Impacts of Air Pollution in the Niger Delta Region of Nigeria

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Abstract
The study adopted the spatial analysis approach using mainly secondary data and few primary data to examine the impacts of air pollution with reference to the Niger Delta Region of Nigeria. The paper argued that air pollution impacts adversely on man and the environment generally. Some of the effects of air pollution common in the Region include: reduction in visibility; causes bronchial disorders, upper respiratory tract disorders, causes eyes, throat and lungs irritations, causes headaches, nausea and also carcinogens and sudden deaths; causes damage to materials (e.g. metal corrosion), plants and vegetation. The paper enumerated some of the main classes of air pollutants common in the Niger Delta Region to include particulate matter (aerosols), oxides of carbon (CO_2 and CO). Oxides of nitrogen (NO_2, NO), oxides of sulphur (SO_X), hydrocarbons, halogens in the form of chlorine (Cl_2) and fluorine. The paper concluded by recommending an immediate adoption of measures aimed at reducing air pollution so as to ameliorate the people's suffering arising from oil and gas and industrial related activities.

Key Words: *air pollution, air pollutants, impacts, Niger Delta Region*

Introduction

Environmental pollution simply means the introduction, release or addition of any biological, chemical, physical or radiological substance into any of the component parts of the environment (air, water, land or soil) at a rate faster than the rate at which the environment can naturally accommodate it through the process of absorption, dispersion or decomposition (breaking down); and which threatens the life or survival of man, plants and animals or any biotic system of the environment. In other words, environmental pollution is any undesirable change in the biogeochemical processes of the earth that may pose potential danger on the health and survival of humans and other living organisms. That is, any alteration in the physical, chemical or biological characteristics of the air, water or land/soil and that will harmfully affect the survival or activities of man and other flora and fauna or any abiotic system can be viewed as pollution (Ukpere, 2017; Ukpere, 2014, Narayanan, 2011; Srivastara. 2011; Kaushik & Kaushik, 2008).

Another closely related concept that is loosely used or interchangeably used with pollution is contamination. **Environmental contamination** on the other hand, is the release of unwanted substances (contaminants) into the environment, but may not necessarily cause any serious adverse effect (i.e. they do not pose any danger or threat to man or other living things) whereas pollutants do. However, when contaminants are allowed to stay in the environment or there is an increase in their occurrence or level of concentration, they therefore lead to pollution. Both the level of concentration and condition of the receiving medium (soil, water or air) can enhance the chances of a contaminant becoming a pollutant in the environment. For instance, sulphur dioxide (SO_2) is more corrosive and reactive in an aqueous or humid environment. In the same vein, other substances are more reactive under

reducing atmosphere while others are more reactive in oxidizing atmosphere. This implies that atmospheric contaminants can graduate to become pollutants under certain conditions even at trace level concentrations (Ukpere, 2016; Narayanan, 2011).

Sources of Environmental Contamination and Pollution

It is important to remind us here that both contaminants and pollutants are physical, chemical, biological or radiological substances or matter (e.g. heat) that poses some level of effects on soil/land, water or air. They are either natural or anthropogenic in origin (Ukpere, et.al, 2016).

Example of Contaminants include toxic metals in fine particulate form from metallurgical operations, large quantities of CO_2, CO and SO_2, from coal and fuel burning processes, certain chemical substances like nitrates, sulphates, phosphates, surfactants and hydrocarbons, and other organic components from chemical and petrochemical industries.

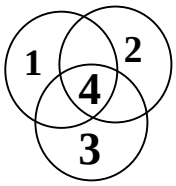
Example of pollutants - It is imperative to state here that most of the dangerous pollutants found in water, soil or atmosphere are mainly from anthropogenic sources. For example, power generating plants, commercial and domestic heating units as well as transport vehicles release a lot of gaseous pollutants. Air pollutants may be from inorganic or organic sources. Inorganic pollutants include SO_2, Cl_2 NH_3, CO_3 and ions like halides, NO^-_3; trace metals such as As, Bi, Co Cr, Cu, Fe, Hg, Mo, Ni, Pb, Sb, Se, Sn and V. Organic pollutants are hydrocarbons e.g. polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), organic solvents, organometallic compounds, pesticides, and surfactants (Ukpere, 2017; Narayanan 2011; Kaushik and Kaushik, 2008).

