

Impact of Gas Explosion on Water Qualities and Soil Properties in Nsit Ibom L. G. A, Akwa Ibom State

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Abstract

Impact of gas explosion on water qualities and soil properties in Obotim Nsit, Nsit Ibom L.G.A, Akwa Ibom State were investigated. The aim was to establish baseline information on the impacts of gas explosion in water and soil properties. Soil samples were collected from three points and bulked to form composite sample at depth of 0-15 and 15-30 cm using soil auger within the vicinity of explosion and along the pipeline corridor. Also, soil samples were collected 300m away from the gas explosion vicinity to serve as control. A total of 7 composite soil samples were collected for laboratory analysis. Undisturbed soil samples were equally collected using core ring for the determination of permeability and bulk density. Rain and stream water were collected within the vicinity of explosion. The samples were properly bagged, labelled and taken to the laboratory for analysis. The study revealed that, in comparison with the control, gas explosion increased sand fraction, bulk density and reduced clay fraction, permeability and total porosity. Gas explosion reduced soil pH, soil organic matter, total N, available P, exchangeable bases (Ca, Mg, Na and K), cation exchange capacity and raised electrical conductivity and exchangeable acidity. Gas explosion also increased the concentrations of Cd, Cr, Pb and Ni in the soil, water qualities affected by gas explosion were temperature, pH, turbidity, chloride, Cd, Ni and Cr. These parameters were raised by gas explosion in the area. Therefore, gas explosion is responsible for the fast decline in soil and water qualities in the explosion vicinity. It is recommended that gas pipeline should be regularly checked and service to avoid leakages and explosion.

KEYWORDS: Explosion, Corridor and Samples.

Introduction

Gas explosion is an explosion resulting from a gas leak in the presence of an ignition sources. The principal explosive gases are natural gas, methane, propane and butane because they are widely used in heating purposes. The deleterious effect of gas explosion on the environment is wide and varied. The explosive gases make up about 80% of greenhouse gases which give rise to global warming and eventual climate change. The heat radiation from gas explosion results in micro bacteria decline of the affected areas which gives rise to poor farm yields (Okezie, 1989). Efe (2003) reported that over 10 hectares of vegetal land were destroyed by gas explosion in Otakeme area of Bayelsa State. The explosive gases acidity the soil, and deplete soil nutrient. Studies have shown that the nutritional values of crops within gas explosion vicinity are low compared non-gas explosion area. In some cases, there is no vegetation in the areas surrounding the gas explosion vicinity due partly

to the tremendous heat that is produced and acid nature of soil (low soil pH). The effects of changes in soil temperature due to excessive heat on crops included stunted growth, scotched plants and withering of young crops. It is therefore, concluded that soils of gas explosion vicinity are fast losing. Their fertility and capacity for sustainable agriculture due to the acidification of the soils by the various pollutants associated with the explosive gases (Etukudoh EN, Ikpe FN, Gbarake R, Akpan Joyce Fidelis). The explosive gases contribute to global warming; acidify lakes and streams and damages aquatic lives. Recently, there was gas explosion in Obotim Nsit, Nsit Ibom Local Government Area of Akwa Ibom State; this investigation was done to assess the impact of gas explosion on water and soil properties.

MATERIALS AND METHODS

Study Area

Impact of Gas Explosion on Water Qualities and Soil Properties in Nsit Ibom L. G. A, Akwa Ibom State

This investigation was done in Obotim Nsit village, Nsit Ibom Local Government Area of Akwa Ibom State. Nsit Ibom is a Local Government Area located in the

southwestern part of Akwa Ibom State, Nigeria. It is one of the Ibibio speaking local government areas.

MAP OF AKWA IBOM STATE (NSIT IBOM) INSERTED



Field Work

Soil samples were collected from three points and bulked to form composite sample at depth of 0-15 and 15-30 cm using soil auger within the vicinity of explosion and along the pipeline corridor. Also, soil samples were collected 300m away from the gas explosion vicinity to serve as control. A total of 7 composite soil samples were collected for laboratory analysis. Undisturbed soil samples were equally collected using core ring for the determination of saturated hydraulic conductivity (permeability) and bulk density. Rain and stream water were also collected within the vicinity of explosion. The samples were properly bagged, labeled and taken to the laboratory for analysis.

