Journal of Environment Pollution and Human Health, 2018, Vol. 6, No. 1, 20-25
Available online at http://pubs.sciepub.com/jephh/6/1/3

DOI:10.12691/jephh-6-1-3

Seasonal Particulate Pollution in Port Harcourt Nigeria

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Abstract Air quality in Port Harcourt had reached such an alarming level that particulate matter has been observed to be literally falling out of the atmosphere. This has led to outcry from several quarters asking for the situation to be addressed. The problem is that government has not been able to address the fundamental issues involved, namely the sources, the potential impact and how to control the episode. In this regard, the Centre for Occupational Health, Safety and Environment (COHSE) decided to set up a monitoring station. Daily monitoring readings obtained were astronomical. Some of the readings were far above both the Federal Ministry of Environment (FMEnv) and WHO exposure limits. Results reveals that particulate matter especially $PM_{2.5}$ and PM_{10} exceeded the exposure limits set by both FMEnv and WHO by up to 90 per cent. Emission sources are recommended to be regulated.

Keywords: *$PM_{2.5}$ pollution, PM_{10} pollution, particulate pollution, air pollution*

Cite This Article: Happy Abali, "Seasonal Particulate Pollution in Port Harcourt Nigeria." *Journal of Environment Pollution and Human Health*, vol. 6, no. 1 (2018): 20-25. doi: 10.12691/jephh-6-1-3.

1. Introduction

The current soot episode in Port Harcourt and its environs in Rivers State has brought air pollution to the forefront of debate and research. Several groups such as NGOs, regulatory agencies and foreign missions in Nigeria have also expressed their concerns. Port Harcourt is an industrial port city, but in addition to industrial and vehicular air pollution the current soot problem is linked to illegal refineries and some very poorly operated industrial flares and plume stacks.

Air pollution is a concern to many people as it directly influences the quality of human health, especially respiratory problems, heart and lung diseases, and may in extreme cases cause death. Children are at greater risk as they are generally more active outdoors and their lungs are still developing, while elderly people are also sensitive to some serious types of air pollution [2].

The change in atmospheric concentration of any pollutant is affected by source strength or emission rate and meteorological factors such as rain, sunlight, geography, cloud cover, moisture, and weather patterns. The elevated levels of particulate matter settling on Port Harcourt has been obvious even to the least illiterate as soot is visibly seen dropping from the atmosphere or blown around. The result of this investigation will be compared to Federal Ministry of Environment (FMEnv) Nigeria and the WHO permissible emission standards (Table 1).

Recently the government of Rivers State of Nigeria has set up a task force with the responsibility of finding out the source of the increased particulate matter pollution and curbing it. Membership is drawn from the Department of Petroleum Resources, State Ministry of Environment and House of Assembly but none from the academia.

Table 1. Pollutants exposure limits

Pollutant	Monitoring Duration	FMEnv Limit	WHO Limit
$PM_{2.5}$	1-hour mean	15 $\mu g/m^3$	
	24-hour mean		25 $\mu g/m^3$
	Annual mean		10 $\mu g/m^3$
PM_{10}	1-hour mean	50 $\mu g/m^3$	
	24-hour mean		50 $\mu g/m^3$
	Annual mean		20 $\mu g/m^3$
CO	1-hour mean	5 mg/m^3	
	8-hour mean		55 $\mu g/m^3$
NO_2	1-hour mean	0.5 mg/m^3	
	24-hour mean		200 $\mu g/m^3$
	Annual mean		40 $\mu g/m^3$
SO_2	1-hour mean	0.83 mg/m^3	
	10 minutes mean		500 $\mu g/m^3$
	24-hour mean		20 $\mu g/m^3$

From studies already carried out in the Niger Delta in the last ten years, the critical air pollutants are: sulphur dioxide (SO_2), nitrogen oxide (NO_2), carbon monoxide (CO), ground level ozone (O_3), lead (Pb), fine particles less than 10 micrometres (PM_{10}) and nitric acid (HNO_3). [1]. Table 2 summarizes the effects of these pollutants on human health.

