

Black soot in Port Harcourt: sources and health implications

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By

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Outline

- Media report of the black soot, and public outcry
- The soot
- Possible sources of the soot
- Why Port Harcourt, and that time
- Possible health implications
- Control measures



PORT HARCOURT RESIDENTS WORRIED ABOUT BLACK SOOT



HEADLINES

BUHARI FELICITATES WITH CHRISTIANS AT CHRISTMAS

09:08

Public outcry

- “It has come to the notice of the state government of the sudden appearance of strange black soot deposit noticeably seen on cars and rooftops in our environment especially in Port Harcourt and its environs. The public is hereby advised not to panic as the Ministry of Environment has duly dispatched its officials to different locations in the state to monitor and locate the source of the black soot for prompt action.
- “It is apparently obvious that the state government cannot decontaminate the airspace, but it can put a stop to this pollution if the source of the soot is located. Consequently, the public is hereby urged to complement the effort of the state government by assisting to look for the source of this strange soot.”
 - Press statement of the Rivers State commissioner for Environment

The soot

- The soot is black, and therefore carbon,
 - most probably from the combustion of hydrocarbon
- It is found in the ambient air, and therefore technically called suspended particulate matter (SPM)
- SPM is commonly classified based on their diameter and ability to get into the respiratory tract:
 - Visible smoke that comprise of particles of PM10 size or larger.
 - PM10, particles with a diameter less than 10 microns.
 - PM 2.5, particles with a diameter of less than 2.5 microns; and
 - PM0.1, comprising particles with a diameter less than 0.1 microns

Visible smoke

- The particles of visible smoke are too large to be lodged into the respiratory tract,
 - Are filtered out by the hairs of the nostrils, and do not often go beyond the nostrils; and
 - Are therefore said to be outside the respirable range
- They therefore pose no danger to human health, except to soil the laundry, our feet and nostrils

PM10 particles

- PM10 particles are commonly called coarse SPM particles
- The particles are smaller than those of visible smoke, and are not often visible to the naked eyes in the ambient air, except when they settle on objects
- Most of the particles can get beyond the nostrils, but can't go beyond the trachea or the bronchi, where they are trapped by the mucus
- They therefore do not pose much danger to health beyond the blackened sputum and the ability to trigger off asthmatic attack in susceptible persons
- Fortunately, most of the soot that cause the panic in Port Harcourt are within this diameter

PM 2.5 particles

- PM 2.5 particles are usually called fine particles
- They are very small, and can therefore reach all the way down to the alveoli in the lungs
- They are therefore responsible for most of the health problems associated with the inhalation of SPM
- These particles were not among those they caused the outcry in Port Harcourt,
 - but were produced at the same time as the others,
 - but went unnoticed, because they are mostly invisible and pass unhindered into the lungs

PM 0.1 particles

- A sub-class of PM_{2.5}, comprising of particles with a diameter less than 0.1 microns, and called ultra-fine particles has also been described.
- This class of SPM have the ability not only to reach the alveoli of the lungs, but the bloodstream, and therefore have even more profound health effects.

Possible sources of the soot

- The main sources of hydrocarbon combustion in Port Harcourt are:
 - Motor vehicles
 - Firewood
 - Generators
 - Industries, especially the gas flares of the oil companies
 - Artisanal refining of crude oil
 - Activities of law enforcement agents

Motor vehicles

- The USEPA estimates that motor vehicles (in good condition) generates 1.75g/km of soot
- This is significantly higher in diesel vehicles and old cars with poorer catalytic systems
- The number of motor vehicles in Port Harcourt has increased significantly in recent years,
 - as shown by the parking problem in the State secretariat complex



Firewood

- Firewood is the most commonly used domestic fuel in Rivers State
 - Used for cooking food; and
 - For fish preservation
- It is so used by 63.7% of households in Nigeria, according to the 2013 NDHS
- It is estimated that the 24-hour level of pm_{10} in houses where firewood are used, often exceeds $3,000mg/m^3$;
 - even as the WHO guideline value for PM_{10} is $100mg/m^3$.



Generator

- Generators are known to emit soot more than motor vehicles, because they have poor emission control systems
- The number of generators in Port Harcourt has increased significantly in recent years, because of:
 - Increased affordability (Chinese-built generators, second-hand generators)
 - Deterioration in public electricity supply



Gas flaring

- Oil companies operating in Nigeria flares more gas than any other place in the world,
 - because it is the cheapest way to dispose the associated gas that most oil companies operating in Nigeria are not equipped to utilize.
- These gas flares emit tons of soot into the atmosphere, on a daily basis,
 - because of their low efficiency.



Artisanal refining of crude oil

- This involves stealing crude oil, and distilling it into various petroleum products, using crude refining equipment.
- The distillation process involved in artisanal refining of crude oil in Rivers State results in massive emission of soot, much more higher than the quantity emitted in gas flares
- Artisanal refining of crude oil has increased in Rivers State in recent years, and is widely seen as the source of the black soot



Activities of law enforcement agents

- The policy of the JTF on bunkering is to burn down the illegal refineries, including the stolen crude oil.
- This results in the emission of massive quantity of soot into the atmosphere



Why are the soot just being noticed?

- The answer lies in the Biblical story of the sacrifices of Cain and Abel recorded in Genesis 4:4
 - The soot became noticeable, because they hung around, and refused to go up
- Why did the soot refuse to go up?
 - Might be because God, like with Cain is not happy with us, and therefore want to tell us that we are not taking good care of the earth, He created for our enjoyment



Why are the soot just being noticed? 2

- Science also indicate that the soot hung around the city of Port Harcourt because of:
 - temperature inversion and
 - meteorological factors
- As were noted in the Great London of 1952 and Los Angeles smog
- These smog were said to have been caused by
 - meteorological factors that hindered the dispersal of pollutants, and
 - temperature inversion that prevented the ascent of hot, polluted air, and the descent of fresh, clean air

Calm winds and the inversion result in poor air quality.



