International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 767-777 www.ijaem.net ISSN: 2395-5252

Assessing Air Quality Leve within Port Harcourt Metropolis, Rivers State, Nigeria

Otumu Paul Ehis

Department of Geography and Meteorology,(Environmental management and Control) Faculty of Environmental Sciences ,Enugu State University of Science and Technology (ESUT)

Submitted: 01-12-2021 Revised: 11-12-2021 Accepted: 14-12-2021

ABSTRACT

Residents of Port Harcourt including prominent Nigerians, protested about the increased deterioration of air quality within the city, in February 2017. Complaints made include black soot setting on cars, floors, roofs, and household furniture surfaces. Furthermore, frequent cleaning off amass of soot from nostrils occurs at regular basis; Residents also complained that drinking and domestic water has turned black. The aim of the study therefore is to determine the air quality (how clean or polluted the air is) by assessing the Air Quality Index among different land use types within Port Harcourt, metropolis. To carry out the studies, there were four objectives: (1) To examine various land use types in the study area, (2) To measure Air Quality Index among different land use types during the period of rainy and dry season, also compare it with regulatory agencies acceptable limit. (3) To determine the status / concentration of the pollutants in the study area (4) To reveal and analyze the implication of the result on the sustainability of the environment. The study adopted experimental research design approach. The critical air pollutants which include: particulate matter(PM2.5 and PM10) Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2) Carbon Monoxide(CO), Carbon Dioxide (CO_2),Hydrogen Sulphide (H_2S), Ammonia (NH_3) ,Methane (CH_4) and Ozone (O_3) were assessed. We used mobile air quality devices, GPSMAP78 and one in ten meteorological devices at the Fourteen different locations within the study period (January 2020 to August 2020), in other to cover the dry and wet season. These station points or locations were spread among the different land use (Residential, Commercial and Industrial Area), including road junctions in Port Harcourt metropolis. The monitoring were carried out three days in a week, (Monday, Wednesday and Friday), a day for one station point (SP). The monitoring which was done twice daily- (Morning: 8:00am and Afternoon 3:30pm) measured air quality data analyzed using the standards acceptable regulatory limit (FMENV, UNEP, USAAQS) and Research Hypotheses using " %Difference Formula . Similarly, the influence of wind spread and wind direction on atmospheric dynamics were assessed with the aid wind rose diagrams which revealed that the wind speed and wind direction contributed significantly to the dispersion and transportation of the atmospheric pollutants. Result of air quality analysis ranged from 151ppm-628ppm that implies unhealthy, very unhealthy and hazardous air quality. Based on findings, some pollutant gases (PM2.5,PM10 ,NO_2,NH_3,and H_2S) recorded above the acceptable limit during the Dry season, when compared with the Rainy season. Having identified the measures to ameliorate the impact of air pollution, the level of health concern in the environment ,and suggestion being made ,it is proper that, heeding to the recommendations to a greater extent will help the authority manage the air quality properly thereby achieving sustainable environment. There is need to bridge the administrative gap: (fully enforcement of environmental laws, Compliance, and willingness; engaging environmental Professional to carry out environmental studies; consultancy service for best practice). The Ministry of Environment and other regulatory agencies should collaborate with the Professional body, trained to manage the environment for best practices, reduction /elimination of gas flaring and conversion of the flare gas for economic uses.

Key words: Air Quality, Assessing, Port Harcourt Metropolis, Environment,Pollutants.

I. INTRODUCTION

One of the major environmental challenges that has bedeviled both the developed and the developing countries of the world today is air pollution which has recently been linked to increased morbidity and mortality rates (Pope, Thun, Calle, Krewski, Ito and Thurston, 2019). Air pollution refers to the release of pollutants into the air, which are detrimental to human health and the planet as a whole (WHO 2020).

According to the World Health Organization (WHO 2020), each year, air pollution is responsible for nearly seven million deaths around the globe. Nine out of ten human beings currently breathe air that exceeds, the WHO's guideline limits for pollutants, with those living in low and middle income countries suffering the most. In the United States, the clean Air Act, established in 1970 authorizes the U.S Environmental Protection Agency (EPA) to safeguard public health by regulating the emissions of these harmful air pollutants (American Lung Association2020).

However, air pollution can be due to natural sources, but a major anthropogenic source of air pollution is due to man's quest for a better standard of living and the utilization of natural resources for rapid industrialization, urbanization and consequently causing excessive air pollution. (Tawari and Abowel, 2013).

Therefore, air pollution problems have continued to receive a great deal of interest worldwide due to its negative impact to human health and welfare (Brunekreef and Holgate, 2002).

Among the reported cases of extreme air pollution conditions that affect humanity include the issues of high blood pressure and other cardiovascular problems (Sanjay, 2008). Air pollution, therefore, is a serious threat to the environmental health in many cities of the world today (Chen and Hong, 2009). It is very pertinent to note that this condition is connected to the fact that one of the basic requirements of human health and existence is clean air (Mohammed and Caleb, 2014). All living things need air to survive, without, which they die off within six minutes or it will result in brain damage. An average person takes in 7 to 8 liters of air per minute and a total of about 15,000 liters of Air per day (Nnadi, 2019). Man's immediate environment comprises of air on which all forms of life depend; Air is a mixture of gases, which composition by volume is approximately Nitrogen 78.1%, Oxygen 20.93% and Carbon dioxide 0.03% (Ugochukwu, 2018). The balance is made up of other gases, which occur in traces such as argon, neon, krypton, xenon and helium. In addition to these gases, air also contains water vapour, traces of ammonia and suspended particulate matters such as dust, bacteria, spores and vegetable debris (Majra, 2011).

