THE PORT HARCOURT 'BLACK SOOT' PHENOMENON: CAUSES AND EFFECTS ON PUBLIC HEALTH AND ENVIRONMENT.

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1.0 Introduction.

'Then Abraham looked down on the City and saw dense smoke over the city, like smoke from the furnace… and so was Sodom and Gomorrah destroyed …Gen. 9:28

The continuous deterioration in Air quality in the Port Harcourt metropolis during the past 2 years have caused a lot of public outcry and anxiety. There is the regularly observed intense carbonised aerosols generally referred to as 'black soot', resulting from a myriad of sources and descending on the city as dry deposition. This dry deposition phenomenon of black soot over Port Harcourt and surrounding towns was most evident during the dry season of December, 2016 to April, 2017. The soot consists of aerosols, which are tiny particulate matter whose granulometric dimensions range from sub-micron diameters to about 10 microns and greater in size. They are suspended in the lower troposphere, inhibiting cloud formation and capable of causing long term environmental and health hazards to residents in Port Harcourt and environs.

The ubiquitous presence of the soot constitute hazards of air pollution and thus have appreciable effects on air quality, visibility and ultimately exacerbates the changing climate impacts in the Port Harcourt metropolis and the surrounding communities in the region. Most coastal communities contiguous to the artisanal refineries whose activities generate the most part of this air pollution dilemma are constantly 'fumigated'; experiencing continuous showers of soot deposits, enveloping every sphere their blackened daily existence.

Plate 1.1: Disasters of the artisanal refining industry: A boat carrying crude oil ablaze on the Bodo Creek.

1.1 Air Quality in Port Harcourt Metropolis

Air, a non-visible form of matter is one of the most important of earth's resources without which life cannot exist on the planet. It is however, a sink into which gaseous and particulate matter from anthropogenic and other natural sources are released. Air becomes polluted when it carries gaseous and particulate matter at levels at which they become objectionable; capable of causing discomfort or harm to man or his amenities. The quality of air in the Port Harcourt metropolis and surrounding towns, as well as other parts of the Niger Delta have been studied by various scholars, who rank the region's air quality amongst the top 10 most polluted regions in the world (Oyegun, 2016; Weli, 2014; Kuenzer, et al, 2014; Sokari, 2016; UNDP, 2004; Oyekunle, 1999).

Air Pollution is the introduction of contaminants into the natural environment that can cause adverse changes in the environment. It is characterised by an increase in the oxidizing capacity of the atmosphere, reduced atmospheric visibility, and the deterioration of air quality in a region (Wang, et al; 2014). It significantly influences the climate, living environment, and human health (Ilten and Selici, 2007; Zhang, et al; 2011).

In recent times, cases of dry deposition contamination otherwise known as 'black soot' have been reported in many parts of Port Harcourt and the state at large at unusual levels; causing discomfort, respiratory ailments and aesthetic concerns. Amenities left unattended for a few days are often coated in thick soot, increasing the cost of maintaining clean and healthy households. These particulates are most often acidic, and not only alter the pH of soils and water bodies but also cause rapid deterioration of physical amenities, such as the corrosion of roofing sheets, other metallic structures and even cars. They constitute health hazards to humans when inhaled, causing respiratory ailments, especially for infants, the aged and those with heart diseases. Tawari and Abowei (2012) observed that the operations of the oil industry as well as biomass combustion and traffic emissions release a barrage of substances like volatile organic compounds, oxides of carbon, nitrogen, sulphur, dioxins, furans, heavy metals, particulate matter and other toxins at levels that most times exceed national and international limits.

2.0 Characterisation of the Pollutant Load in the Air within Port Harcourt and Surrounding Areas.

The main change in atmospheric composition is primarily due to the combustion of fossil fuels. Soot is a powder-like form of amorphous carbon, produced during the incomplete combustion of organic matter. Soot particles sampled during the 2016 soot pollution episode were described as black (elemental carbon) to greyish black in different particle size ranges. Gas-phase soot contains polycyclic aromatic hydrocarbons (PAHs). The PAHs in soot are known mutagens and are classified as a "known human carcinogen" by the International Agency for Research on Cancer (IARC). In our day-to-day life we are exposed to different kinds of pollutants, which compromise our state of health and wellbeing.