Major Sources of Pollutants Common in the Niger Delta Region of Nigeria:

- **(i)** Oxygen demanding organic wastes (mostly from domestic, municipal/urban and industrial activities).
- **(ii)** Pathogenic/infective agents (e.g. bacteria, viruses, protozoa).
- **(iii)** Plant nutrients (mostly nitrate and phosphates).
- **(iv)** Certain organic chemicals (mostly from petrochemicals, oils, insecticides, pesticides, herbicides, detergents and carcinogens).
- **(v)** Minerals and trace metals
- **(vi)** Radioactive minerals and compounds (e.g. through the use of explosive like dynamites).

The Earth's Environmental Systems and Cycles and their Pollution Effects

The earth is made up of three main component parts namely the lithosphere with land/soil being its main component; the hydrosphere which is composed of all the water bodies; and the troposphere, which is the lowest layer of the atmosphere, is composed of air and water vapour. The interaction of these three main components or physical systems produces a fourth component known as the biosphere which is composed of living organisms (biota) and non-living (abiotic) factors from which the biotic factors derive their energy and nutrients. See the diagram below.



1. Lithosphere
2. Hydrosphere
3. Troposphere
4. Biosphere

Figure 1: Earth physical systems interacting with one another

Within the biosphere, exist inter-related environmental cycles of processes taking place. These cycles and the reaction or interaction they produce, lead to the release of certain pollutants in the environment. Popular among these systems of environmental cycles are the carbon cycle (C), Nitrogen cycle (N), sulphur cycle (S), Hydrogen cycle (H) and nutrient Cycles. We shall briefly examine how each of these cycles leads to the release of pollutants into the environment.

Air Pollution

Air is a mixture of gases that constitutes the earth's atmosphere in relatively fixed volume but varies across different geographic space depending on the quality of the air space which is a function of existing natural and anthropogenic activities of the different environmental landscapes. It is imperative to state here that, virtually all the elements within the earth's crust are also present in the atmosphere but in very small amounts as compared with those in the soil. These elements find their way naturally into the atmosphere through geological processes (earthquakes, volcanic eruptions), meteorological processes (hurricanes, tornadoes, dust bowl, and cyclones), and weathering processes (abrasion); or through human activities such as industrial processes, space explorations and testing of nuclear missiles and weapons of mass destruction into the atmosphere, mining activities, chemical discharges, gas flaring, bush burning, burning of wastes at dumpsites, thermal heating at homes, etc (Ukpere, 2017; Ukpere, et.al, 2016).

Air Pollution is therefore the presence of one or more contaminants or pollutants in the atmosphere in such a quantity and duration that seems to impair the free air (i.e. quality of the atmosphere) and which is harmful to man, animals, plants, other materials or properties exposed in the environment such as cars, house roofs, metal objects, etc.

Classification of Air Pollution

There are two main classes. These are:

(a) Primary Pollutants

These are those that are emitted directly into the atmosphere. They include sulphur dioxide, nitric oxide and carbon monoxide (see Table 1 below). These primary pollutants are further classified as follows:

(i) Particulate Matter (or Aerosols) – they are very small particulate matter that floats in the air. They are caused by both natural and human activities. Examples are dust, smoke, fog, smog (which is a mixture of both smoke and fog).

(ii) Oxides of carbon (CO_2 and CO). CO is produced as a result of incomplete combustion and mostly from automobiles, domestic fires, power plants, burning of coal etc. CO_2 is mostly from the burning of fossil fuels, bush burning and industrial plants.

$$2C + O_2 \longrightarrow 2CO \text{ (incomplete combustion)}$$

$$C + O_2 \longrightarrow CO_2 \text{ (Complete combustion)}$$

(iii) Oxides of Nitrogen (NO_2, NO) produced mostly through lighting discharges and stratospheric oxidation of ammonia.

(iv) Oxides of Sulphur (SO_X) - Sulphur dioxide, hydrogen sulphide (H_2S) and sulphate particles are the three forms of sulphur found in the atmosphere. The Chief source of SO_2 and H_2S is mostly emissions from burning of fossil fuels (e.g. coal), smelting of sulphur containing ore and chemical industries which produces fertilizers and sulphuric acid.
(v) Hydrocarbons which include methane, ethane, toluene, n-butane, iso-bentane, acetylene coming mainly from automobile industrial exhausts and decomposition process.
(vi) Halogens in the atmosphere in the form of chlorine (Cl_2) and fluorine coming mainly from caustic soda industries for Cl_2 and smokes from brick kiln and iron and steel industries.