The level of air pollutant concentration depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emissions

(Sengupta, 2003). This is a hinged on space variation of sources as well as atmospheric gradients, which most often result in the diffusion, and transportation of the pollutants to areas outside the sources of the air pollution (Ogba and Utang, 2009). Atmospheric dynamics which are generally controlled by meteorological factors (including temperature, humidity, wind speed and wind direction, etc.) remarkably influence the tendency for the release of atmospheric toxins to the environment (Ibe, 2016). In view of this, atmospheric pollutant conditions most often are subjected to spatial-temporal variations causing the air pollution pattern to change in meteorological and topographical conditions (Sengupta, 2003).

Air quality assessment and monitoring is, therefore, very important in determining the nature of population exposure in a variety of health effects. These health effects generally depend on the types of pollutants, its magnitude, direction and frequency of exposure and of course the toxicity of the pollutants (Hanninen, Economopoulos and Ozkaynak, 2009).

The way people live and breathe could be an effect of the air quality of a particular locality and air quality like weather normally changes from time to time. It is important to report monitored air quality index of a locality, it may be useful in understanding the atmospheric concentration levels of a locality since its helps in the classification of the health conditions inherent in human exposure to air pollution (EPA, 2014). Air pollution constitutes the largestamong all of the environmental risks: 3 million annual deaths are associated with outdoor air pollution exposure. In 2012 alone, 11.6 percent of global deaths equivalent to 6.5 million deaths were outdoor air pollution-related. 94% of the approximately 90% of air pollution-related deaths occurring in low and middle-income countries are as a result of non-communicable diseases, including cardio vascular diseases (CVDs), chronic obstructive pulmonary disease (COPD), and lung cancer. Industrial activities constitute a principal source of air pollution (World Health Organization, 2017). Data for Nigeria's air quality status contained in the Little Green Data Book 2015 (WHO, 2017) puts the population exposed to air pollution at PM2.5 levels, and exceeding WHO guidelines, at 94%. This number is above the 72% Sub-Saharan Africa average (WHO, 2017). The poor are further disproportionately affected (WHO, 2017).

In the recent past, plumes of soot in the air have affected the residents of Port-Harcourt, and its environs. According to sources, the first observation was in November 2016 (Allen, 2017). Some affected residents complained that the government delayed in responding, and only acted when people began expressing their concerns on social media, and publicly challenging their inaction. (Allen, 2017 and Punch, 2017).There is, therefore, the urgent need of assessing the air quality condition within Port Harcourt Metropolis due to increase in population, industrialization and urbanization levels of the area.

II. STUDY AREA

The study area is Port Harcourt metropolis. It is situated between Latitude 4^{o} 45'. 0" N and 4^{o} 55'.0" N, and 6^{o}55'.40" E and 7^{o}05' 0"E in the State, occupying the entrance of the Bonny River. The City is bounded in the north by Abia and Imo States; east by Akwa-Ibom State; west by Bayelsa State; and, south by the Atlantic Ocean. It is the capital of Rivers state Nigeria, occupying approximately 1811.6 km2 area (Weli and Efe,2015), with a population of about 1.5 million(Akukwe and Ogbodo, 2015). Port Harcourt metropolis, the study area, spans over two Local Government Area which are Port Harcourt and Obio/Akpor .It constitutes the state's main city and has one of the largest seaports in the Niger Delta region, thus being the center of administration, commerce, and industrial activities (Weli and Efe,2015). Its estimated altitude is 12 km above average sea level, lying between the Dockyard Creek/Bonny and the Amadi Creek (Weli and Efe, 2015).

Rivers State is a predominantly low-lying pluvial state in southern Nigeria, located in the eastern part of the Niger Delta on the ocean ward extension of the Benue Trough. The inland part of the state consists of tropical rainforest, and towards the coast, the tropical Niger Delta environment features many mangrove swamps. Rivers State has a total area of 11,077 km2 (4,277 sq mi), making it the 26th largest state in Nigeria. Its topography ranges from flat plains, with a network of rivers to tributaries.

Only some few studies have been conducted in the study area so far for the assessment of pollution levels. Port Harcourt in Rivers State is a typical example of a place that is seriously affected because of air pollution from stationeries, oil refineries and indoor sources. Meanwhile both outdoor and indoor air quality data represent the true exposure for human being (Ideriah, 2001).