Results from the investigations into the composition of the pollutant load within the air in Port Harcourt revealed the following:

Pollutant Type	Concentration	Allowable Limits (μg/m^3) (WHO/EPA)
PM2.5 & PM10	**0.035-396.8 (**μg/m^3)	**10 & 25** (Annual and 24Hr Means)
Lead (Pb)	**<0.01-1.17 (mg/Kg)**	**0.5** (μg/m^3)
Nickel (Ni)	**<0.01-0.15 (mg/Kg)**	**0.5** (μg/m^3)
Cobalt (Co)	**<0.01-0.07 (mg/Kg)**	**0.5** (μg/m^3)
PAHs	**44 – 190** (ng/m^3)	**1** (ng/m^3)
TPH	**16.2 – 96.0 (mg/Kg)**	

From the foregoing, the particulate load over Port Harcourt during the 'Black Soot' incidents revealed that the concentration of the particulate matter ranges from 16.6-360 μg/m^3, 62-270 μg/m^3 & 0.035-180 μg/m^3, (SPDC, 2017; RSME, 2017; Ede & Edokpa, 2017) respectively. Thus, the particulate matter within the lower reaches of the boundary layer over the Port Harcourt region exceeds the national limits of 40-60 μg/m^3 and also WHO limits of 10-25 μg/m^3 for suspended particulate matter and black smoke. The authors posit that laboratory analyses of the particulate matter in Port Harcourt reveal them to be of petroleum combustion origin.

Burning fossil fuels releases gases and chemicals into the air in an especially destructive feedback loop. Air pollution not only contributes to climate change but is also exacerbated by it. The introduction of carbon dioxide and other greenhouse gases which are by-products of combustion raises the earth's temperature or rather increases heat. This increasing warmer weather facilitates smog formation due to atmospheric chain reactions in the presence of more ultraviolet radiation.

2.1 Characterisation of Products of Petroleum Hydrocarbon Combustion.

The primary combustion products of crude oil are CO_2 and water. In addition, dense black smoke, primarily composed of elemental carbon (soot) is produced. The soot is often sorbed (coated) by condensed organic compounds, sulphates and pre-existing particles, such as soil dust and/or sea salts. Other gaseous pollutants resulting from the combustion are CO, NO_X, SO_2, PAHs, VOCs found in the vapour phase of the smoke. Chemical reactions within the smoke plume and atmosphere produce secondary ground level ozone (O_3). Combustion of PAHs produce more toxic higher molecular weight organic compounds.

Health concerns arise due to the potentially high concentrations of inhalable and respirable particles and toxic gases from the combustion of petroleum hydrocarbons. PAHs are carcinogenic. Another potentially deleterious effect of the combustion of petroleum hydrocarbons is the reduction in atmospheric visibility. The smoke contains high concentrations of Condensation Nuclei (CN), which are often hydrophobic in nature, and only a small percentage may be active as Cloud Condensation Nuclei (CCN) (Hallet, et al; 1989; Hudson et al; 1991).

Plate 2.1 : Noxious fumes emanating from the burning of crude oil along a breached pipeline

2.2 Pollutants and Sources of emission

The causes and mechanisms of air pollution are quite variable; however, the distribution of pollution sources, air temperature, pressure, wind speed and direction, relative humidity and the boundary layer structure determine the intensity of air pollution within the city. Air pollutants are emitted at low (ground) levels or High levels. Low level emitting sources include the hundreds of artisanal refineries situate in communities in the state and their destruction by security forces, vehicular emissions, and all other combustion sources such as asphalt plants, tyre burning operations, abattoir combustion of animal hides and skin, etc which situate at or close to ground level (0-10m); While High level emitters include numerous gas flare stacks from IOCs. There are about 217 artisanal refineries within coastal communities South of Port Harcourt (Gundlach, 2017); whose distillation of crude oil produce a lot of smoke and particulate matter into the atmosphere.

Model the dispersion of air pollutants over the city reveal the sources of the emissions to be located in localities south of Bakana, Isaka and Buguma; with a trajectory oriented south West- North East over the city of Port Harcourt (Ede & Edokpa, 2017). The authors further argue that the spatial extent of the black soot envelop was between 200-230 Km^2; thus every receptor within the Port Harcourt metropolis was at high risk. The pollutant load observed in the city is higher during the night (post-midnight) than the day time hours. This is due to radiation inversion created by night time radiation of heat energy from the earth’s surface;

air closest to the surface cools faster than overlying layers, effectively trapping this cold parcel of air and also the pollutant load. Furthermore, most artisanal refining activities happen at night, sea breezes transport the aerosols from their coastal locations into the city.

