



# Assessment Of Possible Dissolved Aerosol Contaminants In Rainwater Sample: A Case Study of Rumuolumeni Community In Obio-Akpo LGA, Nigeria

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## ABSTRACT

The study considered possible contaminants in rainwater sample collected at Rumuolumeni community in Obio Akpor Local Government Area (4° 45' E and 4° 60' E and longitudes 6° 50' E and 8° 00' E) of Rivers State, Nigeria. The laboratory analyses of the rainwater sample using Agilent 6890N and Hach 3900DR instruments indicated the presence of the following contaminants: Total Petroleum Hydrocarbon (TPH) 0.00034ppm, Polycyclic Aromatic Hydrocarbon (PAH) 0.00069ppm, and 0.70210ppm of nitrates. These substances-TPH, PAH and Nitrates are potential contributors to health problems in man and animals. The pumping out all sorts of chemicals – particulates, carcinogens, dioxins (toxic chemicals) and even heavy metals into the Earth's atmosphere have been attributed largely to anthropogenic activities. This calls for public awareness campaign on the dangers associated with consumption of contaminated rainwater and the need to control the indiscriminate release of these toxic substances into the environment of the affected community.

**Keywords:** *Assessment, Dissolved Aerosols, Contaminants, Rainwater Sample*

## 1. INTRODUCTION

The Presence of tiny solids or particles in the air generally referred to as aerosol is of great concern to atmospheric and environmental scientists, the world over. The concern for these tiny particles is not unconnected to their direct and indirect impacts on solar and infrared radiations in the atmosphere and the consequence of climate change.

The type and size distributions of these tiny particles (aerosols) depend solely on the local meteorological factors and the local nature of the earth's surface (Rees, 2001). The size range of these particles is between  $10^{-4}$   $\mu\text{m}$  and 900 $\mu\text{m}$ . These particles are classified into aitken, large and giant particles (Cotton, 2000). High concentrations of some of these particles also influence the colour of raindrops.

### Origin of Aerosols

Aerosols are both natural and anthropogenic (man-made) in origin. According to Union of concerned scientists (2015), most atmospheric aerosol particles are generated by natural process-particles from grinding and erosion of land surfaces, salt-spray from ocean bubbles and breaking waves, biological decay, forest fires, chemical reactions of atmospheric gases and from volcanic eruptions. A very minor source emanates from meteors (Cotton, 2000). The burning of meteors produces aerosols in the lower atmosphere.

Industrial, agricultural, transport, domestic and construction activities constitute anthropogenic sources of aerosols. These are regarded as primary or secondary particles. Primary particles evolve directly as liquids or solids from their

sources. For example, the burning of biomass, Secondary particles are produced during the process of gas-to-particle conversion from chemical reaction in the atmosphere (Poschl, 2005).

### Composition of Aerosols

Aerosol composition is dependent upon their origin. Aerosol from sea spray contains sea salts such as sodium chloride; others are magnesium, sulphate, calcium, potassium and organic compounds (UNEP, 2001). In the tropospheric level of the atmosphere, aerosol is composed of sulphate, ammonium, nitrate, sodium chloride, trace metals, carbonaceous materials, crustal elements, and water (Seinfeld & Pandis, 2006). Aerosol may also contain minerals (such as silicon) (Union of concerned scientists, 2015).

### Effects of Aerosols

Aerosol particles affect both humans and animals when they are inhaled. These can cause irritation of the eyes and the lining of the lungs, coughing and asthma. Some are carcinogenic (cancer causing agents) (Climate Education for K-12, 2012).

Dark aerosol such as carbon or dust absorbs light and consequently generates warming effect, but-light-coloured aerosols like sea spray or sulphate reflect light back into the space and cool the planet (European Organisation for Nuclear

Research(CERN, n.d). This cooling effect, according to Abel (2004) suppresses the anthropogenic greenhouse effects.

Aerosol particles affect the formation and properties of cloud. The formation and the precipitating efficiency of liquid-water, ice and mixed-phase clouds are altered by aerosols, this introduces and indirect radiative forcing due to changes in cloud properties (Penner et al, 2001).