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 767-777 www.ijaem.net ISSN: 2395-5252

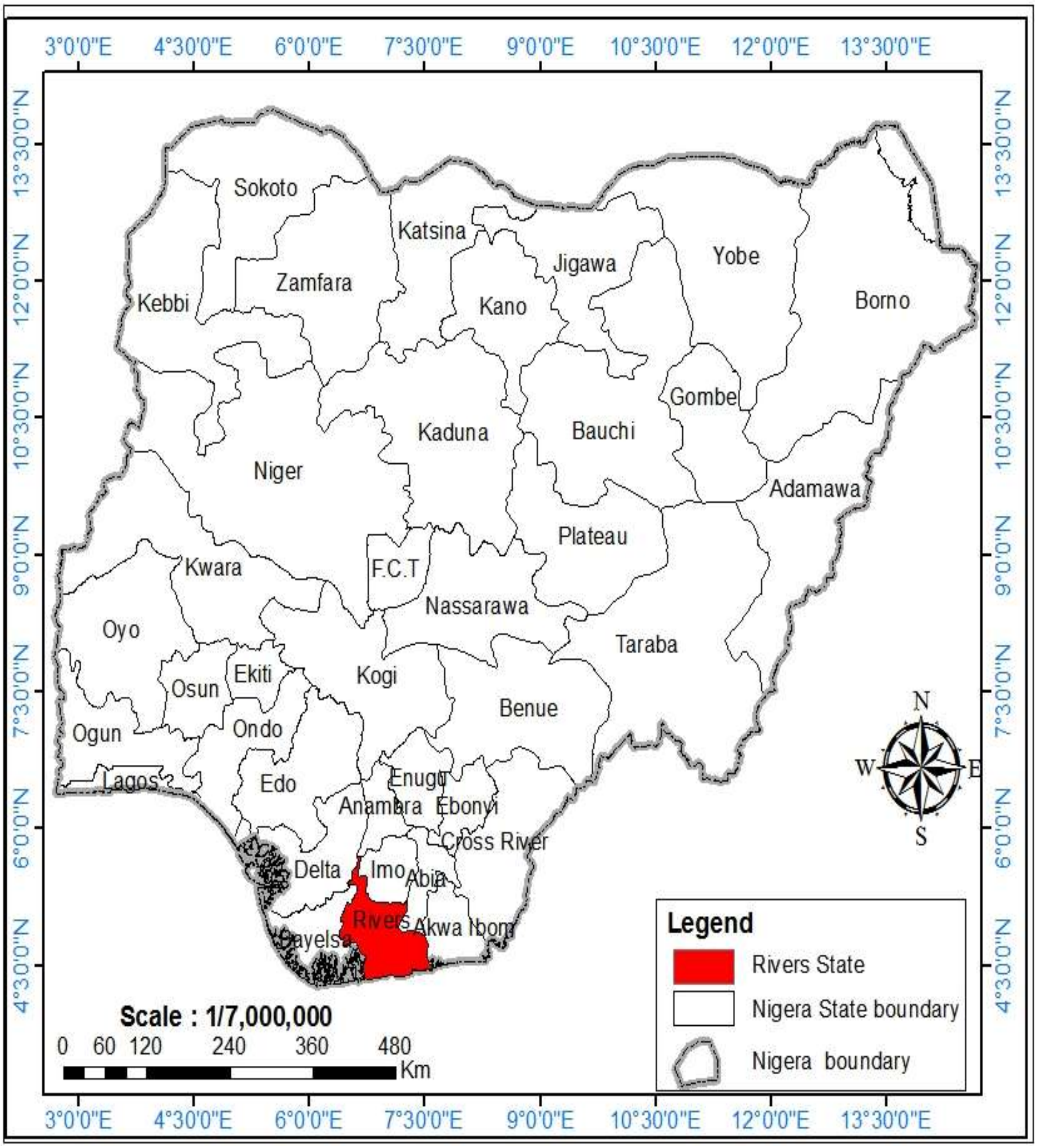

Figure 3.1 : Map of Nigeria showing Rivers State
Source ;-UNCA, Natural Earth, ESRI,NGA and OCHA (2015).

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 767-777 www.ijaem.net ISSN: 2395-5252