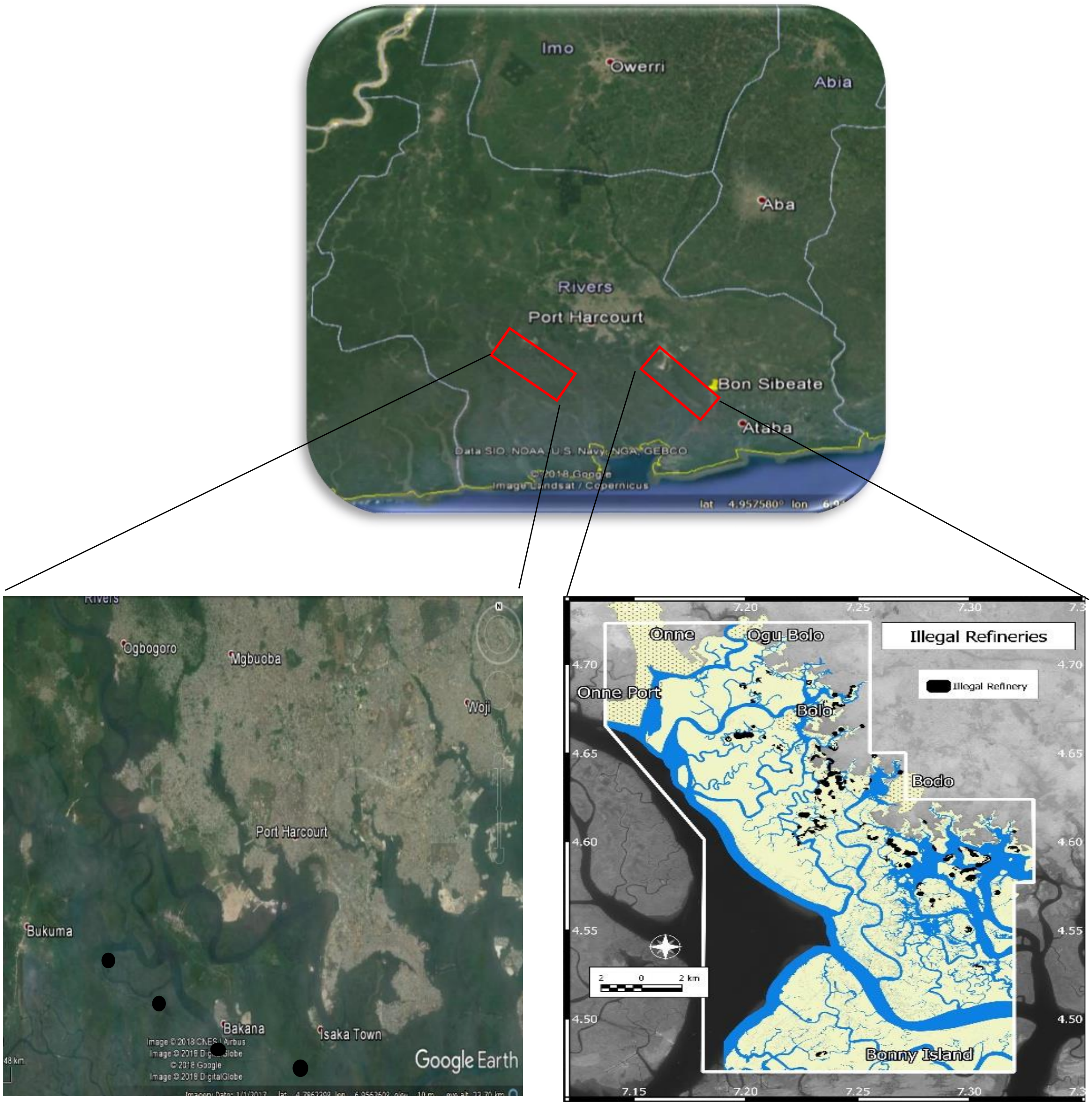

Figure 2.1 : Imagery shows artisanal refinery corridors (black dots) south of Port Harcourt, North of the Bonny River.

Plate 2.2 : Artisanal Refinery (Source: Stakeholder Democracy Network, SDN)

Furthermore, the major categories emission sources in the petroleum industry are as follows:

1. Process Emissions: In petroleum refining and the petrochemical industries, the typical processes that take place include separations, conversions, treating processes such as cracking, reforming, isomerization, etc. The emissions from these processes are typically released from process vents, safety valves releases, sampling points etc.
2. Combustion Emissions: These are generated from the burning of fuels, from stationary combustion sources like furnaces, heaters and steam boilers, flare stacks, etc
3. Fugitive Emissions: These include sudden leaks of vapours from equipment whose sources are mostly valves, pumps and compressors, piping flanges, leaks from seals on equipment.
4. Storage and Handling Emissions: These are emissions emanating from storage facilities and during the loading and unloading of petroleum products.
5. Auxillary emissions: originate from units such as cooling towers, boilers, sulphur recovery units and wastewater treatment units.

2.3 Aerosol diameters and distance of travel

Particulate Matter is a general term used to describe solid particles and liquid droplets found in air. The composition and size of these airborne particles and droplets vary. Some particles are large enough to be seen as dust or dirt, while others can only be seen using powerful microscopes. Two size ranges (PM_{10} and $PM_{2.5}$) are widely monitored; and behave differently in the atmosphere. $PM_{2.5}$ and submicron particles remain airborne for long periods and can travel hundreds of kilometres, while the PM_{10} and coarser particles have shorter residence times within the atmosphere, they are not readily transported for long distances; and so are deposited close to their sources.