Table 2. Basic pollutants in Niger Delta of Nigeria

Pollutants	Description	Sources	Effect
Particulate Matter	$PM_{2.5}$ and PM_{10}	Residues from burning of hydrocarbons – gas flaring etc	increase respiratory symptoms, aggravate asthma, and cause premature death.
Sulphur Dioxide SO_2	Reactive gas	power plants and smelters.	Aggravates asthma and bronchitis. Cause lung damage. Irritates eyes, nose and throat.
Carbon Monoxide (CO)	Poisonous gas	incomplete combustion from vehicles and gas flaring.	affect mental function, alertness, and worsen cardiovascular diseases. Harmful even in low concentrations.
Nitrogen Dioxide (NO_2)	Reactive gas. Part of smog formation	Vehicles and power plants, gas flaring	Respiratory illness (short term). Lowers resistance to respiratory infection (long term).
Ozone (O_3)	Reactive gas. Main chemical in smog formation	Sunlight reacting with exhaust from motor vehicles and refineries	significantly decrease lung function, increase respiratory symptoms, aggravate asthma

2. Materials and Methods

2.1. Study Area

Port Harcourt the erstwhile garden city of Nigeria is the capital of Rivers State of Nigeria. Its geographical coordinates are 4° 47' 21" North, 6° 59' 55" East. Port Harcourt is the capital and largest city of Rivers State, Nigeria. It lies along the Bonny River and is located in the heart of the Niger Delta. As of 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006

With the discovery of crude oil in commercial quantities in 1956 at a place called Oloibiri. This turned Port Harcourt's economy into petroleum when the first shipment of Nigerian crude oil was exported through the city in 1958. By the benefits of the Nigerian petroleum industry, the city further developed, with aspects of modernization and industrialization. Multinational Oil companies that currently have offices in Port Harcourt include Royal Dutch Shell, Total, Agip, Chevron and others.

With the activities of these firms involving gas flaring, including nefarious activities of hoodlums engaged in illegal refining nearby along the Bonny River creeks with crude technology comes a peak in particulate pollution.

2.2. Monitoring Location

The monitoring location was 'Mgbuoba' in Port Harcourt as indicated on the map (Figure 1).

