, Totalfina Elf, etc. With this influx, human population increased rapidly within a

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short space of time. The climate of Port-Harcourt falls within the sub equatorial climate belt, with temperature and humidity high throughout the year. The area is marked by two distinct seasons – the wet and the dry seasons – with 70 percent of the annual rains falling between April and August, while 30 percent is spread in the three months of September to November. The driest months are from December to March [12, 16] The soil type consists mainly of poorly-drained silt clays mixed with sand, which is geologically classified under the Benin formation.

The proliferation of private companies, different government parastatals, churches, markets, shopping malls and schools are situated in this city, making it a high commercial and industrial environment. Prior to this oil boom, Port-Harcourt, popularly known as the "garden city", was a very quiet town with well-arranged infrastructure and beautiful gardens in almost every residential and commercial area. The streets were cleaned timely and properly and refuse disposed as at when due without lapses. Presently, and over the past 20 years, this cosmopolitan city succumbed to what can now best be described as a "garbage city".

Figure 1. Map of Port-Harcourt (Google earth, 2025)

Port Harcourt is the capital and largest city of Rivers State in Nigeria and is located at 4.46°N; 7.01°E. It is the fifth most populous city in Nigeria after Lagos, Kano, Ibadan and Benin. It lies along the Bonny River and is located in the oil rich Niger Delta region. Port Harcourt's urban population is approximately 3,480,000. Port Harcourt's economy turned to petroleum when the first shipment of Nigerian crude oil was exported through the city in 1958. Through the benefits of the Nigerian petroleum industry, Port Harcourt was further developed, with aspects of modernization such as overpasses, city blocks, and taller and more substantial buildings. Oil firms that currently have offices in the city include Shell and Chevron. Port-Harcourt features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months od December and January actually qualifies as its dry season. The warmest month of the year is February, with an average temperature of 27.4°C, while December on average is the driest month of the year, with an average rainfall of 20mm. Temperatures throughout the city are relatively constant, showing little variation throughout the year. Average annual temperatures are typically between 26°C and 28°C in the city.

The selected sampling locations are in Obio-Akpor local government area in Rivers State, a place situate in the southern part of Nigeria. Obio-Akpor is listed as the hub of business activities in the city and the ninth richest local government in Nigeria. Eleme junction, Rumuodara junction and Rumuokoro junction lie along the Port-Harcourt East/West road expressway, a major route to other states of the federation. These loctions were selected for the study because of the high traffic density observed at these junctions. Due to the dense traffic congestion, the Rivers state government constructed an overhead bridge at Eleme and Rumuokoro junctions as a bid to mitigate and /or reduce the vehicular air pollution. Nevertheless, there is yet a need to measure, analyse and monitor ambient air quality at these areas to protect human health.

Sampling and Data Collection

In situ meteorological monitoring involving wind direction, wind speed and temperature was conducted. The wind direction was measured directly using a wind vane; the wind speed was measured using light weight three-cup anemometers equipped with sensors with high accuracy at low wind speeds and a low starting threshold; while the temperature and temperature difference were measured using HTC-2 Digital Thermometer Hygrometer. The concentrations of key pollutants, particulate matter (PM2.5 and PM10), ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), and carbon monoxide (CO) were measured by usingMultiRAE Series-dectatordigital air quality monitoring kit, X-AM-5000/5600- Multi-Gas Detector and MultiRAE-PLUS-Monitor**.**

The samples were collected at three different locations and two replications were made per sample location at a graded distance of 200m (0.2km) away from each flare point (Eleme 1 and 2) coded EST1, EST2; while UST1, UST2 for Rumoudara 1 and 2 and RST1, RST2 for Rumuokoro 1 and 2 respectively. Samples were collected in both, prevalent wind direction of the flare point at each flare facility for possible pollutant fallouts. Also, these samples were collected while moving towards the Eleme to Rumuokorocommunities respectively. Samples were collected along the south/west prevalent wind direction moving from Eleme towards Rumuokoro community. At each designated position, the instrument washeld at arm's length in an open space and was adjusted to TEST position and allowed to stand for two minutes minimum. Then the stabilized digit displayed on the LCD was then recorded to be the pollutant value of the sample area.

III. RESULTS AND DISCUSSION

The results as shownin tables 1 to 4 below presents the AQI for air pollutants analyzed for Eleme junction to Rumuokoro axis of Port Harcourt, Rivers State, Nigeria. The ranges obtained in this study for air pollutants when compared with AQI revealed that O_3, NO_2 and SO_2were "Nil" for all the measured hours. CO appeared lowest (15.0 µg/m^3) in Rumuodara junction and highest (53.6 µg/m^3) at Eleme junction in the evening hours. This holds true because of the variation of traffic levels within these locations at the time of this investigation. The AQI varied between 246µg/m^3 to 257.5µg/m^3 in the morning hours and 205.8 µg/m^3 to 313.7 µg/m^3 in the evening hours. For all the measured hours the AQI exceeded permissible limit and is categorized very unhealthy for dwellers of that region. Except for the evening reading of Rumuodara that rose to 313.7 µg/m^3, which also exceeded the EPA air quality index limit and thus, it is hazardous for all categories of people that spends long hours within that region.