**Warming effect:** Atmospheric absorption by aerosol particles (primarily black carbon) in the short wavelength reduces planetary albedo by converting the incoming solar radiation to heat (Abel, 2004).

**Residence time:** This is the length of time substance residences in a particular location before it moves on through a particular process or cycle. The shortness of atmospheric life- time of aerosols is the reason why they are not considered as having a long-term cooling effect to counter the warming effect of greenhouse gases, since greenhouse gases last much longer in the atmosphere than aerosols (Union of Concern Scientists, 2015., Mitchell, 1997).

**Table1.1: Residence times of Aerosols in the atmosphere**

**Stratum**

**Residence period**

Lower	≈	10days
Upper troposphere	≈	
30days		
Lower troposphere	≈	
6 months		
Upper troposphere	≈	
2-3 years		
Mesosphere	≈	
5-10years		

**Source:** Narayanan, P. (2011)

**Visibility:** Suspended particles reduce visibility air quality (Narayanan, 2011). The atmospheric visibility is given by

$$L = \frac{100}{C}$$

where L = visibility in Kilometres

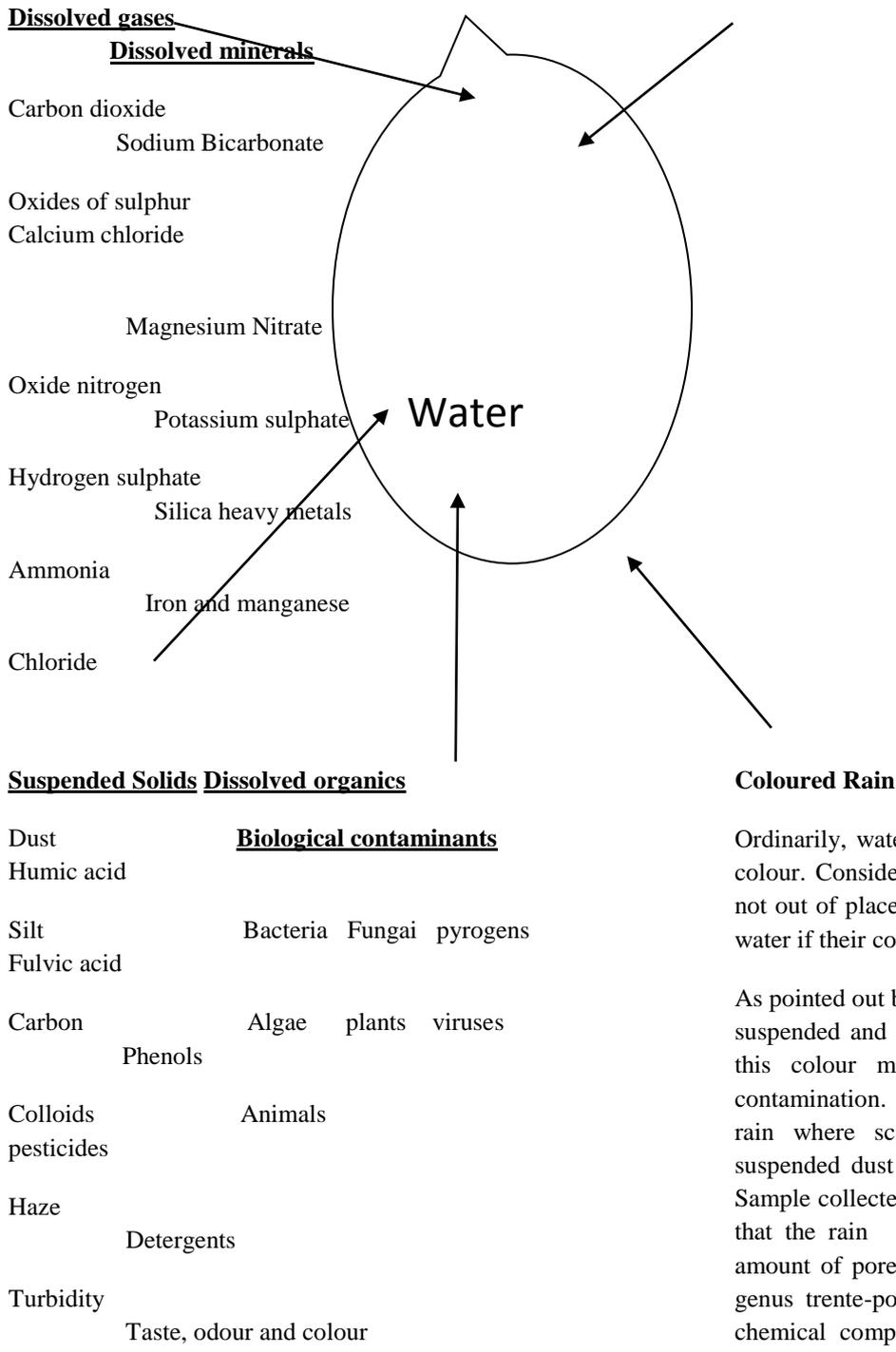
C = concentration  $\frac{\mu\text{g}}{\text{m}^3}$