① The winter sun, low in the sky, supplies less warmth to the Earth's surface.

② Warmer air aloft acts as a lid and holds cold air near the ground.

③ Pollution from wood fires and cars are trapped by the inversion.

④ Mountains can increase the strength of valley inversions



Why are the soot just being noticed? 3

- The soot were first noticed in November, 2016 during the transition period between the rainy season and the dry season
- It therefore seem to have been caused by the stand still, created by the clash between
 - the south-east trade wind, from the Atlantic ocean that bring rainy season, and
 - the north-west trade wind from the Sahara desert that bring the dry season
- This would explain why the first rains that fell in that period were noted to be black in colour
- It also explains the soot that were noted to coat parked vehicles

The health effects of the soot

- Particles more than 3 microns are likely to be trapped either by
 - the hairs of the nostrils or
 - the mucus produced by the trachea and bronchi
- They do not pose much danger to health beyond
 - the blackened sputum and
 - the ability to trigger off asthmatic attack in susceptible persons

The health effects of the soot 2

- Fine particles of less than 3 microns in diameter enter the nose and throat, reach the lungs, and cause breathing problems and irritation of the lung capillaries.
- The following health problems have been associated with the inhalation of such SPM
 - Wheezing, and exacerbation of asthma
 - Increased susceptibility to respiratory infections, especially in children
 - Increased susceptibility to chronic bronchitis and COPD, in adults
 - Exacerbation of COPD in adults; and
 - Excess mortality, especially amongst patients with pre-existing cardiorespiratory ailments.

Triggers asthmatic attack

- The soot can trigger and/or exacerbate asthmatic attack in susceptible individuals
 - A study carried out in Alaska, United States showed that asthma visits were positively correlated with atmospheric concentrations of PM-10s
- The prevalence of asthma among adolescent and adult Nigerians was estimated to be as high as 10.2%, compared to the worldwide average of 4.3%
 - Musa BM, Aliyu MD. Asthma prevalence in Nigerian adolescents and adults: systematic review and meta-analysis. African Journal of Respiratory Medicine 2014; 10 (1): 4 – 9.
- This means that the presence of the soot increased the risk of asthmatic attack in 10.2% of adult Nigerians

Increased susceptibility to respiratory infections

- Inhalation of soot compromises not only the physical barriers, but also the immune system of the lungs, resulting in increased susceptibility to respiratory infections
 - The WHO estimates that in terms of DALYs, 35% of all ALRIs are caused by exposure to SPM
 - Other studies indicate that persons exposed to high concentration of SPM are 2.5 times more likely to develop active tuberculosis.

Increased susceptibility to chronic bronchitis and COPD

- Exposure to soot damages the physical structure of the lungs,
 - and the ability of the cilia of the lungs to clear mucus, resulting in bronchitis
- The WHO estimates that 22% of all COPD are caused by exposure to SPM

Exacerbation of COPD in adults

- Chronic obstructive pulmonary disease (COPD) is a type of obstructive lung disease characterized by long-term poor airflow, shortness of breath and productive cough
 - It includes chronic bronchitis which is defined a productive cough that is present for at least three months each year for two years
- A study carried out in Ife puts the prevalence of COPD among Nigerian adults older than 40 years at 7%
- The WHO estimates that there is a 0.8% increase in the number of patients with COPD that are admitted into hospital, for every $10\mu\text{g}/\text{m}^3$ increase in SPM
- The increase in SPM that caused the public outcry in Port Harcourt is likely to be as high as $200\mu\text{g}/\text{m}^3$,
 - therefore could have worsened the condition of up to 16% of the patients with COPD enough for them to require hospital admission

Excess mortality

- Studies indicate that increase in the ambient level of SPM results in the death of sick persons, especially those with cardio-respiratory diseases
 - The WHO estimates that SPM is directly responsible for 8% of all lung cancer deaths, and 3% of all deaths from respiratory infection.
 - Another WHO study estimates a 0.74% increase in the total number of deaths, for every $10\mu\text{g}/\text{m}^3$ increase in SPM
 - A US study found that PM-10s contributed between 20 and 200 early deaths, each day in America's largest cities.

Control measures

- Control measures should be targeted at the main sources of the soot,
 - as well as addressing the medical needs of affected persons
- Motor vehicles
 - Increase emission standard for motor vehicles. This would require banning smoky vehicles from the road
 - Encourage fuel efficient vehicles
 - Encourage mass transit
- Firewood
 - Encourage the use of cleaner fuel (electricity and LPG)

Control measures 2

- Generators
 - Improve public electricity supply
 - Encourage cleaner source of electricity generation (solar)
- Gas flaring
 - Strict enforcement of the relevant environmental laws and policies, especially the flare out policy
 - Strict enforcement of the polluter-pays principle, to exert economic and social pressure on the erring companies

Control measures 3

- Artisanal refining of crude oil
 - Legalization of artisanal refinery
 - Introduction of better refining equipment
- Activities of law enforcement agents
 - Stop the burning of ceased crude oil

Improved medicare for affected persons

- The treatment for COPD should be made free for patients with no history of cigarette smoking
- Treatment should be funded with fines paid by defaulting companies,
 - according to the polluter pays principle

Conclusion



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