Laboratory analysis

The soil samples were air dried before grinding and sieved with a 2 mm sized sieve. The soil samples were analyzed in accordance with standard laboratory procedures for the following parameters: **Particle-Size Analysis** was carried out using the Bouyoucos hydrometer method as described by Udo, E.J.Ibia T.O.Ojuwale, J.A, And. O, and Esu I.E (2009). **Saturated hydraulic conductivity (permeability)** was determined using constant head permeameter method as described by Klute (1986). **Bulk density** was determined by the method of non-story soil as described by Grossman and Reinsch, (2002). **Soil pH** was determined in 1:2.5 soil: water ratio using pH meter with class electrode (HANNA) Instrument Model 209) (Thomas, 1996). **Electrical conductivity (EC)** of the soil was measured in the extract obtained from 1:2.5 soil: water suspension with digital conductivity bridge. **Soil organic carbon (SOC)** was determined by the dichromate wet-oxidation method as described by Nelson and Sommers (1996). **Total nitrogen** was determined by the micro-Kjeldah digestion and distillation method as described by Bremner (1996). **Available phosphorus** was extracted using Bray P-1 extractant and P in the extract was measured with Spectrophotometer (Model Spectronic 20D) using the

molybdenum blue colour method of Murphy and Riley (1962). **Exchangeable bases** were extracted with 1 neutral NH_4OAc (pH 7) solution. The concentrations of K and Na in the extract were determined using Flame Analyser, Model FP 640, while Ca and Mg were obtained by versenate titration as described by Udo *et al.* (2009). **Exchangeable acidity** (Al^{3+} and H^+) was measured after extracting the soil samples with 1M KCl and titrating against 0.01M standard solution of NaOH as described in ISRIC (1992). **Effective cation exchange capacity (ECEC)** was computed by summation of exchangeable bases and exchangeable acidity (IITA, 1979). **Base saturation (BS)** was also computed as the sum of basic cations expressed as percentage of ECEC. $\% \text{ base saturation} = \frac{\text{summation of exchangeable bases} \times 100}{\text{ECEC}}$

Heavy metals (Cd, Ni Cr and pH) were determined by extraction using perchloric acid as extractant. The concentration of Cd, Ni Cr and pH in the extracts were determined using Atomic Absorption Spectrophotometer (AAS) (Model UNICAM 939). In water samples; hardness, chloride, nitrate, phosphate and sulphate were determined following methods described by AOAC (2006). Acidity, alkalinity pH, EC, DO, BOD, Turbidity and TDS were also determined by methods described by AOAC (2006).

Results and Discussion

1. Physical properties of soil of the gas explosion vicinity

The physical properties of soil within the gas explosion vicinity and control site are presented in Table 1.

Soil Texture

The sand fraction of soil within the gas explosion vicinity ranged from 90.30 to 91.30 % (mean 90.6 %) in the surface soil (0-15cm) and 89.30 to 91.30 % (mean 90.3%) in the subsurface soil (15-30 cm). the sand fraction of the control site was 84.40% in the surface soil (0-15 cm) and 82.40 % in the subsurface soil (15-30 cm). the silt fraction of soil within the gas explosion vicinity ranged from 6.60 to 6.80 % (mean 6.73 %) in the surface soil (0-15 cm) and 6.60 to 6.80% (mean 6.67%) in the subsurface soil (15-30 cm). the

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silt fraction of the control site was 5.0% in the surface soil (0-15 cm) and 10.0% in the subsurface soil (15-30 cm), the clay fraction of soil within the gas explosion vicinity ranged from 2.10 to 2.90 % (mean 2.63 %) in the surface soil (0-15 cm) and 1.10 to 4.10 % (mean 2.70%) in the subsurface soil (15-30 cm), the clay fraction of the control site was 10.60% in the surface soil (0-15 cm) and 14.00% in the subsurface soil (15-30 cm). The soil texture within the gas explosion vicinity was sandy in both surface (0-15

cm) and subsurface soil (15-30 cm). In the control site, soil texture was sandy in the soil surface (0-15 cm) and loamy sand in the subsurface soil (15-30 cm). The sandy subsurface soil within the gas explosion vicinity compared to loamy sand of the control site could be attributed to gas explosion. This is because heat from the gas disturbs the processes of eluviation – illuvation which enhanced clay translocation and formation (Odjugo and Osemwenkhae, 2009).

