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Effect on pH Value of Rain Water and Soil pH in River State Nigeria

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ABSTRACT

This study focuses on some environmental effect of gas flaring on both soil pH and pH value of rain water in River State, Nigeria. Samples at different proximities from the gas flare locations were recorded. Measurements and experimentations were carried out. Parameters studied at each location included Rain-water pH and soil pH measurement. Result shows a trend as all the parameters considered showed a clear difference away from the flare point in all the stations such as the pH changing from Extreme acid (3.6 - 4.5) to Moderately alkaline (7.9-8.5) away from the flare points. The values of all parameters under investigation were above acceptable limit. These show clearly that the inhabitants of these communities are highly polluted. This research recommends that gas flaring should be stopped and that the flared gas should be channeled to meeting the ever increasing demand for energy in the Nigerian sector economy and Nigeria should embrace environmental laws and policies in order to adapt to the changing environment.

Introduction

The development of technology has led to the exploration of man's environment in a bid to increasing his standard of living. It is now very obvious, even to those who had initial doubts about the veracity of the claim by scientists of the resultant effects of gas flaring activities which are the damaging effect of the environment due to acid rain, greenhouse effect, global warming and ozone depletion, Abdulkareem (2014), Obi et. al. (2017) and Obi & Osang (2016). Environmental contamination of air, water, soil, food and properties has become a threat to the continued existence of many plants and animal communities and ultimately threatens the very survival of the human race, Nwaichi et al (2011), Ogar et.al. (2014) and Pekene (2015).

Several studies are known to have been carried out into the health impacts of gas flaring on communities in the Niger Delta area without details experimental evidence. However, the communities firmly believe that the flaring is damaging their health, reducing crop production, destroying the rivers and streams and damaging their homes. While other factors may be at play, the lack of attention paid to this crucial issue, means that the villagers' questions and fears are unanswered. Even in the absence of such a study, however, it is clear that flaring harms people, cattle and the environment, Nwaichi et al (2011), Nwaichi and Uzazobona (2011). It has reached the point that, even the rural dwellers know and believe that the flaring of gas is damaging their health, reducing crop production, destroying the rivers and streams and damaging their homes, Nwaugo et al (2013), Obi et. al. (2013), Osang et. al. (2013) and Egor et. al. (2016).

Source of Natural gas

Natural gas is a subcategory of petroleum that is naturally occurring. It is a complex mixture of hydrocarbons with a minor amount of non-hydrocarbon gases, Penner (1999). The discovery and extraction of natural resources have brought different consequences to countries that are endowed with such resources. Gas flaring is the burning off of gas into the atmosphere, Osang et al (2013), Abdulkareem et. al. (2010), Jike, (2004) and Ewona et. al. (2013, 2014 & 2016).

In Nigeria, the discovering of crude oil was in 1958, while the extraction and gas flaring activities of these natural resources started since 1961, Yusuf (2008), Nyong et. al. (2007). The burning off of gas became illegal since 1984 and the Nigerian government has set up several deadlines to end the practice, but gas flaring continues till date, Avwiri (2003), Obi et al (2013). According to friends of the earth report, in 2005, about 2.5 billion cubic feet of gas associated with crude oil is flared into the atmosphere every day in Nigeria. This is equal to 40% of all African natural gas consumption in 2011 and represents a financial loss to Nigeria of about 2.5 billion USD. It is now very obvious, even to those who had initial doubts about the veracity of the claim by scientists of the resultant effects of gas flaring activities that the damaging effect of the environment due to acid rain formation, greenhouse effect, global warming and ozone depletion are real, Abdulkareem et al (2010), Osang et. al. (2013), Obi et. al. (2013), Ewona et. al. (2013).

Obi et al (2008), FAO (2008), Ubani et al (2013), Ettah et al (2011) pointed out that gas flaring is a major source of climate change which is creating increased uncertainty about the future temperature and precipitation regimes which makes investments in agriculture and other weather – dependent livelihood inherently more risk Nduka et. al. (2008) state clearly that, the smoke that comes from the gas flares does not just contain sooty grey particles, but also many invisible gases that can be very harmful to our environment. The flares have contributed large volumes of greenhouse gases than all of sub Saharan Africa combined as well as several dangerous toxin released into the atmosphere.