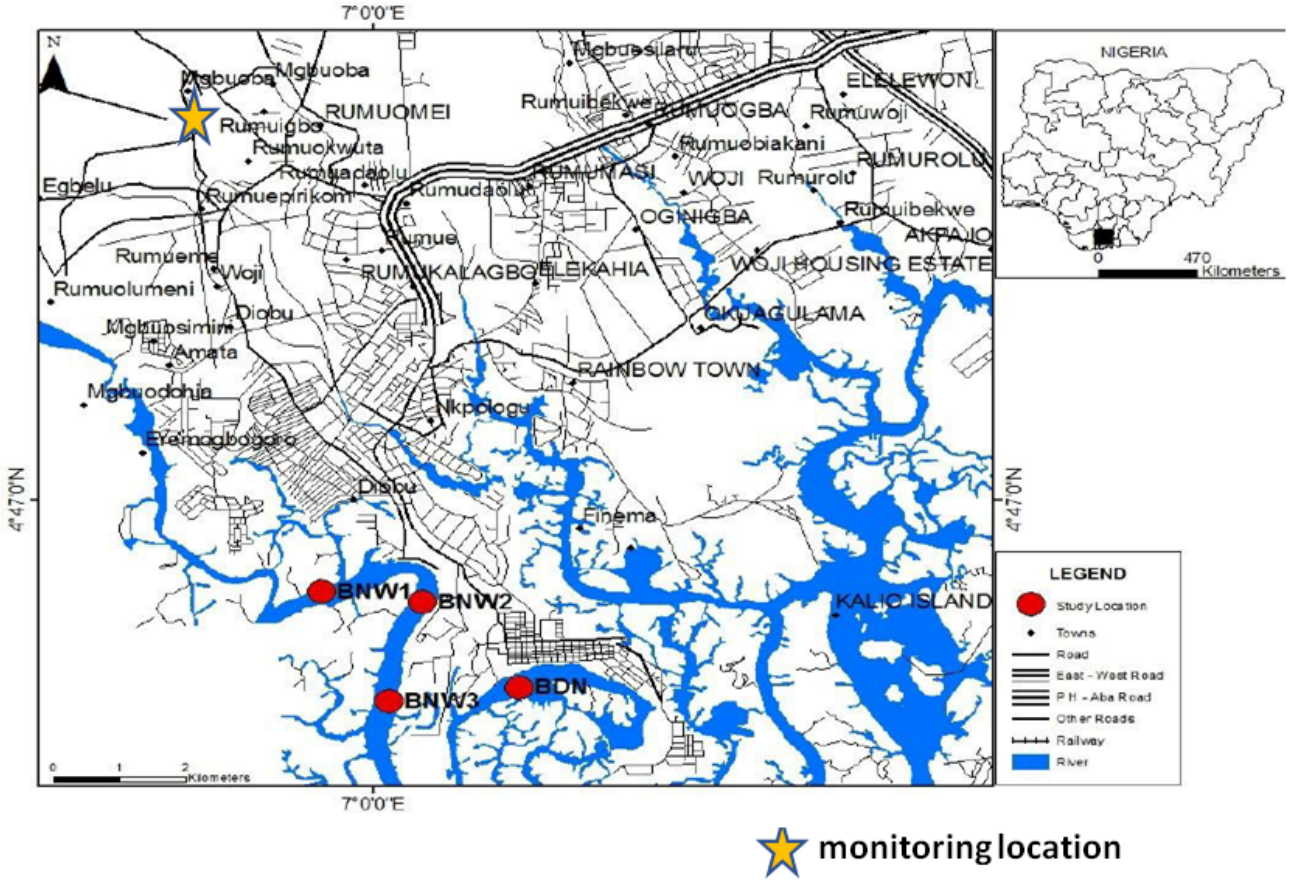

Figure 1. Map of Port Harcourt showing particulate monitoring location

2.3. Equipment Used

1. Davies Vue weather station to measure parameters mounted at 10m high
2. Garmin model 64S GPRS for station identification
3. CW-Hat 200S Particulate Monitor - For hourly monitoring of $PM_{2.5}$ and PM_{10} particulate matter
4. AMSTAT USA Multifunctional Environmental Meter - For hourly monitoring of Temperature, humidity and wind speed.

2.4. Procedure

Levels of particulate matter $PM_{2.5}$ and PM_{10} including meteorological data (temperature, humidity and wind speed). Observations continued throughout the day from January 4, 2017 till the last day in September 2017. This cover the dry and wet seasons.

3. Results and Discussions

Results presented in this paper cover January to February that represents the dry season and May data that represents wet season in Nigeria.

3.1. Humidity and Temperature

The results of the particulate matter and meteorological parameters are plotted in Figure 2. Relative humidity and temperature tend to have minimal effect on particulate matter concentration.