Table 1: Physical properties of soil of the gas explosion vicinity and control site

Sampling point	Depth (cm)	Sand (%)	Particle size Analysis				
			Silt	Clay %	Texture Classes	Bulk Density (g/cm ³)	Total Porosity (%)
Point 1	0-15	90.30	6.80	2.90	S	1.20	54.7
	15-30	90.30	6.80	2.90	S	1.00	62.26
Point 2	0-15	90.30	6.80	2.90	S	1.03	61.13
	15-30	89.30	6.60	4.10	S	1.01	61.89
Point 3	0-15	91.30	6.60	2.10	S	1.00	62.26
	15-30	91.30	6.60	1.10	S	1.10	58.49
Mean	0-15	90.60	6.73	2.63	S	1.08	59.4
	15-30	90.30	6.67	2.70	S	1.04	60.9
Control	0-15	84.40	5.00	10.60	S	0.7	68.0
	15-30	82.40	10.00	14.00	S	0.9	66.0

KEY:

SL= SANDY LOAM

Bulk density

The bulk density of soil within the gas explosion vicinity ranged from 1.00 to 1.20 gcm⁻³ (mean 1.1 gcm⁻³) in the surface soil (0-15cm) and 1.00 to 1.10 (mean 1.0 gcm⁻³) in the subsurface soil (15-30 cm). The bulk density of the control site was 0.7 gcm⁻³ in the surface soil (0-15 cm) and 0.9 gcm⁻³ in the subsurface soil (15-30 cm). The higher bulk density values of soil within gas explosion vicinity compared to control site could be due to gas explosion. Heat from the gas explosion increases bulk density by caking soil particles and destruction of soil structure which gives rise to massive structure and reduce soil pores and infiltration rate (Okeke and Okpala, 2014). High bulk density interferes with root penetration and seeding emergence.

Total porosity and Permeability

The total porosity of soil within the gas explosion vicinity ranged from 54.7 to 62.3% (mean 59.4%) in the surface soil (0-15 cm) and 58.5 to 62.3 % (mean 60.9 %) in the subsurface soil (15-30 cm). the total porosity of the control site was 68.0% in the surface soil (0-15 cm) and 66 % in the subsurface soil (15-30 cm). Total porosity was higher in the control site than gas explosion vicinity. This finding is in agreement with Okeke and Okpala, (2014) that heat caused caking of soil particles. Cake soil particles are dispersed and deflocculated with more or less parallel orientation resulting in less pore space (low total porosity) and less permeability.

Low permeability lead to reduction in rate of translocation of nutrients within plant system, affect soil temperature and microbial activities.

2. Chemical properties of soil within the gas explosion vicinity

The chemical properties of soil within the gas explosion vicinity and control site are presented in Table 2.

Soil pH

The soil pH within the gas explosion vicinity ranged from 4.2 to 4.5 (mean 4.3) in the surface soil (0-15 cm) and 4.1 to 4.2 (mean 4.2) in the subsurface soil (15-30 cm). Soil pH of the control site was 6.0 in the surface soil (0-15 cm) and 5.1 in the subsurface soil (15-30 cm). Soil pH within the gas explosion vicinity was extremely acid in both surface soil (0-15cm) and subsurface soil (15-30 cm) while control site was moderately acid in the surface soil and strongly acid in the subsurface soil. The low soil pH within the gas explosion vicinity compared to control could be attributed to the gas explosion. According to Ogidiolu (2003), one major effect of gas explosion or flaring on soil chemistry is the increase in soil acidity resulting in reduction of soil pH.

