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Influence of Gas Flaring on some physical Properties of Soils in Kwale, Delta State

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Abstract: *This research assessed the influence of Gas flaring on some physical properties of the immediate Environment. The significance of this research is to determine the impact of gas flaring on some physical properties of Soils, especially since agriculture is the occupation of the host Communities. These research findings will address the knowledge gap in this area. It will further provide invaluable information for students, scientist and researchers and assist government to make informed decisions on sustainable management of the Environment. The study entailed collection of twenty seven (27) soil samples from a Gas flare site at Kwale. The samples were collected at a flare site at distances of 200m to 2.250km away from the flare and a control sample was collected at 35km away from the locality. Each of these samples was collected at varying depths of 5cm, 10cm and 15cm respectively. The essence of employing this methodology is to establish possible link between Soil physical properties and the heat and Gases released from the Gas flare in the study area. The results revealed influence from the Gas flare especially in the pH, Temperature and Moisture content of Soils. The pH showed the least value (most acidic) of 5.12 at depth of 5cm and distance of 200m away from the flare. The high acidity observed in the area is likely from such sources as acid rain. The Soil Temperature at 200m and 5cm depth, recorded the highest value (39.7 ^{0}C) and the least value (27^{0}C) km was observed at 35km (control site) away. The least value for Moisture content (5.83%) was recorded at 200m and the highest (15.38%) at the control site. The values obtained from both insitu and laboratory tests, showed that the gas flare has negatively influenced the Soil pH, Moisture content and Temperature.*
Keywords: *Gas Faring, pH, Temperature, Moisture Content, contamination, kwale*

I. Introduction

Gas flaring is the burning of natural gas and other petroleum hydrocarbons at flare stacks in oil fields during operation. The gas produced as associated natural gas during oil production varies in composition from location to location; however, the basic components include methane (CH_4), ethane (C_2H_6), propane (C_3H_8), iso-butane (C_4H_{10}), iso-pentane (C_5H_{12}), hexane (C_6H_{14}), carbon dioxide (CO_2), Hydrogen sulfate (H_2S), Helium (He), and Nitrogen (N). It is used to dispose of associated gas. Low flare stacks bring the flare close to nearby vegetation and soil.

A Gas flare, alternatively known as a flare stack, is an elevated vertical conveyance found accompanying the presence of oil and gas 'Wells, rigs, refineries, chemical plants, natural gas plants, and landfills. They are used to eliminate gas, which is released via pressure relief valve when needed to ease the strain on equipment.

Gas flaring has been reported by many researchers to be a major cause of acid rain, low agricultural productivity, fishing and hunting in the Niger Delta, thereby impoverishing the inhabitants. (Alakpodia, 2000; Daudu, 2001, Odjugo, 2002, Akudo et al., 2012).

Akudo. et al, (2012), has reported increased soil temperatures by between 12.6 degrees Celsius and 23.4 degrees Celsius and reduced soil moisture at 5cm by 18.6% and 2.8% from gas flaring. It is also established that changes on soil temperature and moisture contents is significant with distance away from flare sites.

Gas flaring significantly affects not only the microclimate but also the soil physio-chemical properties of the flare sites. Some of the substances released alters the surface and ground water quality, aggregate nutrient deficiencies in soils, or accelerate the soiling, weathering or corrosion of engineering and cultural materials. There are also visible changes in soil characteristics close to a flare site (Alakpodia (2000). Gas flaring destroys the vegetation and destabilizes the eco-system. (Ogbonanya, 2003).

Metabolically regulated plant processes, such as water and nutrient uptake can be diminished below optimum rate at both low and high temperature, resulting in temperature dependent growth and yield pattern. For instance, corn yields were observed to increase almost linearly as a function of soil temperature between 15-25^{o}C, above 25^{o}C the yield decreases. (Allmaras et al, 1964). Additionally, excessive heat either kills or scares away most of the micro and macro organisms that would have helped to improve the soil through further breaking down of the soil particles, decaying and decomposition of the organic matters. (Alakpodia, 2000).

The extent of human damage attributable to gas flaring is unclear, but doctors have found an unusual high incidence of asthma, skin and breathing problems in oil producing areas (Abdulkareem et al., 2006).