(b) Secondary Pollutants

These are those air pollutants formed by the photochemical reaction of primary pollutants. A good example is smog – which is a combination of smoke and fog. Smoke is made up of carbon particles whilst fog consists of water vapour in air.

Acid rain which is formed by a combination of sulphur dioxide and water vapour is also a secondary pollutant and this affects house roofs, and contaminates water.

Table 1: Main Classes of Air Pollutants

Primary Pollutants	**Secondary Pollutants**	**Type of Reaction**
Acid + Alkali	Salt	Acid-Base reactions
$SO_2 + H_2O$	H_2SO_4	Oxidation
$NH_3 + SO_2$	$(NH_4)_2SO_4$	Oxidation
$NO + O_2$	NO_2	Photochemical
$NO+O_2$+HC (Hydrocarbons)	O_2+Free radicals	Photochemical

Table 2: Broad Classification of Air Pollutants

Major Class of Pollutants	**Subclass**	**Examples**
Inorganic	Gases	SO_x, NO_x, CO_X, NH_3
	Acids	HF, HCl, H_2SO_4, HNO_3
	Mineral compounds	Oxides, chlorides, sulphate. silicates, fluorides, phosphates
Organic	Hydrocarbons, acids,	Benzene, toluene, hexane, acetone
Particulates	aldehydes, ketonnes, alcohols, etc	Benzaldyhyde, alcohol, etc
	Dust, smoke, fumes	Mist, fog, etc

Sources and Origin of Air Pollutants

Both '**sources'** and **'origin'** of air pollutants are used interchangeably. The two concepts infer the direction or point of emergence of air pollutants**.** In terms of **sources of air pollutants**, there are **two main sources** of air pollution. These are:

(a) Natural Sources – mostly from geological and meteorological processes such as volcanic eruptions, forest fires, bio-pollutants, cyclone, dust bowls, etc.
(b) Anthropogenic Sources – mostly man made – e.g. burning of fossil fuels, steal plants, textile industries, automobiles, fertilizer industries, thermal power plants.

In terms of **origin of air pollutants,** there are three main origins of air pollutants**.** These are:

i) Point sources – stationary objects that releases pollutants into the atmosphere e.g. industrial factories (especially metallurgical and chemical industries), smokestacks, thermal and nuclear power plants, oil refineries, and refuse incinerators. Others are particulate matter released during volcanic eruptions with complex chemical composition (e.g. oxides of sulphur and fluorine compounds).

ii) Non-point Source – these are mostly from residential neighbourhoods, hospitals, forest fires, agricultural activities, utility and waste disposal sites

iii) Mobile sources – these are mostly from transportation vehicles using fossil fuels such as coal, diesel and gasoline or premium motor spirit (PMS).

Effects of Air Pollution on Man and the Environment

Although not all air pollutants have adverse effects on man, most air pollutants do. The magnitude of effect of air pollutants depend on the level of concentration of the particular pollutant and the duration (i.e. the time frame) of the pollutant in the air as well as the duration of exposure of man or property to the said pollution. Air pollutants pose different level of effects on man, plants and animals, ecosystem, material objects (such as building roofs and floors, metal objects, sculptures, etc). They therefore pose physical, photochemical, physiological, and physicochemical effects on all living organisms but of different magnitude.

General Effects of Air Pollutants

The general effects of atmospheric pollutants are on both living and non-living things in the environment. The effects of these pollutants can be localized, regionalized or globalized depending on the magnitude of the pollution and nature of pollutant. Broadly speaking, their effects can be summarized as in the table below.

Table 2: General Effects of Atmospheric Pollutants

Pollutants	**Effects**
Particulates	Reduces visibility, damage to materials, bronchial disorders
Oxides of Sulphur (SO_X)	Metal corrosion, causes damage to materials, plants, upper respiratory tract disorders
Oxides of Nitrogen (NO_X)	Damage to plants and vegetation, causes eye and nose irritations
Carbon monoxide (CO)	Causes headaches, nausea and even deaths
Hydrocarbons (HCs)	Damage to plants and the environment, also causes carcinogens
Oxidants	Damage to materials, plants and vegetation, eyes, throat and lungs irritations

1. Effects of Air Pollutants on Man and Animals

High level concentration of air pollutants plus long duration of stay of these pollutants in our bodies can be disastrous. Smaller particles of air pollutants passed through the hairs and sticky mucus in the lining of our nose down to our lungs through the tracheobronchial system and can adversely affect our bodies defence system and also cause lung cancer, asthma, chronic bronchitis, and emphysema (damage to air sacs) which leads to loss of lung elasticity and acute shortness of breath (Narayanan, 2011).