Submicron particulates are respirable as they can penetrate the alveoli and enter into the respiro-circulatory system; while the coarser particulates are inhalable, trapped within the lungs and can be periodically coughed out as 'black/dark phlegm'. The concern with the respirable submicron particulate matter is that they have longer residence times in the atmosphere, can penetrate tiny spaces and are carried to longer distances, several tens to hundreds of kilometres. These are the real dangers, and no one is spared.

2.4 Meteorology and Dispersion of Air Pollutants

Meteorological factors such as temperature, humidity, rainfall, wind speed, solar radiation, turbulence and stability are critical in the dispersion and persistence of particulate matter and other gaseous air pollutants. Stability conditions in the atmosphere determines the rate of dispersion of air pollutants. When there are temperature inversions, aerosols form a ceiling as vertical mixing within the boundary layer is limited; wind speeds are reduced and the concentration of particulate matter steadily accumulates. Under these conditions photochemical reactions lead to the formation haze. The occurrence of Haze indicates widespread, long duration, severe and rapid accumulation of high concentration pollutants in the atmosphere (Wang, et al; 2014). Haze pollution have been essentially attributed to pollutants in the lower atmosphere and the favourable meteorological condition at the time of the emissions (Gorai, et al; 2015, Gorka, et al; 2012).

The Atmospheric Boundary Layer (ABL) expands to about 1000m during the day and contracts to about 400m during the night over land. This explains the higher concentration of pollutants over the Port Harcourt metropolis during the night (Ede & Edokpa, 2017; SPDC, 2017, RSME, 2017). As the day breaks and the heat flux created by solar radiation builds, convective energies generate the required turbulence that disperses the accumulated pollutants by afternoon to early evenings. Furthermore, the maritime air masses that are prevalent over the city engenders a moist atmosphere for most parts of the year. Water vapour within the atmosphere provides the envelope that houses air pollutants. It is within this parcel, that other atmospheric reactions taking place give rise to secondary pollutants such as the formation of ground level ozone and other acid wet and dry deposition compounds of sulphur and nitrogen.

2.4.1 Observed Meteorological Parameters

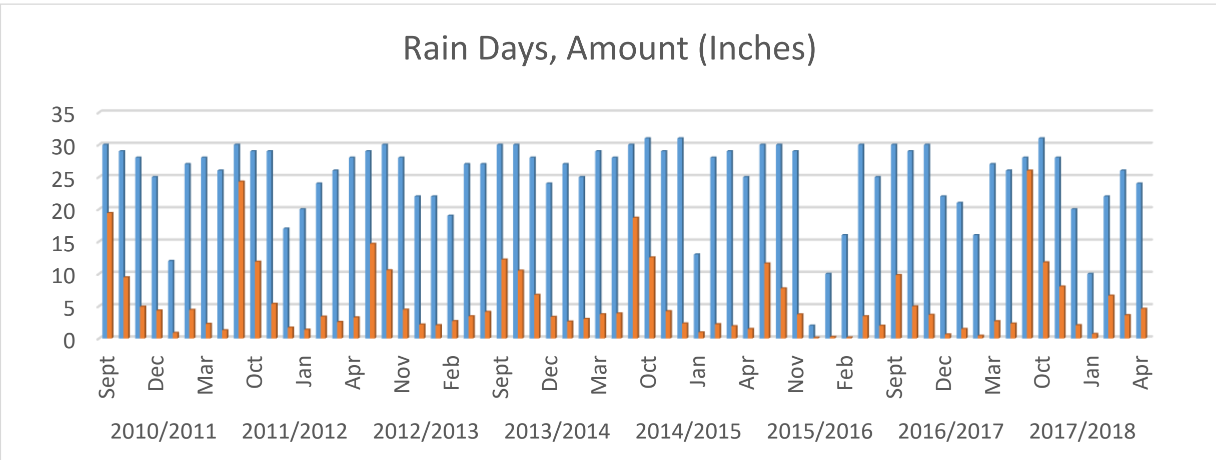

Figure 2.2 Shows the Number of Rain and Amount from Sept-April (2010-2018)

Rainfall and other forms of precipitation scavenges particulate matter and other forms air pollutants from the atmosphere. However, observed meteorological data shown in figure 2.2 above reveal the lowest amount of rainfall and the lowest number of rain days in 2016 (the lowest since 2010), which began from the start of the dry season in November, 2015. This explains the over accumulation of particulate matter in the atmosphere leading to the very high concentrations of the 'black soot' in December 2016 to April 2017. The rainy season in 2017 had relatively more rain days and amount compared to 2016. This explains the lesser amount of 'black soot' experienced during the dry season of 2017-2018.