Electrical conductivity (EC)

The electrical conductivity of soil within the gas explosion vicinity ranged from 0.05 to 0.06 ds/m (mean 0.05 ds/m) in the surface soil (0-15 cm) and 0.06 ds/m (mean 0.06 ds/m) in the subsurface soil 15-30 cm). Electrical conductivity of

the control site was 0.04 ds/m in the surface soil (0-15 cm) and 0.04 ds/m in the subsurface soil (15-30 cm). Electrical conductivity of soil within the gas explosion site was greater than the control site. Atuma and Ojeh (2013) also observed similar result (greater electrical conductivity in gas flare site compared to control) in Ebedei community of Delta State, Nigeria. high electrical conductivity is an indication of excess salts which hinder plant growth by affecting soil-water balance.

Soil organic matter and total nitrogen

The soil organic matter within the gas explosion vicinity ranged from 2.3 to 4.8 (mean 3.2 %) in the surface soil (0-

15 cm) and 1.7 to 4.7 (means 2.9 %) in the subsurface soil (15-30 cm). soil organic matter of the control site was 3.6 % in the surface soil (0-15 cm) and 3.2 % in the subsurface soil (15-30 cm). The mean soil organic matter (3.2 and 2.9 %) within gas explosion vicinity was lower than control site (3.6 and 3.4%). The low organic matter content compared to control could be due to intense heat from the gas explosion. The tower the organic matter contents in the soil, the lower the total nitrogen content. Heat effects the process of organic matter and total nitrogen formation (Ogidiolu, 2003, Etukudoh, N.E, Joyce Akpan F, Chukwu-mali J.A 2017).

Table 2: Chemical properties of soil of the gas explosion vicinity and control site.

Samples Point	Depth (cm)	pH	EC Ds/m(%) mg/kg	Organic Matter (%)	Exchangeable Bases						ECEC
					Av.P cmol/kg	Ca	Mg	Na	K	EA	
1.	0-15	4.3	0.05	4.8	4	2.10	0.9	0.04	0.07	1.30	4.41
	15-30	4.2	0.06	4.7	13	2.6	1.20	0.04	0.08	1.40	5.37
2.	0-15	4.5	0.05	2.3	2	3.00	1.30	0.05	0.10	1.60	5.95
	15-30	4.2	0.05	1.7	5	3.20	1.20	0.04	0.08	1.50	6.02
3.	0-15	4.2	0.06	2.4	6	2.80	1.00	0.05	0.09	1.40	5.34
	15-30	4.1	0.06	2.2	10	2.30	1.08	0.05	0.10	1.30	4.83
Mean	0-15	4.3	0.05	3.2	4.0	2.6	1.1	0.05	0.09	1.4	5.2
	15-30	4.2	0.06	2.9	9.3	2.7	1.2	0.04	0.09	1.4	5.4
Control	0-15	6.0	0.04	3.6	31	5.8	1.8	0.06	0.11	2.2	9.4
	15-30	5.1	0.04	3.2	20	5.4	1.7	0.05	0.10	2.1	8.4

EC = Electrical Conductivity, EA = Exchangeable Acidity, ECEC = Effective Cation Exchange Capacity, BS = Base Saturation, Av,P = Available Phosphorus

Available Phosphorus (P)

The available P of soil within the gas explosion vicinity varied from 2 to 6 mg/kg (mean 4.0 mg/kg in the surface soil (0-15 cm) and 5 to 13 mg/kg (mean 9.3 mg/kg) in the 4.0 mg/kg) in the surface soil (0-15 cm) and 5 to 13 mg/kg (mean 9.3 mg/kg) in the subsurface soil (15-30 cm). Available P of the control site was 31 mg/kg in the surface soil (0-15 cm) and 20 mg/kg in the subsurface soil (15-30 cm). The available P of soil within the gas explosion vicinity was lower than control site. The low phosphorus content of soil within the gas explosion vicinity could be attributed to abundant Al^{3+} prevalent in soil with low pH, which reacts more readily with soluble phosphorus to form insoluble aluminium phosphate. Insoluble aluminium phosphate is not available for plant use.