Also, suspended particulates can cause damage to long tissues and illnesses such as asthma, bronchitis, and cancer. SO_2 causes respiratory disorder including bronchitis. NO_2 also causes lung irritations which can result to chronic bronchitis and emphysema. CO reaches the lungs and combines with blood haemoglobin to form carboxy-haemoglobin

which may result to suffocation. CO also causes dizziness, unconsciousness and sudden death.

Benzene (mostly from unleaded petrol), formaldehyde, poly chlorinated biphenyls (PCBs), and toxic metals and dioxins (mostly from burning polythenes) can cause mutations, reproductive problems, and cancer (Kaushik, et al, 2008). In the same vein, toxic and hazardous materials like Asbestos, Beryllium, Mercury, Arsenic etc. can cause lung diseases and destroys essential organs such as kidney, liver, spleen, and brain.

2. Effect of Air Pollutants on Plants (vegetation)

Pollutants in the air enter plants' bodies through the leaf-pores (stomata) destroying chlorophyll and therefore affect photosynthesis. They also erode away the waxy-coating of plant leaves (i.e. the cuticle) which help to prevent the plants from excessive loss of water and damage from diseases, pets, frost and drought or excessive heat. The damage on plants leaf by air pollutants (i.e. necrosis), which is dead areas of leaves, chlorosis (i.e. loss of chlorophyll) causing yellowing of plant leaves, epinasty (i.e. downward curling of leaves) and abscission (i.e. dropping of leaves).

Particulates on plant leaves cause plugging of the stomata which lead to reduction of amount of sunlight and sudden death of plants. Also, SO_2 causes bleaching of leaves, chlorosis, injury and necrosis of leaves. NO_2 causes increased in abscission and suppressed growth. O_3 causes flecks on leaf surface, premature aging, necrosis and bleaching. Peroxyacetyl nitrate (PAN) causes silvering of lower surface of leaves, damage to young more sensitive leaves and also suppressed growth. Fluorides cause necrosis of leaf-tip. Finally, ethylene results in epinasty, leaf abscission and dropping of flowers.

3. Effects of Air Pollutants on Aquatic Life

Earlier in this work, you were informed that virtually all pollutants from either soil or atmosphere find their way into water bodies. Air pollutants get mix-up with rain causing high acidity which results in the formation of a weak-acid solution which falls into surface waters. This acid rain lowers the pH of freshwater streams and this affects aquatic life (mostly fishes) causing stunted growth and sudden deaths.

4. Effects of Air Pollutants on Materials

Materials (especially metal products) exposed on the earth's surface, are often affected by air pollutants. SO_2 and moisture accelerates corrosion of metallic surfaces through the formation of sulphuric acid affecting building roofs, vehicles, bridges, railway tracks, wires, statues and sculptures made up of marble and limestone. SO_2 also affects fabrics, leather materials, paint and paper. O_3 in the atmosphere cause cracking of rubber materials thus affecting tires while oxides of nitrogen and ozone (O_3) also cause fading of cotton and rayon fibers.

We shall now consider the roles of the different air pollutants in atmospheric destabilization and their individual effects. Thereafter, we shall examine the strategies to adopt in checkmating air pollution.

Roles of the Different Air Pollutants

Let us now examine the contributions of the various air pollutants in atmospheric destabilization and environmental degradation**.**

1. **Particulates**

These are complex mixtures of organic and inorganic substances from primary and secondary sources. They are made up of sediments and 'suspended' particles. They include smoke, soot, dust and other floating particles. They occur in liquid, solid or a combination of both forms. Their sizes range between 0.1- 10µm. These substances find their way into the atmosphere due to man's land use activities mostly from mining, metallurgical, industrial, construction, agricultural activities, and forests fires, combustion of fossil fuels, vehicular exhausts, hydrocarbons, lead compounds, and metal fumes. These particulate matter remained in the stratosphere (>10km) for a very long time as a result of poor vertical mixing.

Although, particulate matter may not cause serious (adverse) physiological effects, they do pose some effects on our health and degradation of the environment.

These particulate sediments stains and defaces surfaces and cause physical and structural deterioration. Specifically, cement dust causes eczema on the skin, sand dust causes silicosis; asbestos causes' asbestosis, smoke, soot and dust cause respiratory disorders and other health challenges.