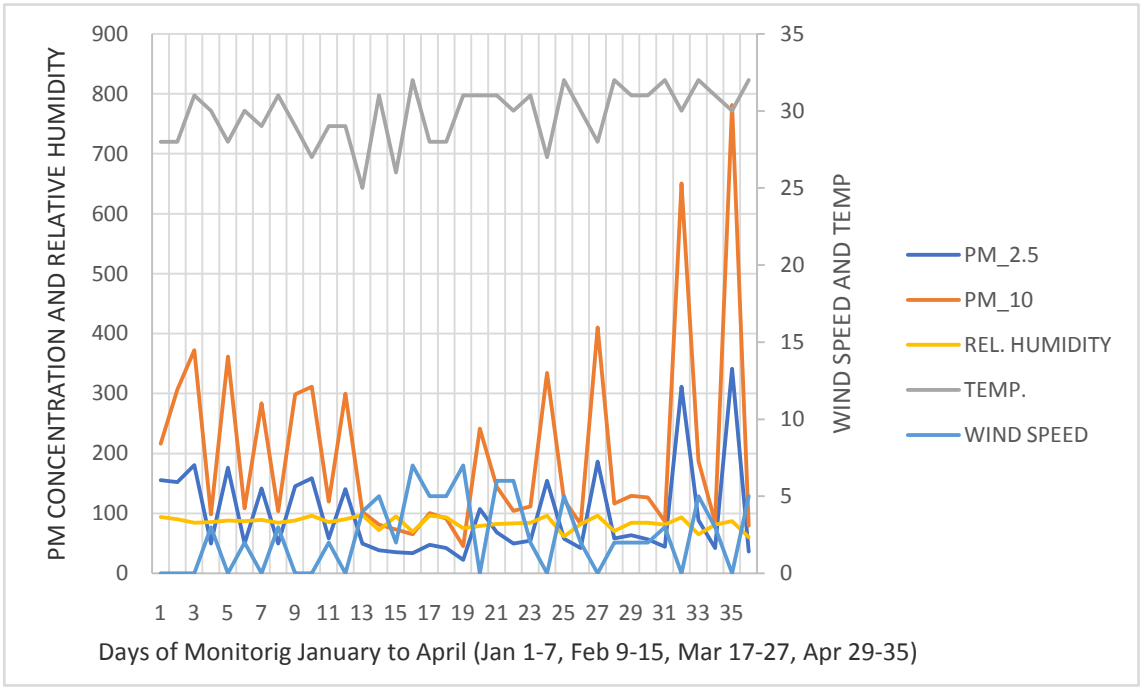

Figure 2. Dry Season Particulate Matter Concentration in Port Harcourt

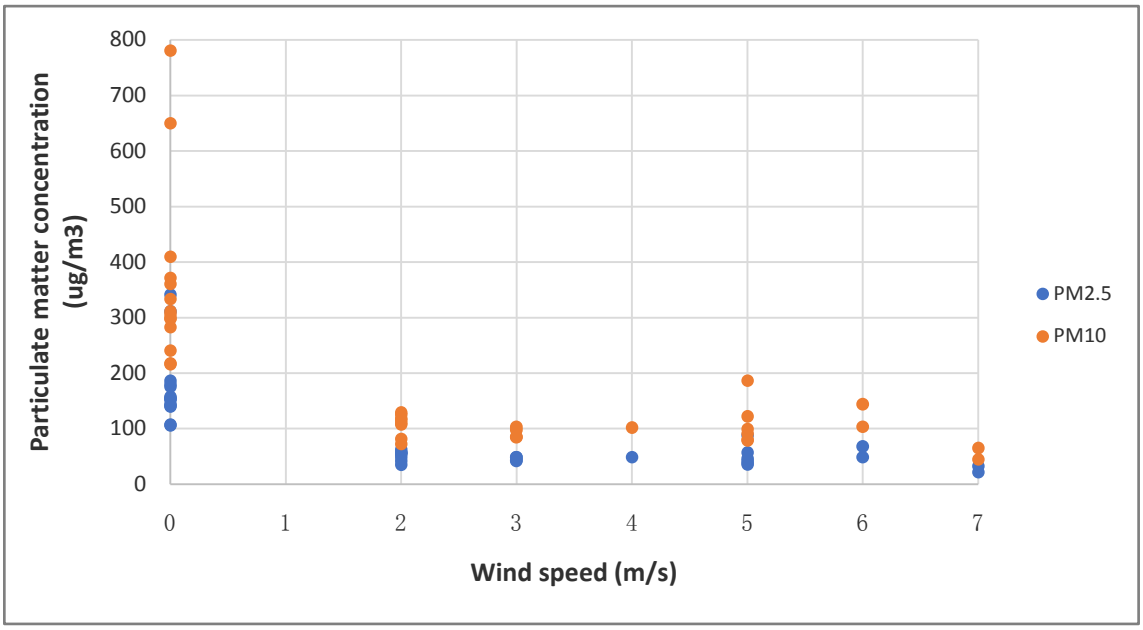

Figure 3. Wind speed effect on PM concentration (dry season)