The existence of Gas flare stacks in most parts of the Niger Delta area including Kwale (study area) necessitated this study. This study therefore investigated the effect of gas flaring on some soil physical properties of the study area.

II. Location Of Study Area

The study area Kwale is within the Sombriero Warri deltaic plain deposit invaded by mangrove and located within latitude $5^0\ 66^1$ N and $5^0\ 75^1$ N and longitude $6^0\ 40^1$E and $6^0\ 45^1$E as shown in fig. 1 below.

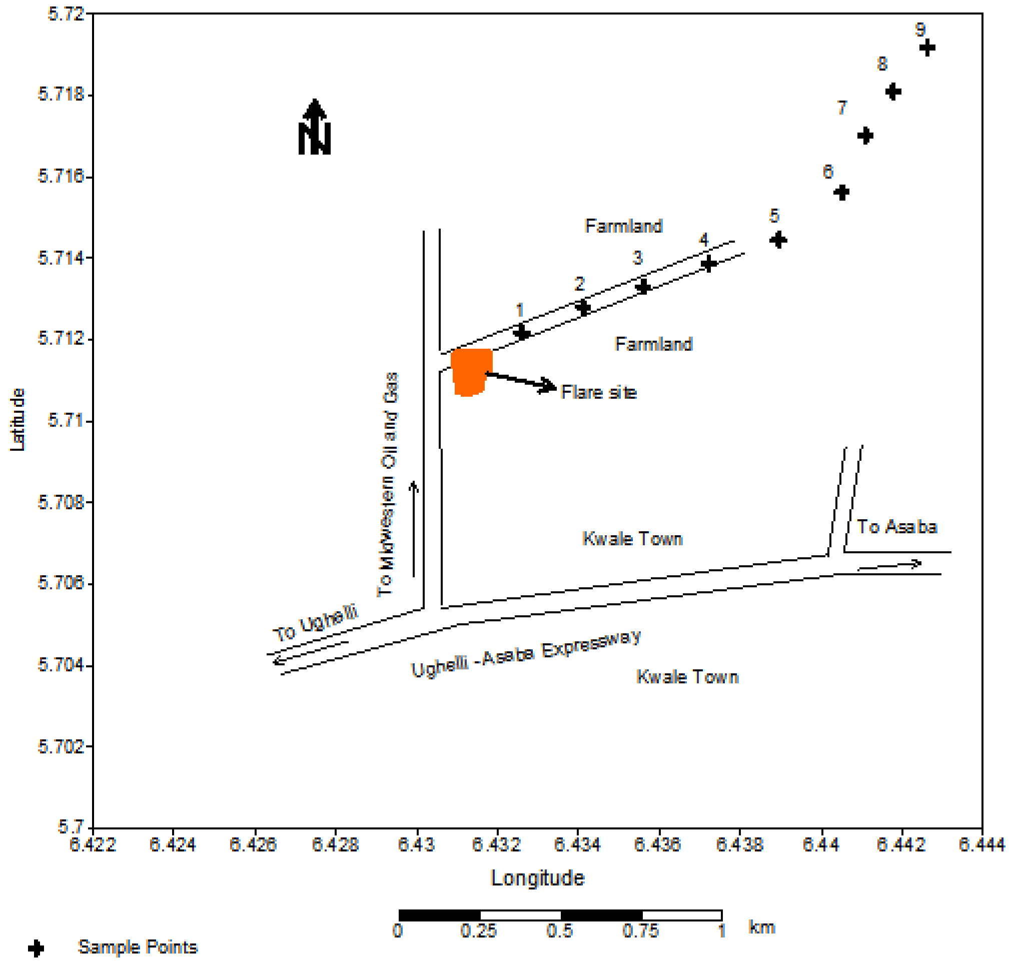

Fig 1.0: Sketch map of study area showing the sample points

The subsurface geology of the Niger Delta Basin to which Kwale belongs is well established. The basin fill is made up of three formations, namely from the oldest to the youngest, Akata, Agbada and Benin Formations [Nwajide, 2006, Short and Stauble, 1967, Frank, and Cordry, and Murat, 1970]. The Akata Formation is composed of continuous shale and about 10% sandstone. The shale is believed to be over pressured and under-compacted. It ranges from Eocene to Recent and was deposited under marine conditions. The Agbada Formation conformably overlies the Akata Formation in the subsurface. It is a parallic sequence of alternating shale and sandstone with a variable age ranging from Eocene in the north to Pliocene/Pleistocene in the south, and Recent in the delta surface. Its lateral equivalents at the surface are the Ogwashi-Asaba Formation and Ameki Formation of Eocene- Oligocene age.