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The flare from gas flaring station is polluting the soil, atmosphere, water and the entire environment. As a result it is affecting the health and wellbeing of the nearby Niger Delta communities, exposing the residents to an increased risk of premature death, respiratory illnesses such as Asthora and cancers, Awosika (1995), Anee (2004). Gas flaring is the singular and most common source of global warming and contributes to emissions of carbon monoxide, nitrogen (II) oxide and methane which have the propensity of causing environmental pollution and ecological disturbances or destruction, Ubani et al (2013),Abdulakreem et al (2010) and Ewona et. al. (2014).

$$q = -k\nabla T \qquad 1$$

Where

k = Thermal conductivity

T = Temperature given and

q = Heat flux vector

This equation determines the heat flux vector q for a given temperature profile T and thermal conductivity k. The minus sign ensures that heat flows down the temperature gradient.

The temperature profile within a body depends upon the rate of its internally-generated heat, its capacity to store some of this heat, and its rate of thermal conduction to its boundaries (where the heat is transferred to the surrounding environment). Mathematically this is stated by the Heat Equation,

$$\nabla^2 T = \frac{1}{\alpha}\frac{dT}{dt} = -\frac{1}{k}q_{gen} \qquad 2$$

Where

k = Thermal conductivity

T = Temperature given and

q_{gen} = power generated per unit volume

∇^2 denotes the Laplace operator

In the Heat Equation, the power generated per unit volume is expressed by q_{gen}.The thermal diffusivity is related to the thermal conductivity k, the specific heat c, and the density by

$$\propto = \frac{k}{pc} \qquad 3$$

where

K=Thermal conductivity

P=Density

$\propto$ = Thermal Diffusivity

c = Specific Heat,

heat equation is a parabolic partial differential equation that describes the distribution of heat (or variation in temperature) in a given region over time. For a function T (x,y,z,t) of three spatial variables (x,y,z) (see cartesian coordinates) and the time variable t, the heat equation is

$$\frac{dT}{dt} - \alpha\left[\frac{d^2T}{dx^2} + \frac{d^2T}{dy^2} + \frac{d^2T}{dz^2}\right] = 0 \qquad 4$$

More generally in any coordinate system:

$$\frac{dT}{dt} + \alpha\nabla^2 T = 0 \qquad 5$$

Where

$\propto$ = positive constant

∇^2 = Laplace operator

Conduction

On a microscopic scale, heat conduction occurs as hot, rapidly moving or vibrating atoms and molecules interact with neighbouring atoms and molecules, transferring some of their energy (heat) to these neighbouring particles. In other words, heat is transferred by conduction when adjacent atoms vibrate against one another, or as electrons move from one atom to another. Conduction is the most significant means of heat transfer within a solid or between solid objects in thermal contact. Fluids especially gases are less conductive. Thermal contact conductance is the study of heat conduction between solid bodies in contact, Michael (2010), Osang et. al. (2013) and Obi et. al. (2008, 2012, 2013, 2016 & 2017).

Base on Fourier's law, Steady state conduction is a form of conduction that happens when the temperature difference driving the conduction is constant, so that after an equilibration time, the spatial distribution of temperatures in the conducting object does not change any further. In steady state conduction, the amount of heat entering a section is equal to amount of heat coming out. In line with Heat equation, Transient conduction occurs when the temperature within an object changes as a function of time. Analysis of transient systems is more complex and often calls for the application of approximation theories or numerical analysis by computer, Michael (2010), Steadman, (1979) & *Cannon (1984)*. Therefore, the rate of change of energy content in any element for conduction to occur in any given system can be calculated using equation (6) below:

$$\frac{\Delta E}{\Delta t} = Q_r - Q_{r+\Delta r} + E_{gen} \qquad 6$$

Where:

