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Effects of gas flaring on the environment, using the Niger delta area of Nigeria as a case study

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ABSTRACT

Gas flaring is common in the oil and gas sector of the Nigerian economy and some other economies in the world without many people being aware of the full impact of its consequences on plants, micro-organisms and the environment at large. This study investigated the effects of gas flaring on the following parameters: soil pH, soil moisture and the nitrogen content of plants using soil and plant samples collected from three different flare sites (namely Ughelli ups, Sapele flow station and Amukpe flow station) and one non-flare (namely Mosogar flow station) as the control. The results of the study showed that the parameters investigated were all negatively affected to some extent. Statistically significant differences ($p < 0.05$) from the control were observed in the nitrogen levels of the roots collected from the three different flare sites. Except the shoot of the plant collected from Amukpe flow station, all the shoots analyzed from the flare sites showed significant reduction ($p < 0.05$) in their nitrogen levels compared to the control. For distance of 200m from the flare site, no significant difference in soil pH was observed for all the three different flare sites studied. For distance of 500m from the flare sites, Ughelli ups and Sapele flow stations showed significant difference ($p < 0.05$) in their soil pH compared to the control. Only Sapele flow station showed significant difference ($p < 0.05$) in soil pH compared to the control, for distance of 750m from the flare site. There was significant reduction in soil moisture contents of Ughelli ups and Amukpe flow stations compared to the control for the distance of 200m from the flare site. For distance of 500m, no significant difference ($p < 0.05$) from the control was seen in the moisture content of all the three flare locations. For distance of 750m, Ughelli ups and Amukpe flare sites showed significant reduction in their moisture content compared to the control. It was observed that the negative effects of the flare decreased with distance from the flare sites.

KEYWORDS

Gas flaring;
Oil and gas;
Environment;
pH;
Moisture;
Nitrogen content.

INTRODUCTION

The presence of unacceptable levels of foreign gaseous and particulate matter in the atmosphere is referred to as air pollution[1]. The deterioration of the environmental quality, which began when man first collected into

villages and started utilizing fire, has existed as a serious problem under ever increasing impacts on exponentially increasing population and industrial society. Gas flaring which is the controlled burning of natural gas that cannot be processed or sold, is one of the causes of environmental and air pollutions. It is also the process of burning off surplus combustible vapour from a well, either as a means of disposal or as a safety measure to relieve well pressure[2]. Gas occurs in two forms: (i) Associated gas (AG) which is either dissolved in and is involuntarily produced with oil, or lying on top of the oil in a combined oil and gas reservoir and (ii) Non-associated gas (NAG), which is in reservoirs containing gas only[2]. The composition of natural gas varies depending on the origin, type, genesis and location of deposit, geological structure of the region and other factors[3].

The impact of gas flaring is of local and global concern, the main components include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), water vapour and sulphur dioxide (SO_2). Carbon dioxide and methane are the main green house effect gases and have been confirmed to raise global temperature by about 0.5 ^{o}C within the last century[4]. Typical gas flares in Nigeria oil fields are located at ground level and surrounded by thick vegetation, farm land and village huts 20-30m from the flare. There is a great physiological impact on crops planted in the vicinity of the flare. It has been reported that there could be about 100% loss in yield of crops cultivated 200m away from the flares, 45% loss in yields of crops 600m away and 10% loss in yields for crops planted 1000m away[5]. With a daily crude oil output of about two million barrels a day, Nigeria has over 200 gas flare sites, some of which have been on continuously for over twenty years[6]. While about 22 billion standard cubic feet (SCF) of natural gas is produced daily, about 75% of it is being flared which equals about 25% of the United Kingdom's total natural gas consumption and is equivalent to 40% of the entire African continent's gas consumption in 2001[6].

This study is aimed at investigating the effects of gas flaring on plants in the Niger- Delta area with respect to the soil pH, soil moisture and the nitrogen content of the plant.

EXPERIMENTAL

Sample collection

The soil and plant samples were obtained from three land locations with flare (Ughelli pump station-ups, Sapele flow station and Amukpe flow station) and one land location without flare (Mosogar flow station) which is the control. All these stations are located in Delta state, Nigeria. The samples were collected 200m, 500m and 750m from the flare at each site. Some soil samples were collected and air-dried for pH determination. The soil samples for moisture determination were used immediately to avoid loss of moisture to the atmosphere. The plant samples (shoot and root) collected were dried for three days and ground to powder before use.

pH, moisture and nitrogen determination

The pH was determined using pH meter while the soil moisture and plant nitrogen were determined using the method of Pearson[7].

RESULTS

The results of the pH values of soil samples collected at the different sites are shown in Figure 1. The mean ± Standard Deviation of the three flare locations for 200m, 500m and 750m were 5.17 ±0.86, 5.23 ± 1.16 and 5.23 ± 1.05 respectively, while that of the control was 6.63 ± 0.06. Statistical analysis showed that Ughelli vs control; Sapele vs control and Amupke vs control are all significant ($p<0.05$).