III. Field Procedures and Records

This study involves sampling and analytical methods. Soil samples were collected from nine different locations in Kwale, and a control from Amai with distances of 200m, 500m, 750m, 1km, 1.250km, 1.500km, 1.750km, 2km, 2.250km, and 35km away from the flare site at a depth of 0 to 5cm, 5 to 10cm and 10 to 15cm respectively. The soil samples were put in a dark polyethene bags properly labeled and then taken to the laboratory for analysis. Before the samples were collected, there was need for bush clearing. This method entailed the use of cutlass to clear the bush and also dig holes to the depths of 15cm so as to enable soil temperature testing and soil collecting. Also atmospheric temperature was measured at each location where soil samples were collected and soil temperature was measured at each depth where soil samples were collected using thermometer (testo 915-1), and latitude and longitude was taken at each location using GPS etrex (Garmin).

Soil samples were taken to the laboratory for analysis, and all analysis were conducted at chemical and biological sciences laboratory. This started by weighing the containers when empty with a weigh balance, the containers in which soil samples were put and the weight before and after drying.

Also an oven was used to dry the soil samples at a temperature range of 110°C. The drying of the samples lasted six (6) hours from 8pm to 2am the following day. The container in which the samples were put was weighed when empty, and then the figures were recorded. The same process was repeated again with samples and it was repeated after the samples had been dried in the oven model MINO/30.

The pH of the various soils was determined using pH meter. The pH instrument was standardized with standard pH near that of the sample and with two others to check the accuracy of the electrode and water sampled as soon as possible and the pH recorded accordingly.

10g of the soil sample was weighed with a weighing dish into a 250ml beaker. 50ml of screened distilled water was measured into it and was stirred for thirty minute with the aid of a magnetic stirrer after which the pH was measured with pH meter (fisher automatic tetrameter Model 36 - pH (AOAC, 2003).

Table 1.0: Results of Insitu and Laboratory Analysis

Distance from flare site	200m	500m	750m	1km	1.250 km	1.500 km	1.750km	2km	2.250km	35km
Air temperature °C	39.2	35.5	36.8	37.5	39	40.8	40.7	35.3	37.2	27.2
Latitude	5°42'49.0 "N	5°42'51.05 "N	5°42' 54.68 "N	5°42'57.46 "N	5°43' 06.52 "N	5°43' 08.97 "N	5°43'13.69 "N	5°43' 15.01 "N	5°43' 16.20 "N	5°44'52 "N
Longitude	6°52'33.38 "E	6°25'36.82'E	6°25' 41.76 "E	6°25'46.32"E	6°25' 50.93 "E	6°25' 53.51 "E	6°25'55.20"E	6°5'57.32 "E	6°5'58.9" E	6°12'24"E
Soil temperature °C (5cm)	39.7	34.2	36.1	36.9	39.6	39.1	37.1	35.1	35.8	27
Temperature °C (10cm)	38.9	32.3	35.8	36.3	38.6	35	35.3	34.9	35.8	27
Soil temperature °C (15cm)	38.2	32.3	36.5	36.6	39.8	38.6	35.3	34.9	35	26
Moisture content% (5cm)	6.98	6.26	9.09	6.99	6.75	10.83	7.14	7.92	9.21	13.90
Moisture content% (10cm)	8.38	7.39	10.55	6.16	7.77	11.81	8.03	9.03	8.44	15.38
Moisture content% (15cm)	5.83	8.13	7.68	7.11	6.58	6.35	13.23	8.51	14.69	14.38
pH 5(cm)	5.12	5.21	5.33	5.30	5.43	5.50	5.67	5.86	5.89	6.62
pH 10(cm)	5.06	5.15	5.26	5.27	5.33	5.41	5.40	5.77	5.77	6.18
pH 15(cm)	5.09	5.12	5.25	5.27	5.18	5.12	5.60	5.70	5.70	5.78

IV. Results And Discussion

The table above (table 1.0) shows results of both insitu and laboratory measurements. The air and soil temperature for instance revealed significant influence from the gas flaring sites.