$Q_r = Rate\ of\ heat\ conduction\ at\ r$

$Q_{r+\Delta r} = Rate\ of\ heat\ conduction\ at\ r + \Delta r$

$E_{gen} = Rate\ of\ heat\ generation\ within\ the\ area$

$\frac{\Delta E}{\Delta t} = Rate\ of\ change\ of\ the\ energy\ content\ of\ the\ element$

Convection

The flow of fluid may be forced by external processes, or sometimes (in gravitational fields) by buoyancy forces caused when thermal energy expands the fluid (for example in a fire plume), thus influencing its own transfer. The latter process is often called "natural convection". All convective processes also move heat partly by diffusion, as well. Another form of convection is forced convection. In this case the fluid is forced to flow by use of a pump, fan or other mechanical means, Michael (2010).

Convective heat transfer, or convection, is the transfer of heat from one place to another by the movement of fluids, a process that is essentially the transfer of heat via mass transfer. Bulk motion of fluid enhances heat transfer in many physical situations, such as (for example) between a solid surface and the fluid. Convection is usually the dominant form of heat transfer in liquids and gases, Michael (2010), Kamgba & Briggs (2010). Although sometimes discussed as a third method of heat transfer, convection is usually used to describe the combined effects of heat conduction within the fluid (diffusion) and heat transference by bulk fluid flow streaming. The process of transport by fluid streaming is known as advection, but pure advection is a term that is generally associated only with mass transport in fluids, such as advection of pebbles in a river. In the case of heat transfer in fluids, where transport by advection in a fluid is always accompanied by transport via heat diffusion (also known as heat conduction) the process of heat convection is understood to refer to the sum of heat transport by advection and diffusion/conduction, Wallace & Hobbs (2006), Cannon (1984), Odjugo (2007), Osang et. al. (2013).

According to Cannon (1984) and Michael (2010), heat transfer coefficient or film coefficient, in thermodynamics and in mechanics is the proportionality constant between the heat flux and the thermodynamic driving force for the flow of heat (i.e., the temperature difference, ΔT):

$$h = \frac{q}{\Delta T} \quad (7)$$

Where:

q = Amount of heat transferred (heat flux), W/m2 (thermal power per unit area

h = Heat transfer coefficient, W/(m2•K)

ΔT = Difference in temperature between the solid surface and surrounding fluid area, K.

It is used in calculating the heat transfer, typically by convection or phase transition between a fluid and a solid. The heat transfer coefficient has SI units in watts per square meter Kelvin: W/(m2K).

Radiation

Radiation plays an important role in the energy balance of human beings. It is the process in which energy can be transferred in the form of electromagnetic waves from one point to another through a vacuum. All objectives release energy in the form of electromagnetic waves. The best absorbers usually make the best emitters of radiation and these are called black-body. Human beings emit radiation in the infrared band, Kamgba & Briggs (2010), Udo and Ewona (2012) and Ewona et al (2013) Udo & Aron (2000)b.

Wien's and Stefan-Boltzmann laws are usually use to explain radiation: Wien's law tells us about the wavelength, □m, that the body at the temperature, T, radiates with the maximum intensity, Udo and Ewona (2012) , Udo & Aro (1999) and Ewona et al (2013). The Stefan-Boltzmann equation, which describes the rate of transfer of radiant energy. For an object in a vacuum, the equation is given as follows:

$$\lambda_m T = b \quad (8)$$

Where:

b = a constant, and for the black-body, b=3.10-3 m-K.

□m = is the wavelength and

T = the temperature of the body

Stefan-Boltzmann law explains the total amount of radiation energy per second (or as power) from a black-body, and was discovered to be proportional to the forth power of the temperature (T), and the area (A) of the surface emitting the radiation, Michael (2010), Kamgba & Briggs (2010).

$$P = \varepsilon\sigma AT^4 \quad (9)$$

Where:

P = Radiation Power

ε = Emissivity

σ = Stefan's constant and for the black-body is σ=5.7.10-8 Wm-2K-4

A = Area of the surface emitting the radiation

T = Temperature

Radiation is important for very hot objects, or for objects with a large temperature difference. The rate of radiation emitted is the different between the energy emitted by the object and the energy absorbs from its surroundings, Cannon (1984).