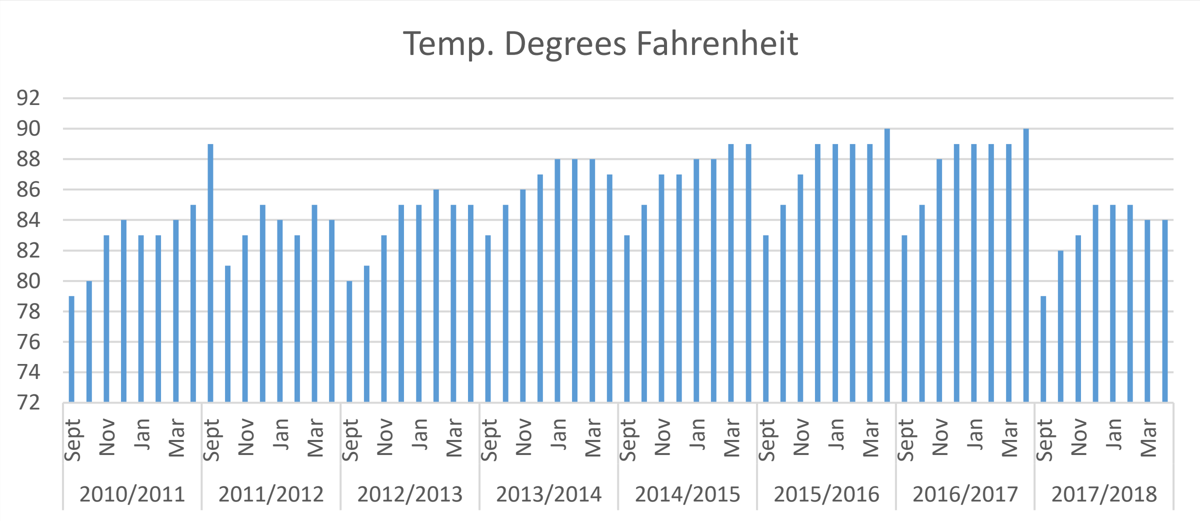

Figure 2.3 shows Mean Monthly Temperature values from September-April 2010-2018.

From the average monthly temperature values from September to April, 2010-2018, the year of the most intense air pollution in times also reveal the year 2016, as the hottest. This is the direct effect of the over accumulation of air pollutants in the atmosphere resulting in the Green House Effect. Thus, the level of discomfort and anxiety was most aggravated during that year; which gave birth to the 'Stop the Soot' campaign and also triggered the initiation of the Port Harcourt City Clean Air Movement.

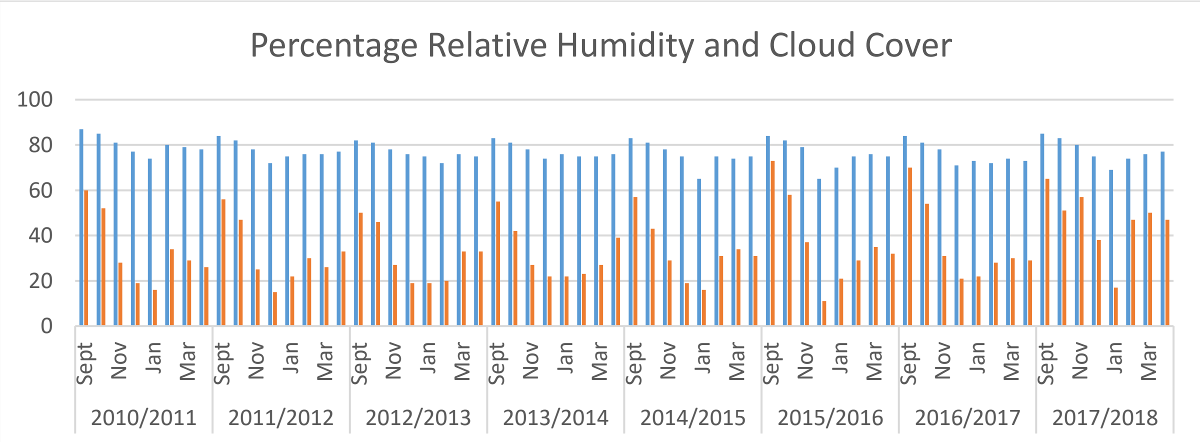

Figure 2.4 shows Average Monthly Cloud Cover and Relative Humidity Values September-April 2010-2018.

Furthermore, during the dry season of 2016-2017, the percentage of Cloud Cover and Relative humidity were also in the lowest range since 2010. The increased concentration of smoke particles in the atmosphere did not conduce to cloud formation, as the condensation nuclei of smoke particles are hydrophobic (Hallet, et al; 1989; Hudson et al; 1991). The whiteness of the sky was occasioned by mie scattering of white light due to the heavy pollutant load of the coarser particulate matter in the atmosphere during the period.