The mean atmospheric temperature taken between 200m-2.250km is 38°C while that taken from the control site (8km away) is 27.2°C. Soil temperature at depth of 5cm and distance of 200m away from the flare recorded the highest value (39.7°C) and the least value (27°c) was observed at the control site (35km). This trend of decrease in soil temperature away from the flare was also observed at 10cm and 15cm depth. This shows that a simple relationship exist between soil temperature and distance of soil from flare site.

This least value for soil moisture content (5.83%) was observed at 200m away from the flare site and (15.38%) for control. This trend of increase in soil moisture content as we go away from the flare sites revealed that the soil will lack adequate amount of moisture due to heat from the gas flare.

The least value for pH (5.12) was recorded at the depth of 5cm and a distance of 200m away from the flare site and the highest value at 6.62 at control site. This trend of increase in pH values away from the flare is also observed in soil samples collected at 10cm and 15cm respectively: This shows that the soil in the area is acidic and does not meet the WHO standard for permissible limit. The charts (Fig 2.0 – 5.0) shown above, explained further the relationships between the distance from flare site and atmospheric temperature, soil temperature, moisture content and PH.

The atmospheric temperature (fig 2.0) reveals a steady decline in readings away from the flare site and as such the heat from the flare has more impact in the overall atmospheric temperature in areas close to the flare.

Soil temperature also showed very high values close to the flare site and declines away from the flare site with the least value recorded at the control site about 35km away. The heat therefore affected the topsoil around the flare facility more than it did affect soils far away.

The moisture content results (fig 4.0) show that all soils from the depth range (5 – 15cm) were influenced by the heat of the flare. A steady increase in soil moisture content was noticed in the chart as we move further away from the flare site.

The PH value (fig 5.0) has shown a distance but imperceptible increase from the point closest to the flare site (200m) up to the control site. The chart (fig 5.0) shows low PH at (200m) and continues to increase up to control site revealing that soils at close distance to the flare site has high acidity, a condition that will impede plants growth and development.

A similar trend of increase in soil temperature at the closest distance to flare site (200m) and decrease in soil moisture content at the closest distance to the flare has been observed in a study of the impacts of distance on soil temperature and moisture content in a gas flare site at Ebedei in Ukwuani by Akudo, et al (2012)

Alakpodia (2000) also observed that soils at very close distance to gas flare sites are impoverished because the heat from the gas flare hinders the process of eluviations and hydrolysis which could have enhanced the formation of clay minerals needed for plants.

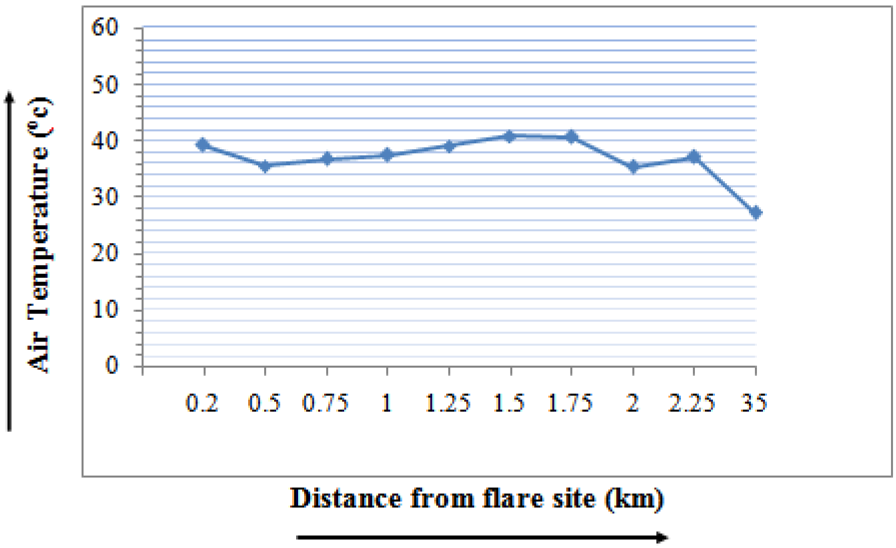

Fig. 2.0: Changes in Air Temperature with respect to Distance from flare site.