Radiative transfer equation

The fundamental quantity which describes a field of radiation is called spectral radiance in radiometric terms (in other fields it is often called specific intensity). For a very small area element in the radiation field, there can be electromagnetic radiation passing in both senses in every spatial direction through it. In radiometric terms, the passage can be completely characterized by the amount of energy radiated in each of the two senses in each spatial direction, per unit time, per unit area of surface of sourcing passage, per unit solid angle of reception at a distance, per unit wavelength interval being considered (polarization will be ignored for the moment) .

In terms of the spectral radiance, I_ν, the energy flowing across an area element of area da located at $\mathbf{r}$ in time dt in the solid angle $d\Omega$ about the direction $\hat{\mathbf{n}}$ in the frequency interval ν to $\nu + d\nu$ is

$$dE_\nu = I_\nu(\mathbf{r}, \hat{\mathbf{n}}, t)\cos\theta \; d\nu \, da \, d\Omega \, dt \quad (10)$$

Where

θ = The angle of unit direction vector

$\hat{\mathbf{n}}$ = unit direction vector

The units of the spectral radiance are seen to be energy/time/area/solid angle/frequency. In MKS units this would be W·m^{-2}·sr^{-1}·Hz^{-1} (watts per square-metre-steradian-hertz).

According to Maxwell transfer theorem, the radiative transfer equation simply states that, as a beam of radiation travels, it loses energy to absorption, gains energy by emission, and redistributes energy by scattering, Anslem (2013). The differential form of the equation for radiative transfer is given as:

$$\frac{1}{c}\frac{\partial}{\partial t}I_\nu + \hat{\Omega}\cdot\nabla I_\nu + (k_{\nu,s} + k_{\nu,a})I_\nu = j_\nu + \frac{1}{4\pi c}k_{\nu,s}\int_\Omega I_\nu d\Omega \quad (11)$$

Where:

j_ν is the emission coefficient?

$K_{v,s}$ is the scattering cross section, and

$k_{\nu,a}$ is the absorption cross section.

Temperature

Temperature is the degree of hotness or coldness of a substance. It is commonly expressed in degree Celsius or centigrade (^{0}C) and degree Fahrenheit (^{0}F). This climatic factor influences all plant growth processes such as photosynthesis, respiration, transpiration, breaking of seed dormancy, seed germination, protein synthesis, and translocation**,** Baroutian et al (2006), Michael (2010), Kamgba & Briggs (2010), Ewona et. al. (2012).

Atmospheric temperature

Atmospheric temperature is a measure of temperature at different levels of the Earth's atmosphere. It is governed by many factors, including incoming solar radiation, man induced radiation, humidity and altitude. **Soil temperature** is simply the measurement of the warmth in the soil. Ideal soil temperatures for planting most plants are 65 to 75 F. (18 to 24 ^{0}C.). Night time and day time soil temperatures are both important, Adebayo (1991).

Humidity

Humidity is the amount of water vapor in the air. Water vapor is the gaseous state of water and is invisible. Gas flaring influences humidity because of the heat it sends to the atmosphere. Humidity indicates the likelihood of precipitation, dew, or fog. Higher humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin.

This effect is calculated in a heat index table or humidex, Michael (2010), Kamgba & Briggs (2010). There are three main measurements of humidity: absolute, relative and specific, Wallace & Hobbs (2006) and *Cannon (1984)*.