IV. CONCLUSION

This research establishes that ambient air quality at Eleme, Rumuodaraand Rumuokoro axis of Port Harcourt are greatly compromised by pollutants and therefore the need for mitigation and constant monitoring.

Recommendations

1. The need for carbon sequestration in Rivers State, Nigeria.
2. Concerned organizations should create awareness in the region and necessary avoidance practiced both individually and collectively.
3. Government and relevant institutions should make workable laws to put an end to illegal refineries, checkmate legally existing ones, and schedule time limits for vehicles up to 12 (twelve) and above metric tons.
4. The Government should develop and enforce policies restraining heavy duty vehicles from operating on the roads in the study areas during peak periods when commuters are more on the roads.
5. Regulatory/implementation of traffic laws by appropriate agencies to ensure reduced congestion.

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Table 1. Data Variation in the Morning Hours

LOCATIONS	STATIONS	PERIOD	DESCRIPTION		PARTICULATE MATTER		GASES					
			WIND SPEED m/s	WIND DIRECTION	PM_{10} µg/ m³	PM_{10} µg/m³	CO µg/m³	O_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	VOC µg/m3	AQI µg/m³
ELEME	St1	8:05am	3.3	P.W	100.5	181.1	14.1	Nil	Nil	Nil	0.09	136.0
	St2	8:15am	3.2	P.W	136.0	230.0	18.2	Nil	Nil	Nil	0.14	193.0
RUMUDARA	St1	8:32am	2.8	P.W	72.6	130.0	14.0	Nil	Nil	Nil	0.07	161.0
	St2	8:45am	2.9	P.W	84.2	151.0	16.0	Nil	Nil	Nil	0.10	193.0
RUMUOKORO	St1	8:55am	3.2	P.W	97.2	163.1	18.0	Nil	Nil	Nil	1.09	168.0
	St2	8:57am	3.0	P.W	65.0	112.2	20.3	Nil	Nil	Nil	1.12	156.0

Table 2. Data Variation in the Evening Hours

LOCATIONS	STATIONS	PERIOD	DESCRIPTION		PARTICULATE MATTER		CASES					AQI µg/m³
			WINBD SPEED m/s	WIND DIRECTION	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	CO µg/m³	O_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	VOC µg/m³	
ELEME	St 1	6:05pm	3.8	P.W	189.9	299.9	34.0	Nil	Nil	Nil	0.09	198.9
	St 2	6:13pm	3.6	P.W	289.7	310.6	39.1	Nil	Nil	Nil	1.05	212.7
RUMUDARA	St 1	7:05pm	5.1	P.W	123.8	220.9	24.0	Nil	Nil	Nil	0.07	201.2
	St 2	7:15pm	4.8	P.W	242.6	390.0	36.0	Nil	Nil	Nil	0.13	225.0
RUMUOKORO	St 1	8:05pm	3.9	P.W	149.6	242.6	26.0	Nil	Nil	Nil	0.08	189.7
	St 2	8:12pm	4.3	P.W	129.0	221.2	34.0	Nil	Nil	Nil	0.06	215.2

Table 3. Mean variation of AQI and Air Pollutants Concentration (Morning Hours)

LOCATION	PERIOD	WIND DIRECTION	WIND SPEED (m/s)	TEMPERATURE (°C)	CONCENTRATION OF PARAMETERS								COLOUR	CATEGORY
					CO µg/m³	NO^2 µg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	SO^2 µg/m³	VOC µg/m³	O^3 µg/m³	AQI µg/m³		
ELEME	8:05am	P.W	3.3	29	23.3	Nil	168.5	296.1	Nil	0.16	Nil	232.5	P	v.u
RUMUDARA	8:32am	P.W	3.2	21	15.0	Nil	78.4	140.5	Nil	0.085	Nil	257.5	P	v.u
RUMUOKO	8:57am	P.W	2.8	21	28.2	Nil	81.1	219.2	Nil	1.65	Nil	246	P	v.u

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Table 4. Mean variation of AQI and Air Pollutants Concentration (Evening Hours)

LOCATIONS	PERIOD	WIND DIRECTION	WIND SPEED (m/s)	CONCENTRATION OF PARAMETERS CO µg/m³	NO² µg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	SO² µg/m³	VOC µg/m³	O³ µg/m³	AQI µg/m³	COLOUR	CATEGORY
ELEME	6:05pm	P.W	3.8	53.6	Nil	334.8	455.2	Nil	0.57	Nil	205.8	P	v.u
RUMUDARA	7:02pm	P.W	3.6	42.0	Nil	245.1	415.9	Nil	0.135	Nil	313.7	M	H
RUMUOKORO	8:05pm	P.W	5.1	42.0	Nil	214.1	353.3	Nil	0.11	Nil	297.3	P	v.u