2.5 Dry Deposition and Season Controlled Dispersion:

The preponderance of the 'black soot 'phenomenon in the city especially during the dry season, particularly, between December and April is determined by dynamics of wind flow within the troposphere. The convergence of the continental and maritime air masses over the region in December/March induces a 'doldrum-like' phenomenon, which does not enhance mixing and dispersion of particulates emanating from various combustion sources within the region.

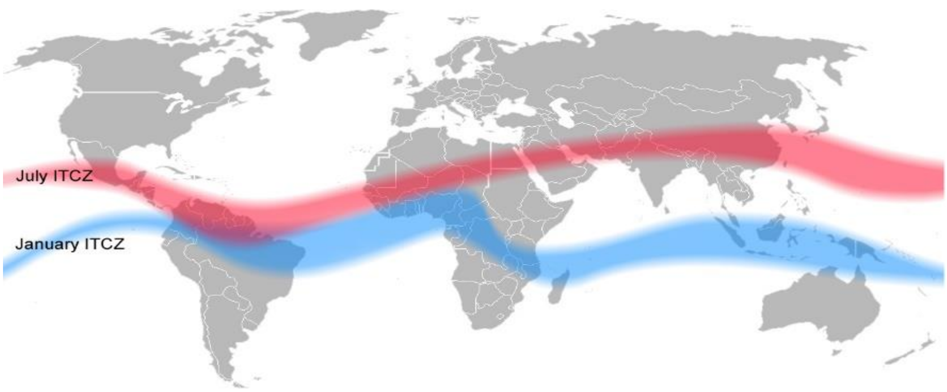

Figure 2.5 shows Inter-Tropical Convergence Zone and the control of air masses and aerosol movement.

Rather it engenders the concentration and descent of these aerosols described as black soot at ground level. More so, the period of December to March coincides with the Peak Dry Season, where precipitation is low; hence, they are not periodically dissolved and washed down in rain water, but have to envelop the air within the lower boundary layer and descend on the city as soot.

Plate 2.3 (a & b) shows combustion of crude oil releasing dense smoke into the atmosphere.

2.6 Gas Flares, Other Combustion Sources of Soot and Acid Deposit

Nigeria flares over 70 million cubic metres of gas daily from its flare stacks, amounting to about 70 million tonnes of carbon dioxide into the environment per day and has thus contributed more greenhouse gas emissions than all other sources in sub-Saharan Africa combined. Similarly, the gas industry statistics publisher, *Cedigaz*, indicates that Nigeria accounted for 19.79% of global gas flaring in 2001, more than Iran and Indonesia combined, making Nigeria the highest gas flaring country in the World (UNDP, 2004). Kuenzer *et al* (2014), using the detection of hot spots in land-sat band data put the number of gas flares in the Niger Delta at 167 with a large proportion of them situated within the sensitive mangrove ecosystem of the Niger Delta. Black soot associated with gas flares cover vegetation and other land-use adjoining gas flare points.

Plate 2.4 (a, b & c) Show Gas flare in the Niger Delta and NASA Satellite Imagery of the Delta at night showing gas flares. Source: *Curse of the Black Gold: 50 Years of Oil in the Niger Delta*

Gas flares and other combustion sources release greenhouse gases of carbon dioxide (CO_2) methane (NH_4) and nitrous oxide (N_2O) which contribute significantly to global warming. Furthermore, the high concentration of volatile oxides of carbon, nitrogen and sulphur released into the air mix with rain water to form acid rain and ultimately increases the acidity of the soils which is deleterious to crops. Uyigue and Agho (2007) have posited that the incidence of acid rain is higher in the Niger Delta in comparison with areas further afield.

Plate 2.5(a & b) shows various combustion sources contributing the pollutant load to the air.

2.7 The Sources of The Black Soot Resulting in The Formation of Haze in The City

Emissions from asphalt plants, combustion of fossil fuels and tyres, vehicular emissions, etc releases gases and chemicals into the air in an especially destructive feedback loop. The introduction of carbon dioxide and other greenhouse gases which are by-products of combustion raises the earth's temperature or rather increases heat. Air pollution not only contributes to climate change but is also exacerbated by it. This increasing warmer weather facilitates smog formation due to atmospheric chain reactions in the presence more ultraviolet radiation.