Absolute humidity

According to Wallace & Hobbs (2006) and *Cannon (1984)*, absolute humidity is the total mass of water vapor present in a given volume of air. It does not take temperature into consideration. Absolute humidity in the atmosphere ranges from near zero to roughly 30 grams per cubic meter when the air is saturated at 30 °C. Absolute humidity is the mass of the water vapor M_w divided by the volume of the air and water vapor mixture (P_{net}), which can be expressed as

$$AH = \frac{M_w}{P_{net}} \qquad 12$$

Where

AH is the Absolute humidity

M_W is the mass of the water vapour

P_{net} is the volume of the air and water vapor mixture

Relative humidity

According to Anee (2004), Relative Humidity $\emptyset$ of an air water molecule according to Wallace & Hobbs (2006*)* is defined as the ratio of the partial pressure of water vapor (e_w) in the mixture to the saturated vapor pressure of water e_w^* at a given temperature. Thus the relative humidity of air is a function of both water content and temperature. Relative humidity is normally expressed as a percentage and is calculated by using the following equation:

$$\emptyset = \frac{e_w}{e_w^*} \times 100\% \qquad 13$$

Where

e_w^* = Equilibrium Vapor Pressure of Water

e_w = Partial Pressure of Water Vapor

$\emptyset$ = Relative Humidity

Relative humidity is an important in weather forecasts and reports, as it is an indicator of the likelihood of precipitation, dew, or fog. In hot summer weather, a rise in relative humidity increases the apparent temperature to humans (and other animals) by hindering the evaporation of perspiration from the skin, Michael (2010), Kamgba & Briggs (2010).

Specific Humidity (q)

Specific humidity is approximately equal to the "mixing ratio", which is defined as the ratio of the mass of water vapor in an air parcel to the mass of dry air for the same parcel, Michael (2010), Wallace & Hobbs (2006).

$$SH = \frac{m_v}{m_a} \qquad 14$$

where

m_v = The ratio of water vapor mass

m_a = The air parcel's *total* (i.e., including dry) mass.

Atmospheric pressure

Atmospheric pressure is the pressure exerted by the weight of air in the atmosphere of Earth (or that of another planet). In most circumstances atmospheric pressure is closely approximated by the hydrostatic pressure caused by the weight of air above the measurement point, Michael (2010). On a given plane, low-pressure areas have less atmospheric mass above their location, whereas high-pressure areas have more atmospheric mass above their location. Air pressure at any height in the atmosphere is due to the force per unit area exerted by the weight of all of the air lying above that height. Consequently, atmospheric pressure decreases with increasing height above the ground. The atmospheric pressure at any level in the atmosphere is the total water that the column of the atmosphere exerts on a unit area of a surface placed at that point, Michael (2010*)*.

Atmospheric pressure can be determine from equation 15 given below:

$$p = p_o e^{-\left(h/h_0\right)} \qquad 15$$

Where

p = atmospheric pressure (measured in bars)

h = height (altitude)

p_0 = is pressure at height h = 0 (surface pressure)

h_0 = scale height

From the above equation, the pressure will be decreasing with height. The pressure of the atmosphere is greatest at the surface of the earth and decreases from the surface upwards. The weight of the atmosphere per unit area is greatest at the surface of the earth and decreases upward, Wallace & Hobbs (2006) and *Cannon (1984)*. Hence the atmospheric pressure is greatest at the surface of the earth and decreases upwards. The net upward force acting on a thin horizontal slab of air, due to the decrease in atmospheric pressure with height, is generally very closely balanced with the downward force due to gravitational attraction that acts on the slab. If the net upward pressure force on the slab is equal to the downward force of gravity on the slab, the atmosphere is said to be in hydrostatic balance, Michael (2010) & Steadman, (1979).

Hydrostatic equation

*T*he hydrostatic equation is one of the most important and most basic equations in meteorology. Understanding the equation makes it easier to physically interpret analysis and thickness charts. The mass of air between heights z and z + δz in the column of air is ρδz. The downward gravitational force acting on this slab of air, due to the weight of the air, is gρδz. Let the change in pressure in going from height z to height z + δz be δp. Since we know that pressure decreases with height, δp must be a negative quantity. The upward pressure must be slightly greater than the downward pressure. Therefore, the net vertical force on the block due to the vertical gradient of pressure is upward and given by the positive quantity –δp.