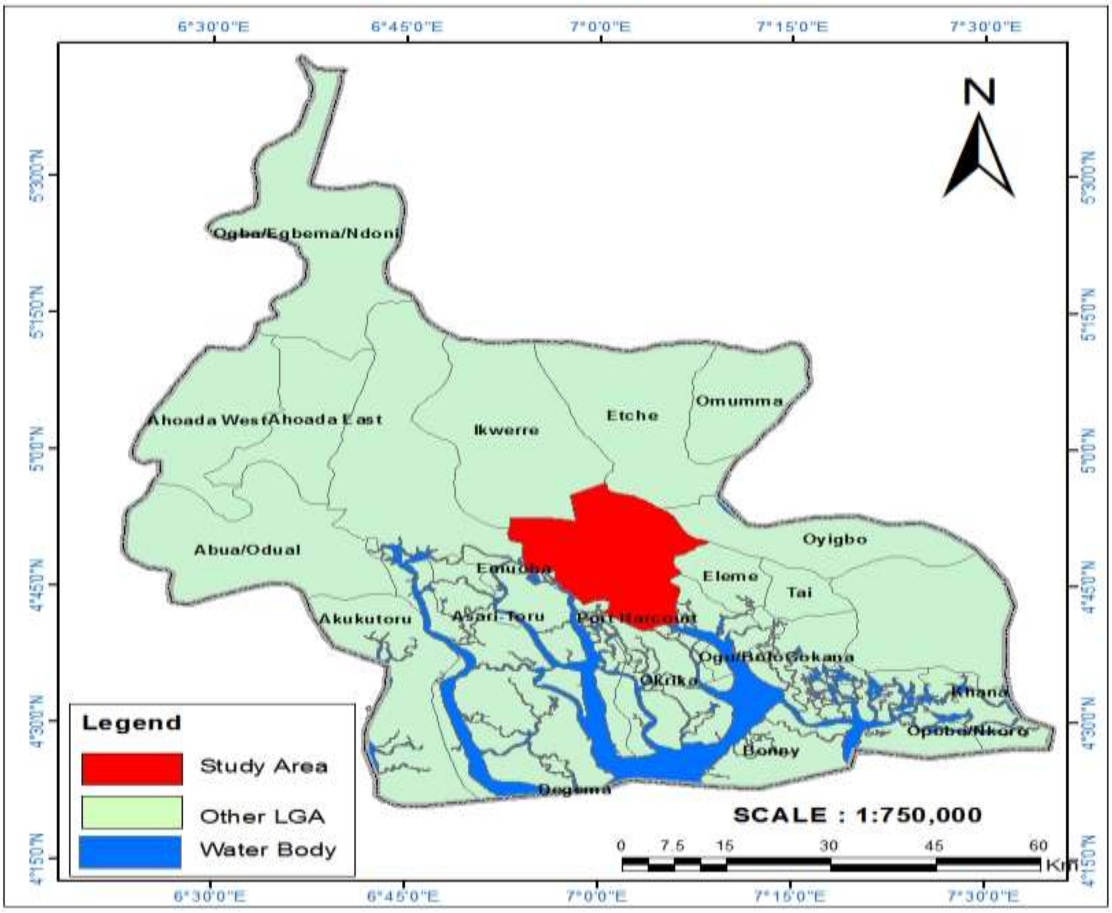

Figure 3.2 : Map of River showing the Study Area.
Source: Nigeria –Scientific Figure on Research Gate, (2019).

III. MATERIAS AND METHODS

The study adopted experimental research design, thus quantitative data were collected through air quality measurement in situ and the data were compared with the Regulatory Agencies (FME, NESREA, USNAAQS and UNEP) acceptable limit standard.

3.1 Sources of Data

The researchers relied on two kinds of data sources-Primary and Secondary. The primary data are the products of experiments, from selected fourteen station point (SP1-14) spread among different land use types within Port Harcourt metropolis, Rivers State Nigeria, using air quality monitoring equipment, meteorological instrument and GPSMAP 78 instrument and secondary data were collected from different sources, like journals, magazines, books, online materials and library.

3.2 Sample Locations/Point

Data generated from fourteen (SP1-14) locations on Air Quality Index within Port Harcourt metropolis were stated as follow;

Table 3.1: List of study location and their coordinate.

S/N	Sample	Location Name	Latitude	Longitude
1	SP1	GRA Phase II	NO4^{0} 49`11.9”	E006^{0} 59’58.7”
2	SP2	Borokiri	NO4^{0} 44`37.1”	E007^{0} 02’27.7”
3	SP3	Eneka	NO4^{0} 53`32.5	E007^{0} 02’33.8”
4	SP4	D/Line	NO4^{0} 47`56.5”	E007^{0} 00’13.3”
5	SP5	Amadi flats	NO4^{0} 47`36.9”	E007^{0} 00’33.6”

6	SP6	Rumuibekwe	NO4^0 50`45.5”	E007^0 02’49.3”
7	SP7	Diobu	NO4^0 47`13.9”	E006^0 59’53.5”
8	SP8	Rumuomasi	NO4^0 49`47.8”	E007^0 01’31.1”
9	SP9	Trans-Amadi	NO4^0 48`26.1”	E007^0 01’41.6”
10	SP10	Woji	NO4^0 48`58.7”	E007^0 02’53.6”
11	SP11	Abuluoma Junction,	NO4^0 47`48.8”	E007^0 01’38.7”
12	SP12	Tank Junction	NO4^0 51`51.3”	E007^0 03’21.4”
13	SP13	Trans-Amadi Junction	NO4^0 53`25.9”	E007^0 00’08.2”
14	SP14	RumukpokwuJunction	NO4^0 48`34.0”	E007^0 01’00.5”

Source: Researchers field work, (2020).

The study locations were divided among different land use types within Port Harcourt Metropolis(Port Harcourt city and Obio/Akpor LGA) which comprises Residential, Commercial, Industrial areas including road junctions (zoning) .

IV. DATA PRESENTATION

Air Quality Index Data Analysis of Port Harcourt Metropolis

Table4.1: Data Analysis (Period of DrySeason).

LOCA TION	PM 2.5	PM 10	CO	H_2S	NH_3	SO_2	NO_2	0_3
SP1	0.065	0.308	0.55	0.38	0.0	0.0	0.193	0.3
SP2	0.085	0.328	0.56	0.29	0.0	0.0	0.162	0.15
SP3	0.076	0.2	0.53	0.35	0.0	0.0	0.16	0.19
SP4	0.098	0.303	0.55	0.67	0.0	0.0	0.187	0.28
SP5	0.091	0.315	0.56	0.34	0.0	0.0	0.186	0.22
SP6	0.072	0.234	0.56	1.16	0.0	0.0	0.222	0.06
SP7	0.091	0.431	1.98	0.39	0.0	0.0	0.478	0.31
SP8	0.123	0.412	1.88	0.25	0.0	0.0	0.364	0.02
SP9	0.067	0.344	0.56	0.45	0.2	0.0	0.27	0.00
SP10	0.1	0.446	0.56	0.61	0.0	0.0	0.281	0.08
SP11	0.064	0.351	2.18	0.37	0.2	0.0	0.174	0.08
SP12	0.089	0.353	0.56	0.61	0.0	0.0	0.234	0.00
SP13	0.107	0.346	0.56	0.27	0.2	0.0	0.451	0.00
SP14	0.106	0.38	0.56	0.58	0.0	0.0	0.168	0.00

Source :Field Survey, (2020).