It is imperative to state here that health hazards of particulate matter depend on the size of the particulate matter. For instance, particulate matter with diameter of >20mm is easily filtered out of the nose and throat and does not enter the lung system. However, sub-micron range particulate matter (PM.10-PM.2.5 range) causes pulmonary health challenges. This is because they are small enough to penetrate deep into the lungs. Particulate matter above the 2.5µm range (PM. 2.5) is removed by ciliary action of the epithelial cells. But those in the range of 0.5-2.0 µm (< PM. 2.5) can reach the lung lymph nodes and can cause impairment in the functions of the lung. Also, Particulates of < 0.5 µm can cause bronchitis while particulates of the size PM. 10 may carry surface-absorbed carcinogenic compounds into lungs.

2. **Aerosols**

Aerosols are liquid and solid 'suspended' particles or sediments in the atmosphere. Solid aerosols are mixtures of dusts, smokes, soot and fumes. Suspended particles in the atmosphere reduce visibility and quality of the air. Aerosols absorb and disperse both solar and territorial radiation thereby affecting the earth's heat- balance system. They also serve as nuclei for condensation of water vapour and cloud formation by initiating and controlling precipitation. It is important to state here that the back scattering of solar radiation increases the reflectivity of the atmosphere.

Again, aerosols reduce the process of terrestrial scattering of infrared (IR) radiation into space and also help to absorb some solar radiation. However, the effect of aerosols on solar radiation is greater than they are on the infrared radiation from the earth to space; and this cause a decrease in atmospheric temperature with increase in aerosol content in the atmosphere. In order words, the net effect of an increase in particulate matter in the atmosphere is to cool the earth. Aerosols have a longer residence time (i.e. they can stay for months or years) in the atmosphere especially within the stratosphere and mesosphere.

3. **Gaseous air pollutants**

These too are small molecular mass of organic and inorganic compounds coming from both primary and secondary sources. Primary pollutants include SO_X, NO_X, CO_X, H_2S, HF. Secondary pollutants include H_2SO_4, Hydrocarbons, PAN, lead and arsenic compounds.

The most important are the primary pollutants of SO_X, NO_X, and CO_X (i.e. the criteria pollutants). Some of them are examined below.

(i) Oxides of Sulphur (SO_X)

Sulphur dioxide is a primary pollutant whose chief source is from the combustion of sulphur containing fossil fuels, smelting of sulphide-containing ores (e.g. FeS_2, PbS, HgS), manufacture of elemental sulphur and sulphuric acid, conversion of wood pulp to paper and incineration of refuse. Narayanan (2011) postulated that 50 per cent of annual global emission of SO_X is from coal burning, 25 to 30 from oil burning and 20 to 25 per cent from volcanoes and forests fires. Sulphur dioxide is oxidized in the atmosphere to sulphuric acid by hydroxyl radicals (OH) which is produced by photodecomposition of ozone (O3).

$$HO + SO_2 + M \rightarrow HSO_3 + M$$
$$HSO_2 + O_2 \Longrightarrow SO_3 + HO_2$$
$$SO_3 + H_2O \Longrightarrow H_2SO_4$$

Both wet and dry deposition of oxides of sulphur damages buildings such as corrosion of roofs, destruction of vegetation and soil degradation. SO_2 pollution is a major problem in areas where coal is been used for domestic and industrial heating and power stations. Hence, to reduce SO_2 pollution, the use of low-sulphur fuels as well as locating power plants away from residential areas should be encouraged.

(ii) Oxides of Nitrogen (NO_X)

Basically, Nitrogen is the chief constituent of the atmosphere, occurring in its molecular state as NO_2. The main oxides of nitrogen are N_2O (nitrous oxide), NO (nitric oxide) and NO_2 (nitrogen dioxide). NO_2 is a pungent irritating gas which is absorbed in the green region of light, often displays with a reddish-brown colour; NO_x helps in the formation of ozone in the troposphere but also reduces the ozone in the stratosphere. NO_2 reacts with hydroxyl radicals in the gas phase to form nitric acid leading to the formation of acid rain with is antecedent side effects.

(iii) Photochemical Smog

Photochemical pollutants (e.g. ozone) are formed when in the presence of sunlight, NO_2 reacts with hydrocarbons leading to the formation of photochemical smog (reddish-brown haze) which affects most urban centres. The main sources of NO_2 are microbial processes, power generation plants, nitric acid factories and automobiles NO_2 is a good absorber of IR radiation, hence, it is a greenhouse gas.