For an atmosphere in hydrostatic equilibrium, the balance of forces in the vertical requires that

$$-dP = g\rho dz \qquad 16$$

Where

$P =$ Pressure

$g =$ Acceleration due to gravity

$\rho =$ Density of air

$z =$ Height

The negative sign ensures that the pressure decreases with increasing height.

Variation of Atmospheric Pressure with Height

Vertical pressure variation is the variation in pressure as a function of elevation. Depending on the fluid in question and the context being referred to, it may also vary significantly in dimensions perpendicular to elevation as well, and these variations have relevance in the context of pressure gradient force and its effects, Michael (2010) and *Cannon (1984)*. However, the vertical variation is especially significant, as it results from the pull of gravity on the fluid; namely, for the same given fluid, a decrease in elevation within it corresponds to a taller column of fluid weighing down on that point, Ewona and Udo (2008).

A relatively simple version of the vertical fluid pressure variation is simply that the pressure difference between two elevations is the product of elevation change, gravity and density, Cannon (1984).

The equation is as follows:

$$\Delta P = -\rho g \Delta h \qquad 17$$

where

P = Pressure,

ρ = Density,

g = Acceleration of gravity

h = Height.

Steadman, (1979), Cannon (1984), density varies more significantly with height. It follows from the ideal gas law that;

$$\rho = \left(\frac{mP}{kT}\right) \qquad 18$$

Where

m = Average mass per air molecule

P = Pressure at a given point

k = The Boltzmann constant

T = The temperature in Kelvin

p = Density

In a simpler way, air density depends on air pressure. It would be easy to get the impression that this was circular definition, but it is simply inter-dependency of different variables. This then yields a more accurate formula, of the form:

$$P_h = P_0 e^{\frac{(-mgh)}{(kT)}} \qquad 19$$

Where

Ph = Pressure at point h,

P0 = Pressure at reference point 0, (typically referring to sea level)

e = Euler's number,

m = Mass per air molecule,

g = Gravity,

h = Height difference from reference point 0, and

k = Boltzmann constant, and

T = Temperature in Kelvin.

And the superscript is used to indicate that e is raised to the power of the given ratio. Therefore, instead of pressure being a linear function of height as one might expect from the more simple formula given in the "basic formula" section, it is more accurately represented as an exponential function of height as temperature also varies with height. However, the temperature variation within the lower layers (troposphere, stratosphere) is only in the dozens of degrees, as opposed to difference between either and absolute zero, which is in the hundreds, so it is a reasonably small difference. For smaller height differences, including those from top to bottom of even the tallest of buildings, (like the CN tower) or for mountains of comparable size, the temperature variation will easily be within the single-digits, Michael (2010).

An alternative derivation, shown by the Portland State Aerospace Society is used to give height as a function of pressure instead. This may seem counter-intuitive, as pressure results from height rather than vice versa, but such a formula can be useful in finding height based on pressure difference when one knows the latter and not the former. Different formulas are presented for different kinds of approximations; for comparison with the previous formula, the first referenced from the study will be the one applying the same constant-temperature approximation, Wallace & Hobbs (2006) and Cannon (1984). In which case:

$$z = \left[\left(\frac{-RT}{g}\right) In \frac{P}{P_0}\right] \qquad 20$$

Where

z = Elevation

R = Gas constant

T = Temperature in kelvin

g = Gravity

P = Pressure at a given point

P0 = Pressure at the reference point

And for the sake of comparison to the above, another formula derived in the same article shows a more complete picture for when constant temperature isn't assumed, and is also a formula for height as a function of pressure difference, Michael (2010) & Cannon (1984).

$$z = \frac{T_0}{L}\left[\left(\frac{P}{P_0}\right)^{-\frac{LR}{g}} - 1\right] \qquad 21$$

Where

L = the atmospheric lapse rate, and

T_0 = the temperature at the same reference point for which $P=P_0$

P = pressure at a given point

P_0 = pressure at the reference point

g = gravity

R = Gas constant

Study area:

Ogba/Egbema/Ndoni is a Local Government Area of Rivers State, Nigeria, with its capital at Omoku. The list of communities in Ogba-Egbema-Ndoni LGA are: (1) Oboburu, (2) Ohiuga, (3) Okposi, (4) Ikiri, (5) Erema, (6) Ede, (7) Obigwe, (8) Okpurupuali, (9) Okansu, (10) Ogbidi. Rivers States of Nigeria is one of the Niger Delta Area which covers 20,000 km² within wetlands of 70,000 km² formed primarily by sediment deposition. Home to 20 million people and 40 different ethnic groups, this floodplain makes up 7.5% of Nigeria's total land mass. It is the largest wetland and maintains the third-largest drainage basin in Africa, Abdulakreem et al (2011),

Fig .1. Map of Nigeria Showing River State of Nigeria.

Fig.2. Map Of River State Showing Ogba Egbema Ndomi.

Data Source:

Visitations to Ogba-Egbema-Ndomi Community River State, Nigeria that flare gas most in Nigeria was done severally to ascertain any existence of common environmental hazards. Standard measurements for each parameter were carried out as follows:

Rain Water PH Measurement:

Clean acid-free glass bottles were used to collect bulk samples of rain water at the time of dropping. The samples were placed at distances of 200m, 400m, 600m 800m, 1000m, 1200m, 1400m, 1600m, 1800m and 2000m from the flare point. The funnel was covered with a plastic net to prevent collection of windblown debris. Each bottle was placed on a stand 1.5m above ground level. The collected samples were tested and analyzed using a digital PH meter.

Soil PH Measurement:

The pH of the soil samples was determined within a distances of 200m, 400m, 600m 800m, 1000m, 1200m, 1400m,1600m, 1800m and 2000m respectively from the flare point using a digital PH meter. The PH meter was placed 2-3 cm into the soil and was left for 5 minutes to stabilize and read before withdrawal. The readings were taken in was at the site of collection.

Data Analysis:

Based on the data, simple descriptive analysis was used to show the impact of gas flaring activities in Ogba-Egbema-Ndomi Community River State of Nigeria.

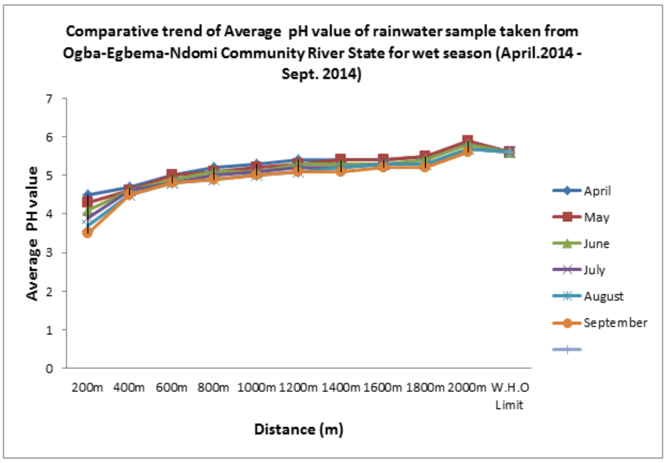

Fig.3.Comparative Bar chat of Average pH value of rainwater sample taken from gas flare location and W.H.O limit in Ogba-Egbema-Ndomi Community River State for wet season (April.2014 - Sept. 2014).