Exchangeable Bases

The exchangeable Ca of soil within the gas explosion vicinity varied from 2.1 to 3.0 cmol/kg (mean 2.6 cmol/kg) in the surface soil (0-15 cm) and 2.6 to 3.2 cmol/kg (mean 2.7 cmol/kg) in the subsurface soil (15-30 cm). Exchangeable Ca of the control site was 5.8 cmol/kg in the surface soil (0-15 cm) and 5.4 cmol/kg in the subsurface soil (15-30 cm). The exchangeable Mg of soil within the gas explosion vicinity varied from 0.9 to 1.3 cmol/kg (mean 1.1 cmol/kg) in the surface soil (0-15 cm) and 1.1 to 1.2 cmol/kg (mean 1.2 cmol/kg) in the subsurface soil (15-30 cm). Exchangeable Mg of the control site was 1.8 cmol/kg in the

surface soil (0.15 cm) and 1.7 cmol/kg in the subsurface soil (15-30 cm). the exchangeable Na of soil within the gas explosion vicinity varied from 0.04 to 0.05 cmol/kg (mean 0.05 cmol/kg) in the surface soil (0-15 cm) and 0.04 to 0.05 cmol/kg (mean 0.04 cmol/kg) in the subsurface soil (15-30 cm). Exchangeable Na of the control site was 0.06 cmol/kg in the surface soil (0-15 cm) and 0.05 cmol/kg in the subsurface soil (15-30 cm). the exchangeable K of soil within the gas explosion vicinity varied from 0.07 to 0.1 cmol/kg (mean 0.09 cmol/kg) in the surface soil (0-15 cm) and 0.08 to 0.1 cmol/kg (mean 0.09 cmol/kg) in the subsurface soil (15-30 cm). Exchangeable K of the control site was 0.11 cmol/kg in the surface soil (0-15 cm) and 0.10 cmol/kg in the subsurface soil (15-30 cm). The values showed that exchangeable Ca, Na and K of soil within the gas explosion vicinity were low while exchangeable Mg was moderate. Exchangeable Ca^{2+} , Mg^{2+} , Na^+ and K^+ of soil within the gas explosion vicinity were lower than that of control site. This finding is in agreement with Alakpodia (2000), Etukudoh *et al.*, (2016) that gas explosion of flare is detrimental to the accumulation of exchangeable bases (Ca, Mg, Na and K) and promotes soil fertility loss.

Exchangeable Acidity

The exchangeable acidity of soil within the gas explosion vicinity varied from 1.3 to 1.6 cmol/kg (mean 1.4 cmol/kg) in the surface soil (0-15 cm) and 1.3 to 1.5 cmol/kg (mean 1.4 cmol/kg) in the subsurface soil (15-30 cm). Exchangeable acidity of the control site was 2.2 cmol/kg in

the surface soil (0-15 cm) and 2.1 cmol/kg in the subsurface soil (15-30 cm). Exchangeable acidity is acidity pool primarily associated with cation exchange sites and with Al^{3+} and H^+ . Exchangeable acidity of soil within the gas explosion vicinity was higher than the control site. This is an indication that potential acidity was higher in gas explosion vicinity than control site.

Effective Cation Exchange Capacity (ECEC)

The ECEC of soil within the gas explosion vicinity varied from 4.4 to 5.9 cmol/kg (mean 5.2 cmol/kg) in the surface soil (0-15 cm) and 4.8 to 6.0 cmol/kg (mean 5.4 cmol/kg) in the subsurface soil (15-30 cm). The ECEC of the control site was 9.4 cmol/kg in the surface soil (0-15 cm) and 8.4 cmol/kg in the subsurface soil (15-30 cm). The ECEC of gas explosion vicinity compared to control site could be attributed to low organic matter and clay content as a result of the heat from the gas explosion (Alakpodia, 2000).

Base Saturation

The base saturation of soil within the gas explosion vicinity ranged from 70.5 to 73.8 (mean 72.5 % in the surface soil

(0-15 cm) and 73.1 to 75.1 (mean 78.7 %) in the subsurface soil (15-30 cm). base saturation of the control site was 79.5 % in the surface soil (0-15 cm) and 78.7 % in the subsurface soil (15-30 cm). Base saturation was high in both gas explosion vicinity and control site.

3. Impacts of gas explosion on soil heavy metals

The impact of gas explosion on soil heavy metals are presented in Table 3.