Finding: Air Quality Data Analysis during the Period of Dry Season

Air quality analysis result revealed that the analyzed parameters were within the acceptable limit except Pm10, Hydrogen Sulphide (H_2S),Nitrogen Dioxide (NO_2) and Ammonia (NH_3), which recorded above the acceptable limit during the dry season;

SP 1, H_2S recorded 0.15 PPM in the morning and 0.23 PPM in the afternoon against the limit of 0.03 PPM.**SP 2,** H_2S recorded 0.14 PPM Morning and 0.15 Afternoon. **SP 3,** H_2S recorded 0.15 PPM Morning and 0.20 PPM Afternoon. **SP 4,** H_2S recorded 0.33 PPM Morning and 0.34 PPM Afternoon. **SP 5,** H_2S recorded 0.11 PPM Morning and 0.23 PPM Afternoon. **SP 6,** H_2S recorded 0.52 PPM Morning and 0.64 PPM Afternoon. **SP 7,** H_2S recorded 0.12 PPM Morning and 0.27 PPM Afternoon. **SP 8,** H_2S recorded 0.10 PPM Morning and 0.15 Afternoon. **SP 9,** H_2S recorded 0.15 PPM Morning and 0.30 Afternoon against 0.03 PPM. PM10 recorded 0.180 PPM Afternoon against 0.05-0.15 PPM and Ammonia (NH_3) 0.2 Afternoon against 0.04 PPM. **SP 10**, PM10 recorded 0.154 PPM Afternoon against 0.05-0.15 PPM; H_2S recorded 0.26 PPM Morning and 0.35 Afternoon. **SP 11,** H_2S recorded 0.25 PPM in the Morning and 0.12 PPM in the afternoon, Ammonia recorded 0.2 PPM in the afternoon against 0.04. Although PM10 was within the limit, which recorded 0.145 PPM against 0.05-0.15 its impact is readily hitting to a limit. **SP 12,** PM10 recorded above the acceptable

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 767-777 www.ijaem.net ISSN: 2395-5252

limit of 0.160 PPM against 0.05-0.15 PPM in the Afternoon, H_2S recorded 0.24 PPM Morning and 0.37 PPM Afternoon. **SP 13,** PM10 recorded 0.165 PPM in the Afternoon against 0.05-0.15; H_2S 0.15 PPM Morning and 0.12 PPM Afternoon against the limit of 0.03 PPM, Nitrogen dioxide (NO_2) recorded 0.279 against 0.05-0.1 PPM. **SP 14,** PM10 recorded 0.154 PPM in the Afternoon above the limit of 0.05-0.15 PPM; H_2S recorded 0.31 PPM Morning and 0.27 PPM in the Afternoon against the limit of 0.03.

Table 4.2 : Comparing the Air Quality Index Analysis among different land –use types within Port Harcourt Metropolis, Rivers State Nigeria, during the Dry season.

S/N	Parameters	Residential		Commercial		Industrial		Road Junction	
	Pollutants	AQI value Recorded	Level of Health concerns	AQI value Recorded	Level of Health concerns	AQI value Recorded	Level of Health concerns	AQI value Recorded	Level of Health concerns
1	PM-2.5	62	Moderate	144	Unhealthy sensitive group	68	Moderate	84	Moderate
2	PM-10	462	Hazardous	744	Hazardous	690	Hazardous	616	Hazardous
3	CO	-94.48	Good	-80.7	Good	-94.4	Good	-90.35	Good
4	H_2S	1,673	Hazardous	967	Hazardous	1,667	Hazardous	1,427	Hazardous
5	NH_3	-100	Good	-100	Good	150	Unhealthy	150	Unhealthy
6	SO_2	-100	Good	-100	Good	-100	Good	-100	Good
7	NO_2	270	Very unhealthy	742	Hazardous	460	Hazardous	414	Hazardous
8	O_3	150	Unhealthy	112.5	Unhealthy for sensitive group	-50	Good	-75	Good

Sources: Field Survey (2020)

In comparing the Air Quality Index among different land use types, within Port Harcourt Metropolis, during the Dry season, using the AQI scale, the parameters results revealed the above AQI value, level of health concern and the Environmental impact.

Air Quality Index Data Analysis in Port Harcourt Metropolis

Table 4.3: Data Analysis (period of Rainy Season)

LOCATION	PM 2.5	PM 10	CO	H_2S	NH_3	SO_2	NO_2	0_3
SP1	0.01	0.005	6.4	0.05	0.4	0.01	0.15	0.00
SP2	0.019	0.023	3.1	0.00	0.0	0.00	0.123	0.14
SP3	0.093	0.028	2.7	0.00	0.0	0.00	0.152	0.13
SP4	0.006	0.047	0.0	0.17	0.0	0.00	0.00	0.01
SP5	0.045	0.037	0.2	0.02	0.2	0.2	0.149	0.00
SP6	0.005	0.1	0.0	0.06	0.0	0.00	0.00	0.00
SP7	0.006	0.012	0.88	0.01	0.2	0.00	0.040	0.00
SP8	0.004	0.008	0.81	0.0	0.2	0.00	0.083	0.01

SP9	0.031	0.043	0.0	0.00	0.1	0.00	0.113	0.07
SP10	0.009	0.02	0.56	0.09	0.00	0.0	0.00	0.00
SP11	0.013	0.017	0.45	2.7	0.00	0.0	0.00	0.00
SP12	0.026	0.046	0.54	1.37	0.0	0.0	0.00	0.00
SP13	0.011	0.028	0.5	0.81	0.0	0.0	0.00	0.00
SP14	0.025	0.042	0.52	0.2	0.02	0.00	0.142	0.02

Source :Field Survey, (2020).