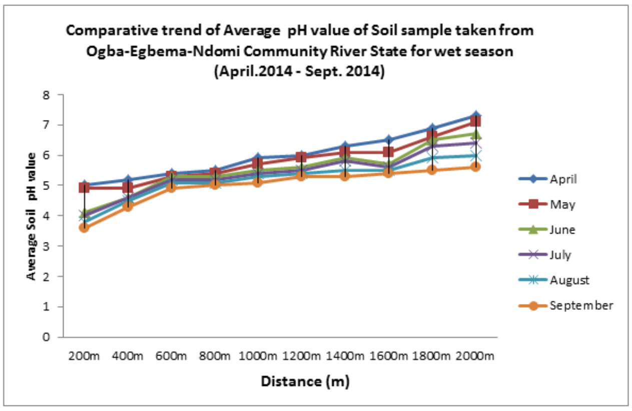

Fig.4.A trend of Average Soil pH Measurement over Distance taken from gas flare location in Ogba-Egbema-Ndomi Community River State During wet season (April.2014 - Sept. 2014)

Discussion of Result

Base on the results on the trend analysis carried out on rain water to determine the acidic content (ie PH value for rain water analysis) shown in Fig. 5. The study revealed the highest and the lowest PH value for rain water in Ogba-Egbema-Ndomi to be 7.3 and 4.0 at 2000m and 200m respectively. The highest and the lowest soil PH value for Ogba-Egbema-Ndomi is 7.3 and 3.6 at 2000m and 200m respectively. The results recorded a low pH values at the flare points, which could be attributed to the acidic oxides produced by the flaring. Both the lower pH and higher aluminum concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals. At pHs lower than 5 most fish eggs will not hatch and lower pHs can kill adult fish. As lakes and rivers become more acidic biodiversity is reduced. Acid rain has eliminated insect life and some fish species over the years due to these gas flaring and dangerous gaseous emissions. The pH values were generally below 5.6 (WHO 1970 limit for rain acidity) for many of the gas flare locations, hence a water-borne diseases prevalence and massive destruction in aquatic life will be recorded in these communities. However, on a few occasions, pH values were greater than 5.6 for rainwater samples collected from some other locations. Some of the general effects of the gas flared at Ogba-Egbema-Ndomi gas plant includes; stunted growth and red leaves observed in the cassava, plantain, palm trees, yam and other crops that were planted within 1800m to the flare station. It was also observed that, majority of the inhabitants who are farmers in Ogba-Egbema-Ndomi Community always migrate to communities that do not flare there gas for settlement in order to meet up their farming profession.

Conclusion

The result obtained in this research shows a marked trend as all the parameters considered which showed a gradient away from the flare point in all the stations, such as the pH changing from Extreme acid (3.5 - 4.4) to Moderately alkaline (7.9 - 8.4) away from the flare points. Hence the gradient of all parameters under studied was above the W. H. O limit. These values portray a bad omen for the affected communities. unacceptable limits of pH has negative effect on man and his environment, especially on the socio-economic activities of the inhabitants. Some of the general effects of the gas flared at Ogba-Egbema-Ndomi gas plant includes the stunted growth and red leaves observed in the cassava, plantain, palm trees, yam and other crops that were planted within the flare area. It was also observed that, majority of the inhabitants who are farmers in Ogba-Egbema-Ndomi Community always migrate to communities that do not flare gas for settlement in order to meet up with their farming profession. The result of this study suggest that, although the people of the Ogba-Egbema-Ndomi Community region may have benefited from oil and gas exploration, the adverse economic, environmental health, social urbanization impacts of the operations out weight the benefits. Oil and gas exploration and exploitation is one of the major reasons the atmosphere, land and sea as well as life's and plant therein are clearly being disturb. This study therefore recommends that gas flaring should be seen as violet action against the people and that the flared gas should be channelled to meeting the ever increasing demand for energy in the industrial sector of the economy.

Recommendation

It is hereby recommended that the gas obtained should either be used by a gas turbine for electric power generation or liquefied and bottled for domestic and industrial purposes. Furthermore, the Environmental law Enforcement Agencies, especially Department of Petroleum Resources (DPR), should be more involved in enforcing all existing environmental laws on gas flaring so as to take care of the community's basic amenities and advice for a strong technological bases that harness Nigeria's gas potentials. Also, Chemical analysis of the roofing sheets and water analysis should be carried out within and away from the area to determine the extent of corrosion and ascertain the portability of the water. Finally, residential buildings should be situated at least 2km away from the flare point.

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