Cadmium (Cd)

In soil within the gas explosion vicinity, the concentration of cadmium (Cd) varied from 18.2 to 19.4 mg/kg (mean 18.8 mg/kg) within 0-30 cm soil depth. In control site, the concentration of Cd was 2.1 mg/kg within 0.30 cm soil depth. The concentration of Cd in soil within gas explosion vicinity was higher than the control and above the maximum permissible concentration of 0.6 mg/kg (Kabata-Pendias, 2001) and 2.0 mg/kg (DPR) for agricultural soil.

Table 3: Impacts of gas explosion on soil heavy metals within 0-30 cm depth

Sampling point	Cd (mg/kg)	Ni (mg/kg)	Cr (mg/kg)	Pb (mg/kg)
Point 1	18.20	16.45	7.80	22.75
Point 2	19.40	1.30	8.30	16.45
Mean	18.8	18.9	8.1	19.6
Control	2.1	7.8	6.0	6.7

KEY: Cd = Cadmium, Ni = Nickel, Cr = Chromium, Pb = Lead

Nickel (Ni)

In soil within the gas explosion vicinity, the concentration of nickel (Ni) varied from 16.5 to 21.3 mg/kg (mean 18.9 mg/kg) within 0-30 cm soil depth. In control site, the concentration of Ni in soil within gas explosion vicinity was higher than the control and below the maximum permissible concentration of 60mg/kg (Kabata-Pendias, 2001) and 100 mg/kg (DPR) for agricultural soil.

Chromium content (Cr)

In soil within the gas explosion vicinity, the concentration of chromium (Cr) varied from 7.8 to 8.3 mg/kg (mean 8.1 mg/kg) within 0-30 cm soil depth. In control site, the concentration of Cr was 6.0 mg/kg within 0-30 cm soil depth. The concentration of Cr in soil within gas explosion

vicinity was higher than the control and within the permissible concentration of 250 mg/kg (Kabata-Pendias, 2001) for agricultural soil.

Lead content (Pb)

In soil within the gas explosion vicinity, the concentration of lead (Pb) varied from 16.5 to 22.8 mg/kg (mean 19.6 mg/kg) within 0-30 cm soil depth. In control site, the concentration of Pb was 6.7 mg/kg within 0-30 cm soil depth. The concentration of Pb in soil within gas explosion vicinity was higher than the control and within the permissible concentration of 350 mg/kg (Kabata-Pendias, 2001) and 200 mg/kg (DPR). For agricultural soil.

Impacts of explosion on water qualities

The impacts of gas explosion on water qualities are presented in Table 4.

	mg/l	79.88	73.735
Chloride			
Ca	mg/l	224.00	48.00
Mg	mg/l	44.099	15.99
Na	mg/l	3.00	1.200
K	mg/l	5.00	2.00
Cd	mg/l	0.96	0.008
Ni	mg/l	0.16	0.45
Cr	mg/l	0.014	0.10
Pb	mg/l	0.097	0.05

Symbols: Ca = Calcium, Mg = Magnesium, Na = Sodium, K = Potassium, Cd = Cadmium, Ni = Nickel, Cr = Chromium, Pb = Lead.

pH

The pH of stream water within gas explosion vicinity was 4.5 and rain water also 4.5.

The pH stream and rain water was below the permissible limit of 6.5-8.5. The lower pH water is likely to be corrosive (WHO,2006).

Electrical conductivity (EC)

Electrical conductivity of stream water within gas explosion vicinity was 56.0 us/cm and rain water was 31.0 us/cm. electrical conductivity of stream water and rain water was below the permissible limit of 2.500 us/cm indicating below ionic content of water samples.

Dissolved oxygen (DO) and Biological oxygen demand (BOD)

The dissolved oxygen of stream water within gas explosion vicinity was 8.1mg/l while rain water was not detected. Biological oxygen demand of stream water within gas explosion vicinity was 2.3 mg/l while rain water was not detected. The non-detected value of dissolved oxygen and biological oxygen demand in rain water is an indication of depletion of dissolved oxygen in the water. Depletion of dissolved oxygen in water can encourage microbial reduction of nitrate to nitrite and sulphate to sulphide (WHO, 2006).

Total suspended solid (SSS)

Total suspended solid (SSS) of stream water within gas explosion vicinity was 0.8 mg/l while rain water was 1.0mg/l. Total suspended solid was below the permissible limit of 50 mg/l for safe drinking water quality in Nigeria (NIS, 2007).