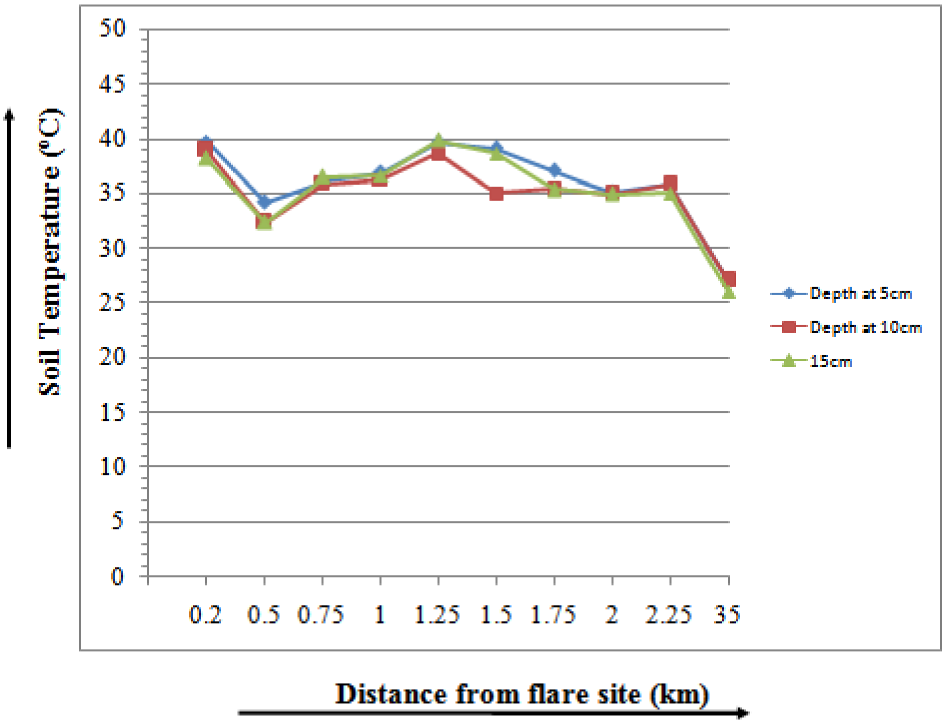

Fig. 3.0: Changes in Soil Temperature with respect to Distance from flare site.