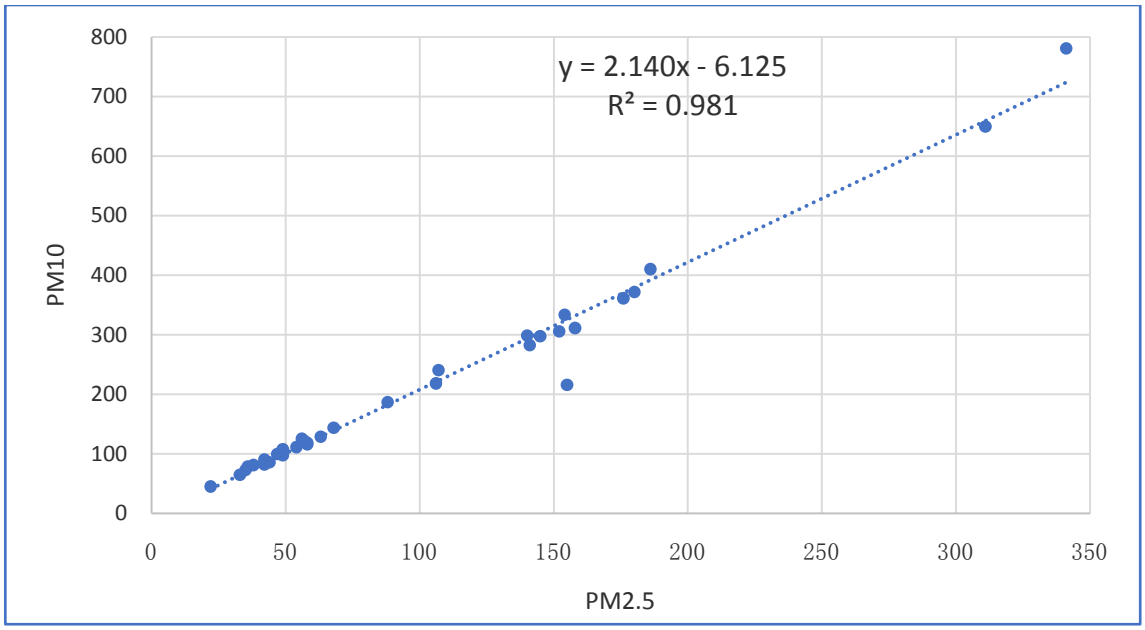

Figure 4. Relationship between $PM_{2.5}$ and PM_{10} concentration

3.2. Wind Speed

The effect of wind on particulate matter distribution is shown in Figure 3 for the dry season. Both the $PM_{2.5}$ and PM_{10} peaked during calm periods (0 m/s wind speed). Thus, the effect of wind dispersion on particulate pollution is strongly at work in this situation. In Figure 4, the concentration of $PM_{2.5}$ went up to 341 µg/m^3 and PM_{10} was at a concentration level of 781 µg/m^3 at 3.32am on Monday February 13, 2017 when the wind was 0 m/s. $PM_{2.5}$ however was at a concentration level of 22 µg/m^3 and PM_{10} was 45 µg/m^3 at 11.57am on Thursday January 26, 2017.

3.3. Relationship between $PM_{2.5}$ and PM_{10}

The relationship is shown in Figure 4 from which a strong correlation was established with a R^2 = 0.98. with the observations in this study and others on particulate concentration due to oil activities in the Niger Delta region of Nigeria, $PM_{2.5}$ is approximately 50 percent of PM_{10} in ratio of 2.2 to 1.

3.4. Particulate Distribution

Percentage distribution of $PM_{2.5}$ and PM_{10} of particulate concentration levels are shown in Figure 5 and Figure 6 respectively. Figure 5a demonstrates that over 70% of the $PM_{2.5}$ particles are of the range 20 to 170 $\mu g/m^3$ while Figure 5b shows that over 60% of the $PM_{2.5}$ particles exceeded 50 $\mu g/m^3$.

Figure 6 shows that 70% of the PM_{10} particles monitored were in the range 70 to 310 $\mu g/m^3$.

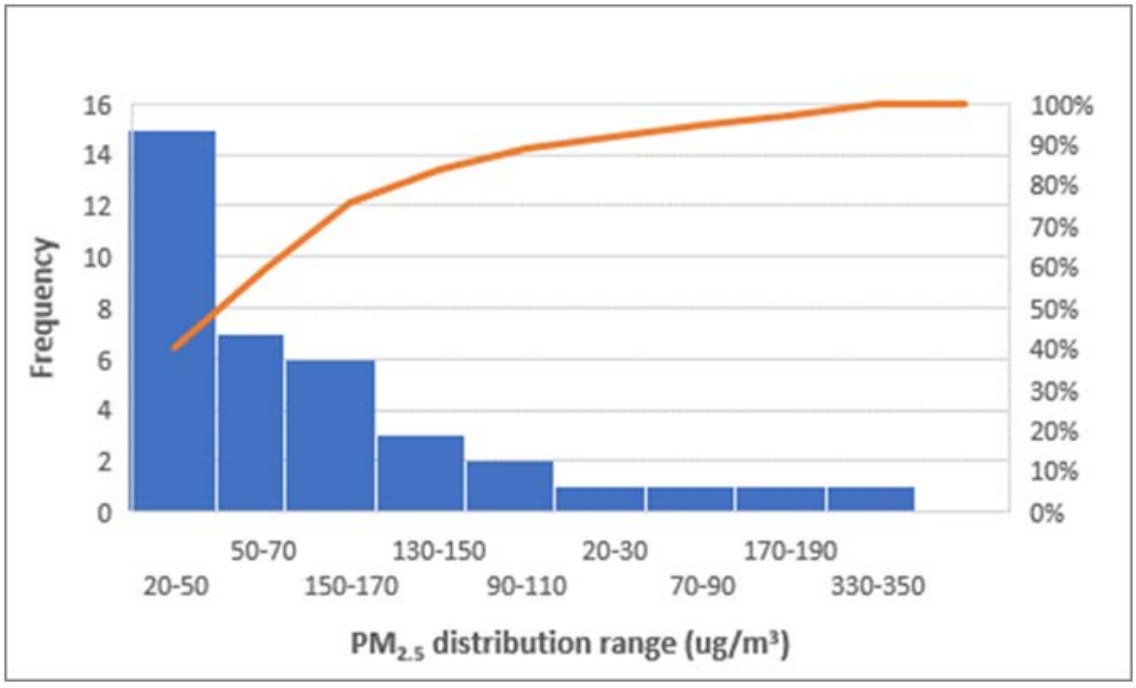

Figure 5a. $PM_{2.5}$ Distribution (dry season)