Finding: Air Quality Index Analysis during the Period Rainy Season

Air quality analysis result during the rainy season revealed that the analyzed parameters were within the acceptable limit, except Hydrogen Sulphide (H_2S),Ammonia(NH_3),Sulphur Dioxide (SO_2) and Ozone (O_3), which recorded above the acceptable limit.

SP 1. Hydrogen Sulphide (H_2S) recorded 0.05 PPM in the afternoon against 0.03 PPM and Ammonia (NH_3) recorded 0.2PPM in the morning and 0.2PPM in the afternoon against 0.04PPM.**SP2**. Ozone (O_3) recorded 0.12ppm in the morning against 0.08PPM.

SP 3. Ozone (O_3) recorded 0.09 PPM in the morning against 0.08 PPM. **SP 4.** H_2S recorded 0.08 PPM in the morning and 0.09PPM in the afternoon against 0.03 PPM.**SP5.** Ammonia (HN_3) recorded 0.2PPM in the morning and 0.2PPM in the afternoon against 0.04PPM and Sulphur Dioxide (SO_2) recorded 0.2PPM in the morning against 0.03PPM.**SP7**. Ammonia (NH_3) recorded 0.2PPM in the morning against 0.04PPM. **SP8**. Ammonia (NH_3) recorded 0.2PPM in the afternoon against 0.04PPM .**SP9**. NH_3 recorded 0.1ppm in the morning against 0.04PPM. **SP 10**. H_2S recorded 0.043 PPM in the morning and 0.045PPM in the afternoon against 0.03 PPM. **SP 11**. H_2S recorded 1.3 PPM in the morning and 1.4 PPM in the afternoon against 0.03 PPM. **SP 12.** H_2S recorded 0.66 PPM in the morning and 0.71PPM in the afternoon against 0.03 PPM. **SP 13.** H_2S recorded 0.41 PPM in the morning and 0.40 PPM in the afternoon against 0.03 PPM. **SP 14.** H_2S recorded 0.08 PPM in the morning and 0.12 PPM in the afternoon against 0.03 PPM the acceptable limit.

Table 4.4 : Comparing the Air Quality index analysis among different land –use types within Port Harcourt Metropolis, Rivers State Nigeria, during the rainy season.

S/N	Parameters	Residential		Commercial		Industrial		Road Junction	
	Pollutants Gases	AQ1 value Recorded	Level of Health concerns	AQ1 value Recorded	Level of Health concerns	AQ1 value Recorded	Level of Health concerns	AQ1 value Recorded	Level of Health concerns
1	PM-2.5	16	Good	-90	Good	-60	Good	-62	Good
2	PM-10	-20	Good	-80	Good	-37	Good	-34	Good
3	CO	-79.3	Good	-91.55	Good	-97.25	Good	-94.95	Good
4	H_2S	67	Moderate	-83.33	Good	206.67	Very unhealthy	413	Hazardous
5	NH_3	-25	Good	400	Hazardous	25	Good	-87.5	Good
6	SO_2	0	Good	-100	Good	-100	Good	-100	Good
7	NO_2	92	Moderate	24	Good	14	Good	-28	Good
8	O_3	-41.25	Good	-93.75	Good	-56.25	Good	-93.75	Good

Sources: Field Survey, (2020).

`In comparing the Air Quality Index (AQI) among different land use types, within Port Harcourt Metropolis, during the rainy season, using the AQI scale, the parameter results revealed that, H_2S is

Moderate in Residential area, Vary Unhealthy in Industrial area and Hazardous in Road Junctions. NH_3 is Hazardous in Commercial area. NO_2 is Moderate in Residential area. While other gases are Good among different land use types.

Table: 4.5: Comparing AQI value and level of health concern between Dry season and Rainy season, among different land use types in Port Harcourt Metropolis, Rivers State Nigeria.

S/N	Parameters	Dry Season			Rainy Season		
	Pollutants	AQ1 value Recorded	Level of Health concerns	Colour	AQ1 value Recorded	Level of Health concerns	Colour
1	PM 2.5	89.5	Moderate	Yellow	-49	Good	**Green**
2	PM 10	628	Hazardous	**Maroon**	-42.75	Good	**Green**
3	CO	-89.98	Good	**Green**	-90.76	Good	**Green**
4	H_2S	1,434	Hazardous	**Maroon**	150.84	Unhealthy	**Red**
5	NH_3	25	Good	**Green**	78.13	Moderate	**Yellow**
6	SO_2	-100	Good	**Green**	-75	Good	**Green**
7	NO_2	472	Hazardous	**Maroon**	25.5	Good	**Green**
8	O_3	34.38	Good	**Green**	-71.25	Good	**Green**

Sources: Field Survey (2020).

$$\text{Average concentration value} = R + C + \frac{Ind + RdJ}{NL}$$

R = Residential AQIV
C = Commercial AQIV
Ind = Industrial AQIV
RdJ = Road Junction AQIV
NL= No of Land use area = 4

Comparing the AQI between the Dry and Rainy season, among the different land use types within Port Harcourt metropolis, the result revealed that, Dry season has a greater negative impact and it is more vulnerable to Human, and Environment. The Analysis also revealed that, there is higher-level concentration of pollution in the air during the dry season than the rainy season. In Dry season, PM 10 recorded 628 ppm, (Hazardous) H_2O recorded 434 (Hazardous) and NO_2 recorded 472 (Hazardous) and PM 2.5 recorded 89.5 (Moderate but of impact to Human and Environment) while other gases, CO, NH_3, SO_2, and O_3 recorded within the acceptable limit (Good of No impact to Human and the Environment: which is Green).