(iv) Ozone (O_3)

Ozone ((O_3) is a tri-atomic molecule containing three atoms of oxygen (o-o distance=0.128nm) with sp^3 hybridization (O-O-O=116.5^O). It is produced by photochemical reactions taking place at the lower part of the stratosphere. It helps to protect the earth's surface from the direct effects of the sun's ultraviolet radiation at wavelengths between 200 to 320nm. At the troposphere, ozone is produced from two main sources namely: from downward movement from the stratosphere, and from direct photochemical production within the troposphere. The ozone layer is very important for the survival of living things on earth because at the mesosphere-stratosphere boundary, it absorbs much of the ultraviolet (UV) rays of the solar radiation. This absorption of the UV radiation by O_3 (and O*) at the upper regions of the stratosphere provides protective cover or blanket against the UV rays from reaching the earth's surface. Regrettably, this important layer is suffering depletion by

the activities of chlorofluorocarbons, discharges from supersonic airplanes and nuclear weapons testing and space craft emissions.

(v) Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are industrially produced chemicals which do not occur in nature e.g. aluminium industries expel fluoride dust, plastics foam industries expel chlorine, fluorine, and carbonaceous organic compounds. Chlorofluorocarbons (CFCs) are mostly from the family of inert, nontoxic, and easily liquefied chemicals. Chlorofluorocarbons (CFCs) moved upwards easily into the upper atmosphere where their chlorine destroys ozone, and therefore they pose serious threat to ozone layer depletion. According to Narayanan (2011), fluorocarbons undergo photolysis to produce oxidants, free radicals and other secondary pollutants as expressed below:

$CF_2Cl_3 \xleftrightarrow{hv} CF_2Cl_2+Cl^+$

$CF_2Cl_2 \xleftrightarrow{hv} CF_2Cl+Cl^+$

$Cl^*+O_3 \longrightarrow ClO+O_2$

(vi) Oxides of Carbon (CO_X)

These include: **(i)** Carbon monoxide **(CO)** (which is a colourless and odourless greenhouse gas with physiological effects originating from both natural and anthropogenic sources. About 90% of CO is produced from traffic emissions and generating plants; and **(ii)** Carbon dioxide **(CO_2)** which is produced in the complete combustion of carbonaceous materials and from the respiration of living organisms. One good thing about CO_2 is that it is used by plants during photosynthesis. Its increase concentration in the atmosphere poses serious climate problems like climate change and global warming because CO_2 absorbs infrared radiation at 1.5-15m range. This absorption effectively reduces the heat loss from the earth and forces the temperature at the troposphere to increase; a leading to what is known as 'greenhouse effect' (Narayanan (2011).

Control/Prevention of Air Pollution

The various techniques or methods that can be adopted for the control of air pollution in the Niger Delta include:

1. By enacting good laws and implementing these laws strictly.
2. Discouragement (through public enlightenments) in the burning of tires by abattoirs and youth engagement in illegal refining of crude oil (artisanal refining).
3. By conducting a thorough environmental audit and environmental impact assessment (E.I.A) before sitting industries.
4. Reduction in activities that may likely cause pollution such as transportation and energy production.
5. Modification of machinery to use other forms of energy that will emit little CO_2
6. By total ban or reduction in gas flaring.
7. By discouraging bush burning by farmers.
8. Through the use of advanced technology for the reduction or removal of particulate matter by gravitational settling camber, cyclone separator, fabric filter, electronic electrostatic precipitator and wet scrubber.
9. Gaseous pollutants can be controlled through the use of absorption in liquid adsorption on solid surface, chemical alteration of pollutants through combustion or catalystic treatment.
10. Through the use of de-sulphurised fuel.
11. By absorbing toxic pollutant gases in different solutions.
12. By afforestation programme of regeneration.

13. By using excessive free air to control NO_X.
14. By building higher smoke stack facilities that can help discharge pollutants farther away from ground level.
15. Through the use of biological filters and bio-scrubbers.
16. By controlling the use of certain vehicles that emit out too much CO_2 or CO; and also by limiting the use of power plants (e.g. generators) at homes and offices.

Recommendation

Arising from the findings of this study, the authors hereby recommend for the adoption of an immediate and proactive measures aimed at reducing air pollution so as to ameliorate the people's suffering arising from oil and gas and industrial related activities.

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