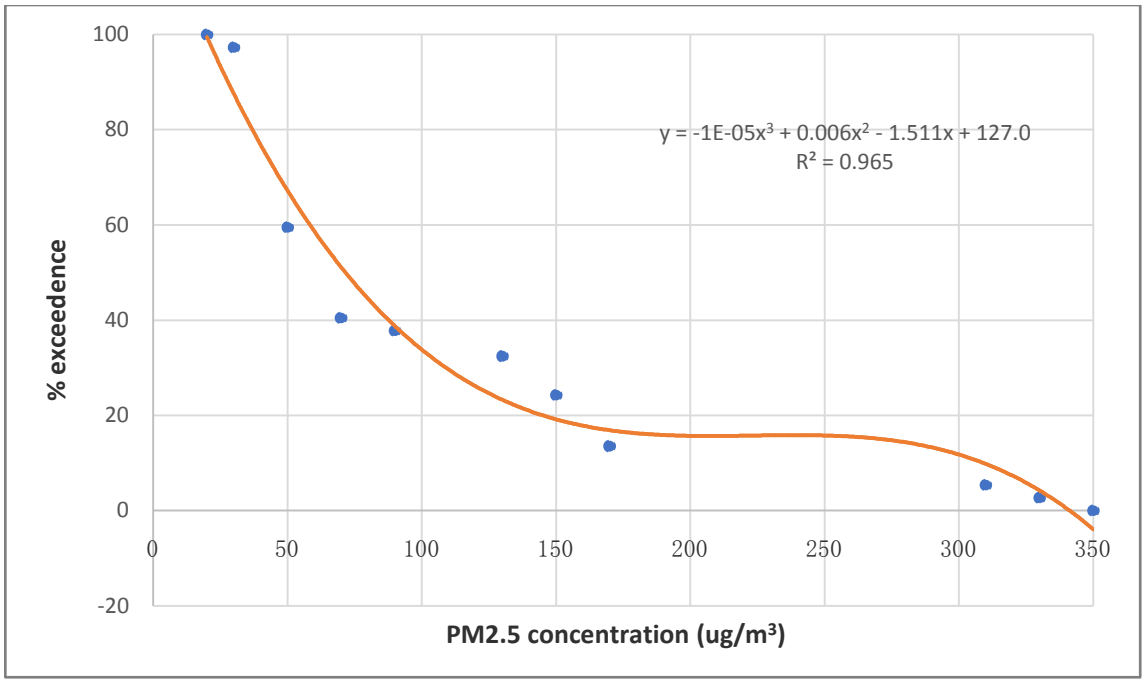

Figure 5b. PM2.5 Percentage Exceedance (dry season)