In rainy season, the pollutant gases recorded within the acceptable limit, which revealed Good (Green) except H_2S which recorded 150.84 ppm Unhealthy (Red) and NH_3 which recorded 78.13ppm moderate (Yellow)

V. CONCLUSION AND RECOMMENDATION

Having examined the air quality in the study area, and compared the Air Quality Index Data among different land use type within Port Harcourt Metropolis Rivers State Nigeria. In addition, compared during the dry season and rainy season, the analysed data has revealed the impact and level of vulnerability between the Dry season and Rainy season. It is categorize as major during the Dry season and minor during the rainy season. The concentration of industries is a major source of air pollutant; some pollutants (PM2.5, PM10, NO_2, NH_3 and H_2S) recorded above the acceptable limit in the studyAreas, when compared with the regulatory bodies. In addition, the health and Environmental concern was also identified base on various pollutant gases.To curtail the danger ahead, policies should be properly enforced and sustained; and a bridging of administrative gap will certainly enhance proper Ambient Air Quality within the study area.

The fact that some human activities has been found to impact negatively on air pollution in the environment, management and harmonious operations of human activities will in turn protect the environment from air pollution in the region.

REFERNCES

[1]. Allen, F. (2017). Dangerous Air Pollution in the City of Port Harcourt. Pambazuka News. Available online:

https://www.pambazuka.org/node/96487 (accessed on 29 July).

[2]. Al-Salem SM, Bouhamrah WS (2006) Ambient Concentrations of Benzene and other VOCs at Typical Industrial Sites in Kuwait and their Cancer Risk Assessment. Research Journal of Chemistry and Environment 10: 42-46.

[3]. American Lung Association: (2020) 'State of the Air despite Progress, 4 in 10 Americans at Risk from Air Pollution. Available online: http://www.lung.org/about-us/media/top-stories/state-of-the-air-2017.html (accessed on 25 July).

[4]. Arslan, S., A. Aybeka and H.C. Ekerbdcer,(2010). Measurement of personal PM_{10}, $PM_{2.5}$ and PM_1 exposures in tractor and combine operations and evaluation of health disturbances of operators. J. Agric. Sci., 16: 104-115.

[5]. Carslaw, D., Beevers, S. Westmoreland, E. Williams, M. Tate, J. Murrells, T. Stedman, J. Li, Y., Grice, S., Kent, A. and I. Tsagatakis (2011). 'Trends in NO_2 and NO_2 emissions and ambient measurements in the UK. Version: 18thJuly 2011'.[online]. Available at https://uk air.defra.gov.uk/assets/documents/reports/cat05/1108251149_110718_AQ0724.

[6]. Centers for Disease Control and Prevention (CDC).(2017). Particle Pollution.Available online: https://www.cdc.gov/air/particulate_matter.html (accessed on 10 August).

[7]. Chen B, Kan H, (2008).Air pollution and population health: a global challenge. EnvironHealthPrev Med [Internet]. 2008 Mar [cited 2017 Feb 13]; 13(2): 94– 101. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2698272.

[8]. Clifford Chuwah, D Santillo, (2017): Air Pollution due to Gas Flaring in Niger Delta: A review of Current state of Knowledge.

[9]. Environmental Impact Assessment. Decree No 86 of (1992).Laws of the Federation of Nigeria. Available online:http://www.nigerialaw.org/Environmental%20Impact%20Assessment%20Decree20No.%2086%201992.htm (accessed on 7 November 2017).

[10]. Environmental Law Research Institute (ELRI) (2017). A Synopsis of Laws and Regulations on the Environment in Nigeria. Available online: http://www.elri-ng.org/newsandrelease2.html (accessed on 4 October).

[11]. EPA (2014) Air Quality Index (AQI). A guide to air quality and your health.US Environmental Protection Agency Office of Air Quality Planning and Standards Outreach and Information Division Research Triangle Park, North Carolina. EPA-456/F-14-002, pp. 1-12.

[12]. EU, (2008) EU Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on Ambient Air Quality and Cleaner Air for Europe, OJ L 152, 11.6.2008(2008), pp. 1-44.

[13]. Fagbeja M. A., Chatterton T. J., Longhurst J. W. S., Akinyede J. O. &Adegoke J. O. (2008), Air pollution and management in the Niger Delta – emerging issues, WIT Transactions on Ecology and the Environment, Vol 116, ©2008 WIT Press, www.witpress.com, ISSN 1743-3541 (on-line), doi:10.2495/AIR080221.