**Health effect:** As noted by Poschl (2005), the molecular mass and structure of organic compound are important parameters for their physicochemical and biological properties and thus for their climate and health problems.

**Rain Water and its Contaminants**

Water is described as a universal solvent. According to Hill (n.d), in the upper atmosphere, condensed raindrops are pure but within a short time, they become contaminated with a number of particles the atmosphere. These contaminants are grouped into the different classes based on their chemical properties.

IWA water Wiki (2010) states that rain water is pure and occupies top position in the class of circulation of water in the natural world. It is distilled water evaporated from the sun, but as it falls, suspended particles from the air dissolve in it.



**Figure 1: Contaminants in rain water**

**Source:** Hill Richard. ([www.whitewaterlimited.com/Bacterial](http://www.whitewaterlimited.com/Bacterial) Activity in Harvested Rainwater.pdf )

Ordinarily, water in its pure state does not have any kind of colour. Considering the contaminants listed in figure 2, it is not out of place to state that they can influence the colour of water if their concentration is high.

As pointed out by State Water Resources Control Board (n.d), suspended and dissolved particles in water influence colour, this colour may provide evidence that there is some contamination. Sampath et al. (2001) stated that coloured rain where scientifically studied was found to contain suspended dust particles, or dissolved pollutants. Rainwater Sample collected from Changana Cherry for analysis showed that the rain colour was due to the presence of a large amount of pores of a lichen-forming algae belonging to the genus trentepohlia (Sampath et al, 2001). The analysis of chemical composition of red rain that fell in Silicy 1872 indicated the presence of organic and inorganic compounds as well as meteoric dust (Sampath, 2001). On August 14, 2007, black rain was reported to have fallen in Shenzhen city (cars parked outside were also blackened and car paints corroded, plants were affected. The rain was acidic and burned through flower petals (Fu Jian Feng's Blog, 2007). On 25<sup>th</sup> July, 2001 red rain was noticed in Kerala (Louis & Kuma, 2006), this red rainwater was attributed to the presence of tiny red cells

of about 10 micrometers in size. There were also reported cases of yellow rain and rare unconfirmed cases of black, green, grey (Louis & Kuma, 2003).

## 2. MATERIALS/METHODS

### 2.1. The Study Area

The sampling site is Rumuolumeni community in Obio/Akpor Local Government Area of Rivers State, Nigeria. Rumuolumeni community is the host to many Oil Companies and others. Obio Akpo Local Government area is located between latitudes 4° 45' E and 4° 60' E and longitudes 6° 50' E and 8° 00' E. The Local Government Area covers 1000 sq mi (260 km<sup>2</sup>). Based on 2006 National Population Census, the area had a population of 878,890.

### 2.2. Sample Collection

The rainwater sample was collected directly outside the house-roof to avoid being contaminated with settled dust and other particles that are being washed down from the roof. The plastic container for the collection of rainwater sample was placed on a standing table of about 1 meter above the Earth's surface. This rainwater sample was filtered to separate the insoluble particles in the sample from the soluble.

### 2.3. Instruments for Sample Analysis

Hach 3900DR and Agilent 6890N instruments with required accessories and reagents were employed in the analysis of the rainwater sample in the laboratory.