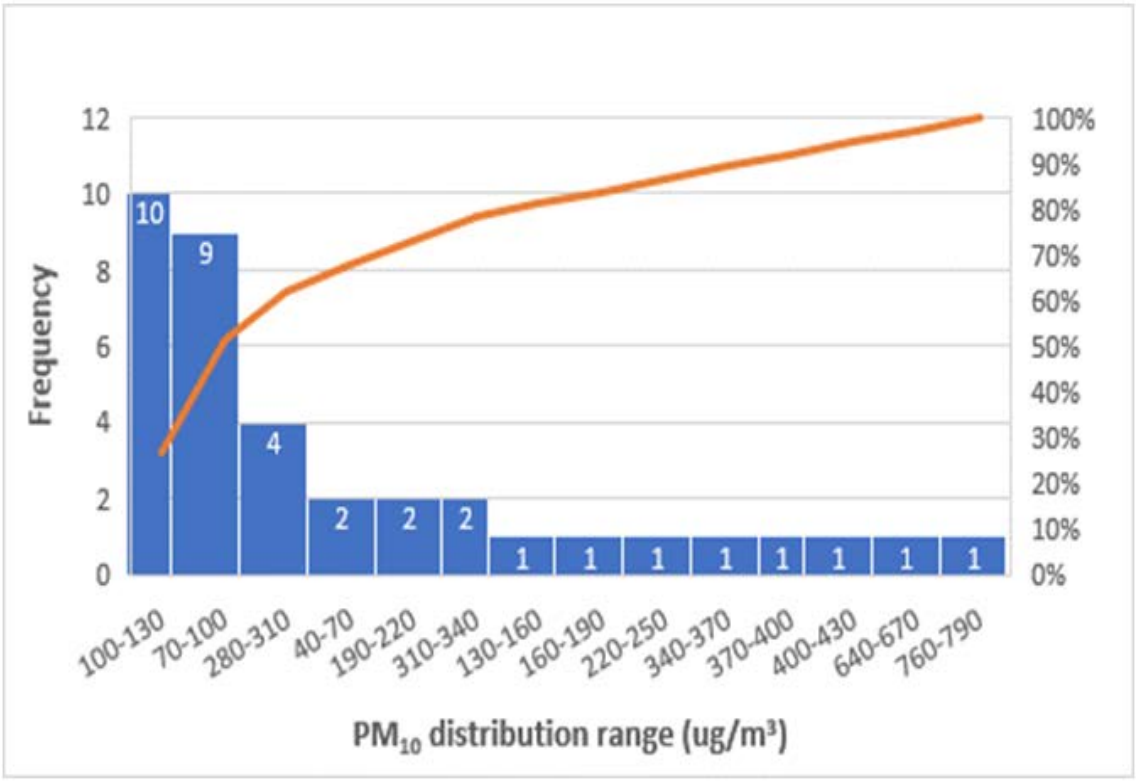

Figure 6. PM_{10} Distribution (dry season)

3.5. Wet Season Particulate Levels

The high particulate pollution levels observed during the dry season started to decline as the rainy season sets in (Figure 7). In May the highest observed daily reading are $PM_{2.5}$ - 28µg/m^3 and PM_{10} - 69µg/m^3 and because the rains scrub the air of particulate matter and other pollutants readings of $PM_{2.5}$ < 20µg/m^3 and PM_{10} < 50µg/m^3 are predominant Table 2. The level of particulate matter is expected to continue to drop in subsequent months of the rainy season. This downwash of pollutants by rainfall may result in secondary pollutant(s) polluting water bodies and soil. This is the case with NO_2 which forms HNO_3 that acidifies surface water, soil and soil water.