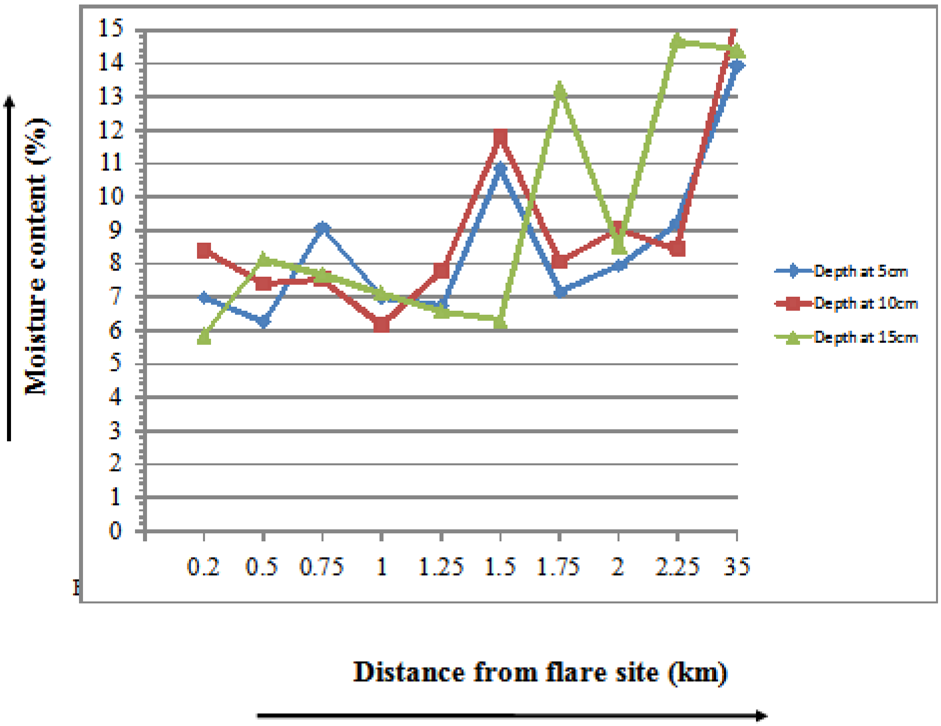

Fig. 4.0: Changes in Soil Moisture Content with respect to Distance from flare site.

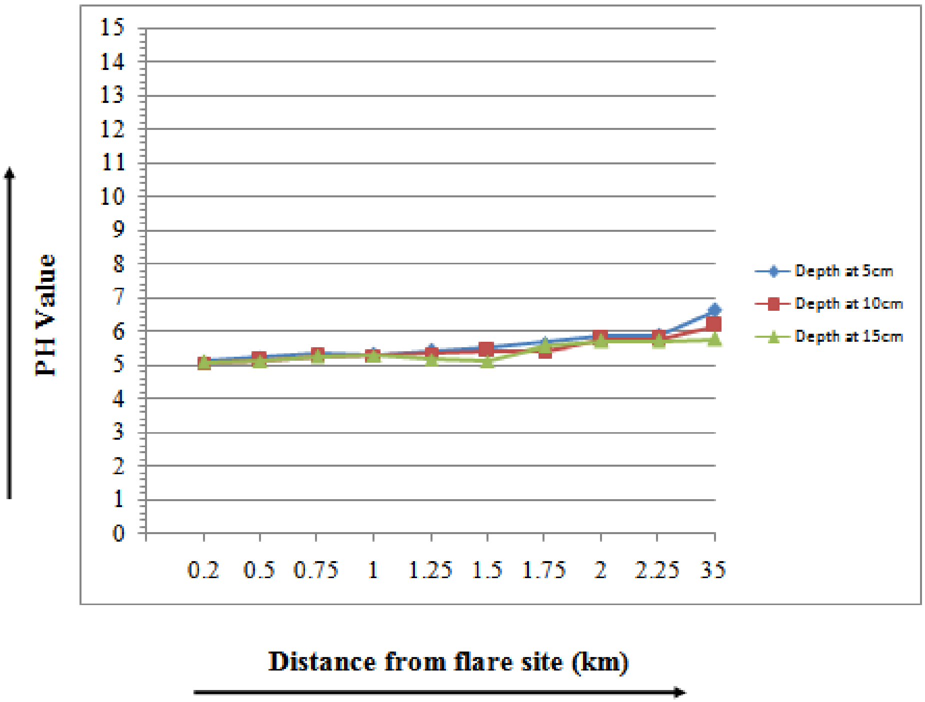

Fig. 5.0: Changes in PH Value with respect to Distance from flare site.

V. Summary And Conclusions

Flaring of associated gas in oil fields during operation affects soil fertility adversely. PH values changes from acidity to near neutral as we move away from the flare and moisture content of the soil increase as we go away from the flare site. It is therefore pertinent to say that soils close to flare sites will not have needed nutrients to support good plant yield.

VI. Recommendation

The government must understand that the human and other costs of gas flaring cannot be equated to even the highest revenue brought in by the sale of crude oil. The so called fines are accounted for as part of production cost of oil and are more or less paid for by the Nigerian state. They are no incentives for the corporations to stop the harmful practice. Halting gas flaring is recommended as a major step that government must take to show any seriousness to address the issue of the Niger Delta and to show acceptable global citizenship. Continued gas flaring is a complete negation of efforts being made in the world today to curb global warming.

VII. Limitation Of The Study

The main limitation of this research was that of adequate funding required to possibly evaluate the Soil nutrients and establish extent of depletion of Soil. Gaining access to the Company premises to collect Soil samples was also not allowed.

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