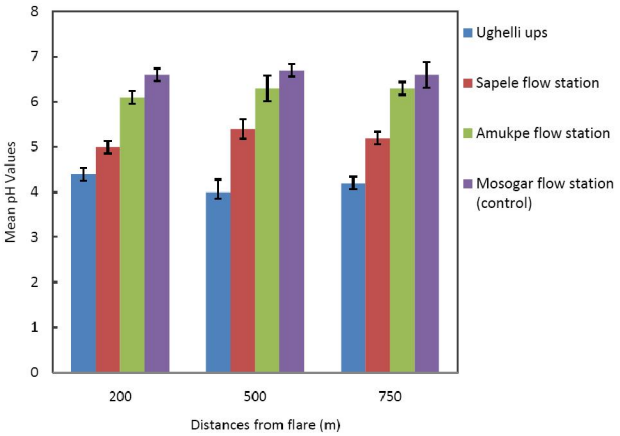

Figure 1 : pH values of soil samples collected at the different sites.

Figure 2 showed the percentage moisture content of the soil samples from the different locations. The mean ± Standard Deviation of the three flare locations for 200m, 500m and 750m were 17.00 ± 1.73, 24.00 ± 2.65 and 34.70 ± 0.64 respectively, while that of the control was 42.00 ± 2.65. Statistical analysis indicated

that Ughelli vs control and Amukpe vs control were significant ($p<0.05$) while Sapele vs control was not significant ($p>0.05$).

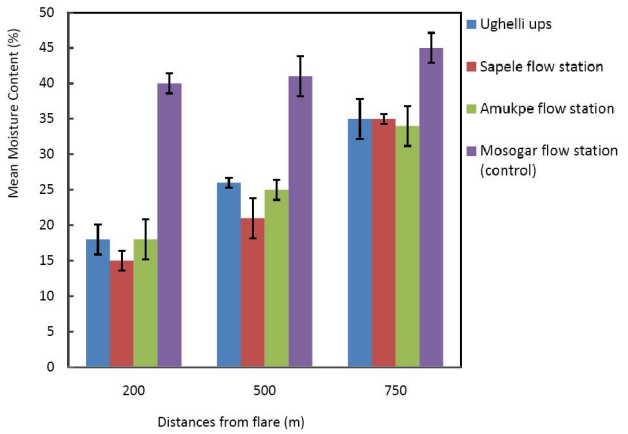

Figure 2 : The percentage moisture content of the soil samples from the different locations.

The percentage nitrogen content of plant materials (shoot and root) obtained from the different study locations are shown in Figure 3. The mean ± Standard Deviation of the three flare locations for root and shoot was 2.31 ± 0.51 while that of the control was 3.20 ± 0.07.

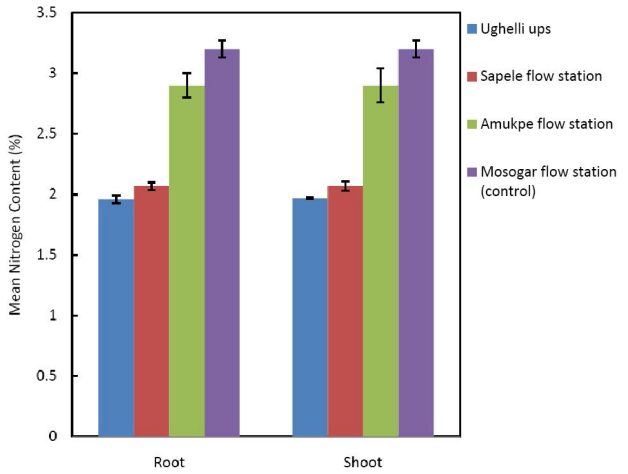

Figure 3 : The percentage nitrogen content of plant materials (shoot and root) obtained from the different study locations.

DISCUSSION

The results of the study showed that while pH values tended towards neutral as the distance from the flare increased. It is evident from the results that moisture content increased with increased distance from the flare. That means as the distance from the flare site increased, the percentage moisture content also increased with it. These results are in line with the work done previously by Nwaugo *et al*[8], who reported increasing pH values from 4.0 to 6.3 as the distance increased from 10 to 200m and moisture content of 18 to 33% for the same range of distance.

The nitrogen content increased with increase in distance. This result agrees with the study done by Okafor[9]. He reported that no vegetation was observed in areas directly surrounding flare sites and that soot from older flames was also known to damage adjacent vegetation. It is also widely believed that flare negatively affects the growth and survival of micro-organisms including nitrifying bacteria. This is supported by Nwaugo *et al*[8].

Soil moisture and pH are important factors in crop production, and anything that negatively affects them will have dire consequences on crop production. The reduction in moisture content of soil can make soil particles lighter and prone to been blown away by wind which can aggravate erosion.

CONCLUSION

The results of the study have shown that gas flaring should be discouraged as it devastates the environment. It can even lead to hunger in the world since it reduces crop yield and this is unfortunate at a time when more than 800million people around the world are on the hunger list.

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