Haze is an atmospheric phenomenon in which dust, smoke and other dry particulates obscure the clarity of the sky. Ground level ozone and particulate load in the atmosphere undergoes complex photochemical reactions in the presence of volatile organic compounds (VOC), sulphur dioxide (SO_2) and oxides of nitrogen (NO_X) to form the horizontal obscuration of smog and haze. It is relatively common during temperature inversions when there is rising temperature with height, and wind is calm. The ground level ozone present during these episodes of air pollution inhibits plant growth and poses respiratory hazards to man and animals. This was an everyday experience during the 2016-2017 dry season soot pollution in Port Harcourt.

Winds are the most important factor in the dispersion of air pollutants. However, Urban Heat Islands created in the city due to radiation from concrete bricks, buildings, pavements and other anthropogenic sources sets up self-contained circulatory patterns; forming a haze-hood from which pollutants cannot escape. This results in the pall of aerosols that covered the skies of Port Harcourt metropolis

Plate 2.6 shows ground level haze and smog within Port Harcourt Metropolis during the soot invasion.

2.8 The Implications of this observed phenomenon:

The implication of the situation is quite varied and can be expressed in the following scenarios: (i) Ecological damage to plants (crops) through deposition of oxides of carbon, nitrogen, sulphur and volatile organic compounds in the aerosols on plant leaves, acidification of soils and water bodies. This will ultimately lead to poor crop/fruit yields, fish catches, dwindling agricultural productivity and livelihoods. (ii) Increased Health Hazards expressed as heightened respiratory diseases especially in children and the elderly, and the risk of developing mutations, carcinogenesis in the long term and teratogenic possibilities in developing foetuses, as a result of constant inhalation of these carbonised aerosols (iii) Rapid deterioration of amenities such as car chassis, roofing sheets and other metallic and non-metallic materials. (iv) Increased cost of house care as constant cleaning and washing of household ware is required. (v) Reduction in the Aesthetic value of our surroundings, due to the deposition of the black soot on all surfaces. (vi) Black rains!

3.0 The Effects of Air Pollution on Human Health.

Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs. The health hazards range from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks. Short and long term exposures have been linked with premature mortality and reduced life expectancy. Air pollutants have been identified as causes of increasing mortality or serious illness. They pose a present and/or potential hazard to human health; based on clinical, epidemiological, and/or animal studies which demonstrate that exposures to these pollutants are associated with health effects (Kampa & Castanas, 2007).

Ndubisi and Asia (2007) stated that gas flares cause respiratory disorders in man leading to kidney and neurological disorders. Poisonous chemicals associated with gas flares include nitrogen dioxide (NO_2), sulphur dioxide (SO_2), volatile organic compounds (VOC) like benzene, toluene, xylene and hydrogen sulphide. Others are carcinogens like benzo (a) pyrene, and dioxins. These chemicals intensify asthma, cause chronic bronchitis and pain. Benzene is well known as a cause of leukaemia and other diseases of the blood system.

Particulate matter load ($PM_{2.5}$ and PM_{10}) during the dry season of 2016/2017 in Port Harcourt was more than 10 times above the maximum allowable limits set by the WHO. The ultra-fine and submicron particulates (<1µm) are particularly more toxic than the coarse grade particles (>10 µm). They are capable of penetrating the alveoli and enter into circulatory system where they may be deposited in the heart and other organs and systems of the body; while the coarser particulates are deposited in the upper respiratory tract. The submicron particulates often exist in association with heavy metal colloids, PAHs and other organic components due to their very large surface area. Once they enter into the circulatory system, they form endotoxins which expresses particulate matter toxicity. Air pollutants are of varying composition; the dose and duration of exposure to these toxins lead to diverse impacts on human health.

Submicron and ultra-fine particulates can also find their way into the human system through ingestion. They are invisible to the human eye, and thus get deposited on exposed food materials and are ingested with food and water. Sporadic air pollution events, like the soot phenomenon in Port Harcourt in 2016, contributes to increased mortality and clinical visits and admissions. Epidemiological and animal studies indicate that besides the primarily affected cardiovascular and respiratory systems; acute and chronic exposures to these cocktails of air pollutants can indicate as nausea, difficulty in breathing, skin irritation, birth defects, serious developmental delays in children, reduced activity of the immune system, leading to a number of other diseases (Cohen, et al., 2005; Huang and Ghio, 2006; Sharma and Agrawal, 2005).

3.1 Effects of Air Pollutants on Different Organs and Systems

Air pollutants exists in various forms, with different chemical compositions. They undergo complex transformations in the atmosphere and vary in reaction properties, emission, persistence in the environment and ability to be transported through long and short distances. Hence, they have been indicated to affect different human or animal organs and systems.

3.1.1 Impact on the Respiratory System:

Acute or chronic exposures to high concentrations of air pollutant cocktails, such as is presently observed in Port Harcourt affects the airways, presenting symptoms of nose and throat irritations, bronchoconstriction and dyspnoea; especially in asthmatics after exposure to increased levels of sulphur dioxide, nitrogen oxides and certain heavy metals such as arsenic, nickel or vanadium. More so, particulate matter that penetrates the alveolar epithelium, initiate lung inflammation, reduces lung function and generally worsens the respiratory conditions of the affected (Balmes, et al., 1987; Kagawa, 1985 Ghio and Huang, 2004).