[14]. Fernándeza, L.C., Alvarezb, R.F., González-Barcalac, F.J and Portald, J.A.R. (2013).Indoor Air Contaminants and Their Impact on Respiratory Pathologies.Archivos de Bronconeumología (English Edition) 49 (1): 22-27. Final_report.pdf (Accessed 30 Jul 2018).43CEN 'EN 14625:2005 Ambient air quality–standard method for the measurement of the concentration of ozone by ultraviolet photometry'. 2005.

[15]. Franklin, M.; Zeka, A.; Schwartz, J. (2007)**.**Association between PM2.5 and All-Cause and Specific-Cause Mortality in 27 U.S. Communities. J. Expo. Sci. Environ. Epidemiol., 17, 279–287.

[16]. FRN,(2011). Official gazette national environmental (non-metallic minerals manufacturing industries sector) regulation. Federal Republic of Nigeria Official Gazette Government Notice No. 134, Vol. 98, May 23, 2011, Lagos, pp: B637-B692.

[17]. Godson, R.E.E.A.; Sridha, M.K.C.Asuzu, C.M. (2010)**.**Environmental Risk Factors and Hospital-Based Cancers in Two Nigerian Cities. J. Public Health Epidemiol., 2, 216–223.

[18]. Henry E. O., Nnamdi H. A, Olusola T., and Adebayo A. O, (2018), Air Pollution Monitoring Around Residential and Transportation Sector Locations in Lagos Mainland, J Health Pollut. 2018 Sep; 8(19): 180903.Published online 2018 Aug 21. doi: 10.5696/2156-9614-8.19.180903, PMCID: PMC6257165, PMID: 30524862.

[19]. Ibe F. C., Opara A. I., Njoku P. C. and Alinnor J. I.(2017),Ambient Air Quality Assessment of Orlu, Southeastern, Nigeria, Journal of Applied Sciences ,Volume 17 (9): 441-457, 2017.

[20]. Isuwa, S. (2008). Nigeria: transportation, major cause of air pollution. Report of the Director General of National Environmental Standards and Regulations Enforcement Agency (NESREA) at a seminar on WHO Air Quality Guidelines. 2008. Online: www.allafrica.com/stories/200804040160.html.

[21]. Kan, H., B. Chen and C. Hong, (2009).Health impact of outdoor air pollution in China: Current knowledge and future research needs. Environ. Health Perspect., 117: A187-A187.

[22]. Kan, H.; London, S.J.; Chen, G.; Zhang, Y.; Song, G.; Zhao, N.; Jiang, L.; Chen, B. (2008). Season, Sex, Age, and Education as Modifiers of the Effects of Outdoor Air Pollution on Daily Mortality in Shanghai, China: The Public Health and Air Pollution in Asia (PAPA) Study. Environ. Health Perspect., 116, 1183–1188.

[23]. National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, (2007).Available online: http://extwprlegs1.fao.org/docs/pdf/nig120569.pdf (accessed on 7 November 2017).

[24]. Niaja.com. (2017).5 Ways to Live Healthy with the Black Soot Pollution in Port Harcourt. Available online: https://www.naij.com/1089333-5-ways-live-healthy-black-soot-pollution-port-harcourt.html (accessed on 28 July).

[25]. Ogba, C.O. and B.P. Utang, 2009.Air pollution climatology in spatial planning for sustainable development in the Niger Delta, Nigeria.Proceedings of the FIG Working Week: Surveyors Key Role in Accelerated Development, May 3-8, 2009, Eilat, Israel.

[26]. Pope, C.A., R.T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, K. Ito and G.D. Thurston, (2002). Lung cancer, cardiopulmonary mortality and long-term exposure to fine particulate air pollution. J. Am. Med. Assoc., 287: 1132-1141.

[27]. Punch. (2017). The Black Soot Plague in Port Harcourt. Available online: http://punchng.com/black-soot-plagueport-harcourt/ (accessed on 25 July).

[28]. Rivers State Ministry of Health. (2011). "Strategic Health Development Plan" (PDF).Archived from the original (PDF) on16 June 2016.Retrieved 4 August 2017 – via Mamaye.org.

[29]. Sengupta, B., (2003). Guidelines for ambient air quality monitoring. National Ambient Air Quality Monitoring Series, Central Pollution Control Board, PariveshBhawan, East Ajun Nagar, Delhi, April 2003.

[30]. The Guardian. (2017) Air Pollution: Rivers Resident Decry Invasion by Black Soot. Available online:https://guardian.ng/sunday-magazine/air-pollution-rivers-resident-decry-invasion-by-black-soot/ (accessed on 11 July).

[31]. The Guardian.(2017). Residents Leave Port Harcourt over Sooth Emission. Available online: https://guardian.ng/features/health/residents-leave-port-harcourt-over-sooth emission/ (accessed on 29 July).

[32]. United States Environmental Protection Agency (USEPA) (2017). Particulate Matter (PM) Pollution: Particulate Matter (PM) Basics. Available online: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics# PM (accessed on 14 August).

[33]. USEPA.,(2016). US National Ambient Air Quality Standards (NAAQS).https://www.epa.gov/criteria-air-pollutants/naaqs-table.

[34]. WHO Regional Office for Europe; (2016) ,Health risk assessment of air pollution: general principles. Copenhagen: (http://www.euro.who.int/__data/assets/pdf_file/0006/298482/Health-risk-assessment-air-pollution-General-principles-en.pdf?ua=1, accessed 17 July 2018).