Total dissolved solid (TDS)

Total dissolved solid (TDS) of stream water within gas explosion vicinity was 38.4 kg/l while rain water was 15.5 mg/l. Total dissolved solid was less than 600mg/l generally considered to be good for drinking water in Nigeria (NIS, 2007). High TDS give rise to saline water.

Turbidity

Turbidity of stream water within gas explosion vicinity was 58.INTU while rain water was 16.2 NTU. Turbidity of both stream and rain water was above the permissible limit of 5NTU for safe drinking water quality in Nigeria (NIS, 2007). High turbidity is an indication of the presence of very finely divided solid that are not filterable by routine method.

Acidity and alkalinity

Acidity of stream water within gas explosion vicinity was 2999.9 mg/l while rain water was 66.7 mg/l. Alkalinity of stream water within gas explosion vicinity was 166.7 mg/l while rain water was 73.3 mg/l. Acidity of water affect its corrosiveness while alkalinity is responsible for eutrophication. Alkalinity in the study area was below the permissible limit of 400 mg/l.

Hardness

Hardness of stream water within gas explosion vicinity was 44.2 mg/l while rain water was 16.2 mg/l. Both stream and

rain water hardness was below 50 mg/l, indicating that the water was soft. (not hard).

Anions

Nitrate of stream water within gas explosion vicinity was 3.4 mg/l while rain water was 2.3 mg/l. Sulphate of stream water within gas explosion vicinity was 45.1 mg/l while rain water was 33.6 mg/l. Phosphate of stream water within gas explosion vicinity was 0.05 mg/l while rain water was 0.3 mg/l. Chloride of stream water within gas explosion vicinity was 79.9 mg/l while rain water was 73.3 mg/l. Nitrate and phosphate were below the maximum permissible levels of 50 mg/l and 0.7 mg/l while chloride was above the permissible level of 5 mg/l for safe drinking water quality in Nigeria (NIS, 2007).

Cations

The content of Ca in stream water within gas explosion vicinity was 224.0 mg/l while rain water was 48.0 mg/l. The content of Mg in stream water within gas explosion vicinity was 44.1 mg/l while rain water was 16.0 mg/l. The content of Na in stream water within gas explosion vicinity was 3.0 mg/l while rain water was 1.2 mg/l. The content of K in stream water within gas explosion vicinity was 5.0 mg/l while rain water was 2.0 mg/l. The contents of Ca, Mg, Na and K were within the permissible levels for safe drinking water quality in Nigeria (NIS, 2007).

Heavy metals

The content of Cd in stream water within gas explosion vicinity was 0.96 mg/l while rain water was 0.008 mg/l. The content of Ni in stream water within gas explosion vicinity was 0.16 mg/l while rain water was 0.45 mg/l. The content of Cr in stream water within gas explosion vicinity was 0.014 mg/l while rain water was 0.10 mg/l. The content of Pb in stream water within gas explosion vicinity was 0.1 mg/l while rain water was 0.05 mg/l.

The contents of Cd (0.03 mg/l), Ni (0.07 mg/l) and Cr (0.05mg/l) were above the permissible levels while the content of Pb (0.01 mg/l) was below the permissible level. (William *et al.*, 2013).

Recommendation

Therefore, gas explosion is responsible for the fast decline in soil and water qualities in the explosion vicinity. It is recommended that gas pipeline should be regularly checked and service to avoid leakages and explosion.

Conclusion

The study revealed that, in comparison with the control, gas explosion increase sand fraction and bulk density and reduced clay fraction, permeability and total porosity Gas explosion reduced soil pH, soil organic matter, total N, available P, exchangeable bases (Ca, Mg, Na and K), cation exchange capacity and raised electrical conductivity and exchangeable acidity. Gas explosion also increase the concentrations of Cd, Cr, Pb and Ni in the soil. Water qualities affected by gas explosion were temperature, pH, turbidity, chloride Cd, Ni and Cr. These parameters were raised by gas explosion. Therefore gas explosion is responsible for the fast decline in soil and water qualities in the vicinity

Recommendation

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