### 2.4. Sample Analysis

Firstly, the sample bottle was marked on its side corresponding to the water meniscus for later determination of sample volume. The entire sample was later poured into 1 litre Separatory funnel. 50ml of methylene chloride was added to the sample bottle, sealed and shaken for 30 seconds to rinse the inner surface. The solvent was transferred to the separatory funnel to extract the sample by shaking the funnel for two minutes with periodic venting to release excess pressure. A minimum of 10 minutes was allowed for the organic layer to separate from the water phase and the methylene chloride extract was collected in a 250ml flask. A second 60ml volume of methylene chloride was added to the sample bottle. The separatory funnel and the column were rinsed with 20 ml of the solvent into the extract.

The extraction procedure was repeated the second time and the extracts in the Erlenmeyer flask were combined. In the same manner, the third extraction was performed.

The combined extract was poured through a drying column containing packed cotton wool anhydrous sodium sulphate and silica.

The extract was collected with the vial and it was concentrated by blowing it down with nitrogen gas to 1.0ml of the solvent and 1.0microlitre (1.0µl) was injected into the flame ionization detector gas chromatograph for its Poly Aromatatic Hydro- carbons (PAHs) analysis.

## 3. RESULTS AND DISCUSSION

The results obtained from the analysis of rainwater sample are given in Table 1..

**Table1: Concentration in part per million (ppm) of hydrocarbons and nitrates in the rainwater sample**

S/NO	Sample Parameter	Concentration in Part Per Million (ppm)
1	Total petroleum hydrogen carbonate (TPH)	0.00034
2	Poly Aromatu hydrocarbon (PAH)	0.00069
3	B tex: Benzene Toluene Ethylene benzene & xylene	0.00000
4	Nitrate NO <sub>3</sub>	0.7021

### 3.1. Discussion

The laboratory analyses of the rainwater sample using Agilent 6890N and Hach 3900DR instruments indicated the presence of the following contaminants: 0.00034ppm of TPH, 0.00069ppm of PAH and 0.70210ppm of nitrates. Benzene Toluene Ethylene and xylene (Btex) was nil.

### 3.2. Implication of Result

According to Ukemenam (2014), aromatic compounds such as benzene, toluene and xylene are suspected carcinogens

(cancer causing agents) and may lead to leukaemia through prolong exposure.

Animals' studies have shown the effects of TPH on the lungs, central nervous system, liver, kidney, developing foetus, and reproductive system from exposure to TPH compounds, generally after breathing or swallowing the compounds (Agency for Toxic Substances and Disease Registry(ATSDR, 1999). Irritations of the skin and eye have also been reported on exposure to TPH.

Polycyclic Aromatic Hydrocarbons (PAH) like naphthalene have been reported to have health effect on man, such as breakdown of red blood cells if inhaled or ingested in large quantity. Mixtures of PAH are also carcinogenic to humans (Lah, 2011). Environmental Working Group (EWG, 1996), stated that human and animal studies have shown a possible link between intake of nitrate with birth defects, hypertension and disruption of thyroid function. According to EWG (1996), nitrates are converted to nitrites after ingestion and these undergo some chemical reactions with natural and synthetic organic compounds to produce N- Nitroso compounds in the human's stomach; many of which are carcinogenic in humans.

#### 4. CONCLUSION

The rainwater sample analyses have shown the presence of some contaminants, and these substances-TPH, PAH and Nitrates are potential contributors to health problems in man and animals. According to The Naked Scientists (2007), if one is far from pollution sources, the rain is coming from a pristine ocean and is clean, but if one is in a built up area, or downwind of heavy industry and power stations, they can be pumping out all sorts of chemicals – particulates, carcinogens, dioxins (toxic chemicals) and even heavy metals. This calls for public awareness campaign on the dangers associated with consumption of contaminated rainwater, especially in communities where rainwater serves as a source of drinking water. More so, there is need to check those anthropogenic activities that introduce these hazardous substances into the atmosphere. This could be done by imposing fines on companies operating in the host communities to deter them from releasing these hazardous substances indiscriminately into the environment.

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