3.1.2 Impact on the Cardiovascular System

Carbon monoxide binds with haemoglobin modifying its capacity to transfer oxygen. This reduced oxygen availability affects different organs, especially the high oxygen consuming organs such as the brain and the heart; resulting in impaired concentration, slow reflexes and confusion (Badman & Jaffe, 1996). Particulate matter induces systemic inflammatory changes, affecting blood coagulation. Changes in blood clotting obstructs (cardiac) blood vessels, leading to angina or even myocardial infraction; while heavy metal pollution can induce increased blood pressure and anaemia (Riediker, et al., 2004, Vermylen, et al., 2005, Huang and Ghio, 2006).

3.1.3 Impact on the Nervous System

The nervous system is mainly affected by heavy metals (lead, mercury and arsenic) and dioxins. Neurotoxicity leading to neuropathies, with symptoms such as memory disturbances, sleep disorders, anger, fatigue, hand tremors, blurred vision and slurred speech have been observed after arsenic lead, and mercury exposures. Dioxins decease nerve conduction velocity and impaired mental development of children (Ratnaike, 2003; Thomke, et al., 1999).

3.1.4 Impact on the Urinary System

Heavy metals can induce kidney damage such as an initial tubular dysfunction evidenced by an increased excretion of lower molecular weight proteins, which progresses to decreased glomerular filtration rate (GFR). In addition they also risk of stone formation and renal cancer (Jarup, 2003).

3.2 Exposure during Pregnancy

Chronic and Acute exposure of pregnant women to high concentration of air pollutants can affect the developing foetus. Maternal exposure to heavy metals in the air, especially lead, increases the risks of spontaneous abortion reduced foetal growth (pre-term delivery, low birth weight), congenital malformations and impairment in the new-born's cognitive abilities. Dioxins can also be transferred from mother to the foetus through the placenta; disrupting endocrine functions and affecting the growth and development of the central nervous system of the foetus (Wang, et al., 2004; Schell, et al., 2006; Bellinger, 2005; Garza, et al., 2006).

4.0 What to do?

In the face of the prevailing circumstances, we cannot throw up our hands and say 'hoolala'. It calls for immediate action from both government and the citizenry. First, government should institute and enforce the 'Clean Air Act' which safeguards air quality and targets the abatement of air pollution from all sources. There should be deliberate policies at reducing emissions from flare stacks, artisanal refineries, tyre burning, asphalt plants, abattoirs, vehicular emissions and all other combustion sources. Secondly, more in-depth, multi-disciplinary, longer duration studies should be commissioned to characterise the contaminant cocktail within the troposphere, their concentrations at different times of day, month and year, their locations, and their advection/dispersion patterns through the seasons. The constant monitoring of this phenomena will aid in the dissemination of information in the public domain (radio, television and the print media) on the true nature (composition) of the air pollutants, their times of occurrence and mitigation against their occurrence. Public awareness campaigns and advocacy such as the august Port Harcourt Clean Air Summit that will propagate factual, sensible scientific data and not the present conjecture that permeates the entire public domain!

Conclusion: The present air pollution situation in the Port Harcourt metropolis and surrounding towns calls for positive urgent action on the part of government, academia, civil society, corporate organisations, all and sundry. We are all being slowly poisoned, and the consequences will certainly manifest in forms and magnitudes that we have not yet contemplated, far into the future. A continuation of the present levels of air pollution within the city and other parts of the state is a sure recipe for a rapid deterioration in not only the quality of life, but also can lead to a serious compromise in the aesthetics of our surroundings and amenities. We should all rise as one to 'Stop this Soot' and demand cleaner and safe air!

RECOMMENDATIONS:

1. Air Quality Management Authority: There reality of the times we live in imposes it on us/government to establish the AQMA whose primary responsibility should include the development of the ways and means of real time monitoring and documenting the Air Quality Index at various parts of the metropolis
2. Regional Emissions Inventory: Constantly monitors the Sources, Volumes and duration of all emissions within the State/Region as a primary step in air quality management.
3. The academia, industry, civil societies and government should collaborate to tackling the air pollution problem; through broad based research, pollution abatement and emission control.
4. The health sector should be more proactive in investigating and documenting cases of respiratory ailments and respiratory related mortalities; and presenting the statistics of their findings to government and the public domain. They should also communicate an advisory of what to do in times of air pollution emergency such the 2016 episode.
5. Government should take the lead in locating and eradicating all sources of aerosol ('black soot') generation.

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