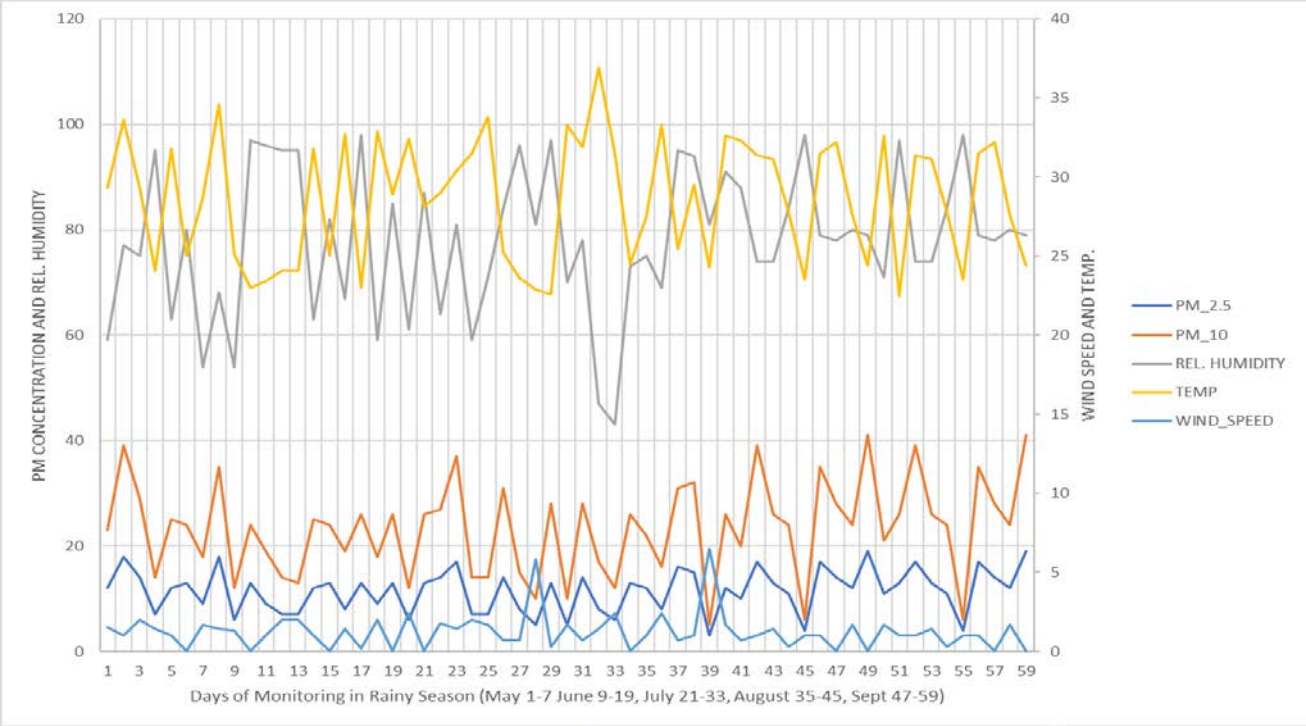

Figure 7. Rainy Season Particulate Matter Concentration in Port Harcourt

4. Conclusion

Nigerian cities are developing fast and experience the problems of development. Air pollution is a major problem of development. We should see our problems as such that has to do with development. The cooperation of all, corporate and private individuals is solicited for a healthy environment to rid the environment of this dangerous inhalable and respirable particulate matter.

References

[1] Abali, H. "Assessment of some pollutants from gas flaring in Ogba/Egbema/Ndoni Local Government Area of Rivers State", M.Sc Thesis, Centre for Occupational Health, Safety and Environment, University of Port Harcourt, Nigeria. 2015. (unpublished).

[2] Wahid, H; "Neural Network-based Metamodelling Approach for Estimation of Air Pollutant Profiles." A dissertation work for PhD submitted to Faculty of Engineering, University of Technology, Sydney, Australia. 2013.

[3] Abali, H.W; Environmental Monitoring and Modelling of Particulate Matter at Idu and Environs, Rivers State of Nigeria. A dissertation work for PhD in Environmental Technology and Management of the Centre of Occupational Health, Safety and Environment, University of Port Harcourt. 2018 (unpublished).

[4] Abali, H. W; Port Harcourt Air Pollution. A paper presented to the Rivers State Government on air quality of the city of Port Harcourt. 2017.

[5] Abril, G. A; Diez S. C.; Pignata M. L.; Britch J. "Particulate matter concentrations originating from industrial and urban sources: Validation of atmospheric dispersion modelling results" *Elsevier. Atmospheric Pollution Research Journal*.2015.

[6] Anyanime, A. O. "Environmental Sustainability: Assessing the Impact of Air Pollutants Due to Gas Flaring - Qua Iboe Estuary Case" *World Journal of Environmental Engineering* Vol. 4, No. 1; pp 1-5. 2016.

[7] Ite, Aniefiok E and Udoh J. Ibok. "Gas flaring and Venting Associated with Petroleum Exploration and Production in the Nigeria's Niger Delta" *American Journal of Environmental Protection* 1.4 (2013): 70-77.

[8] Mishra V. Health Effects of Air Pollution. Population-Environment Research Network (PERN) Cyberseminar. www.populationenvironmentresearch.org. 2003.

[9] Nwaogazie I. L; Abali H. W; and Henshaw T. Assessment of Standard Pollutants in a Gas Flaring Region: A Case of Ogba/Egbema/Ndoni Local Government Area in Rivers State of Nigeria. *International Journal of Civil Engineering & Technology (IJCIET). Volume:7, Issue:3, Pages: 7-17*. 2016.

[10] Pal Arya S. "Air Pollution, Meteorology And Dispersion" *Oxford University Press*, New York. 2000.

[11] Querol X., A. Alastuey, S. Rodríguez, M. M. Viana, B. Artiñano, P. Salvador, E. Mantilla, S. García do Santos, R. Fernyez Patier, J.de la Rosa, A. Sanchez dela Campa and M.Menéndez. "Levels of PM in rural, urban and industrial sites in Spain" *Sci. Tot. Environ. Pp 334-335, 359-376*, 2004.

[12] Samia Fathy Hamed Esmail. Assessment of Concentration of Air Pollutants using Analytical and Numerical Solutions of The Atmospheric Dffusion Equation. A Thesis Submitted to Faculty of Science, Zagazig University for the Degree of Doctor of Philosophy in Mathematics. 2011.

[13] Yang Li; Quanliang Chen; Hujia Zhao; Lin Wang and Ran Tao. 2015. "Variations in PM_{10}, $PM_{2.5}$ and PM_1 in an Urban Area of the Sichuan Basin and their Relation to Meteorological factors" *Atmosphere Journal* 2015, 6, 150-163.