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# Environmental impact of gas flaring within Umutu-Ebedei gas plant in Delta State, Nigeria

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## ABSTRACT

*The development of technology has lead to the exploration of man's environment in a bid to increasing his standard of living. This exploration includes oil drilling which in turn leads to gas flaring. In the Niger Delta region of Nigeria, especially within Ebedei and Umutu communities in Ukwuani Local Government Area of Delta State, the effects of gas flaring are obvious. Some of them include increase in temperature (thermal gradient), acid rain, low agricultural productivity and in short changes in the ecosystem. Some of the environmental impacts resulting from the gas flared at Umutu-Ebedei gas plant are hereby reported. Surface temperature variations with distances away from the flare point were investigated along the four (4) cardinal directions with the aid of Global Positioning System (GPS). The longitudes and latitudes at each location were also noted. Using python and surfer 8 programs, graphs of temperature against distance and the contour of temperature on the latitudes and longitudes of the study area where generated. From the analysis, it was observed that the temperature tends to normalize at about $31.5^0$C. This result shows a surface temperature elevation of about $4.7^0$C above mean normal daily temperature within a distance of 800m radius away from the flare point. Hence the thermal equilibrium within Umutu – Ebedei environs has been altered. This increase in temperature 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 Umutu-Ebedei 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. Also Observed in Umutu-Ebedei is the migration of the inhabitants who are mainly farmers to other towns such as Obiaruku and Agbor for settlement. It could be conveniently 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 DPR (Department of Petroleum Resources), 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 rooting 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 1km away from the flare point. This information obtained will be useful to both the government and individuals.*

**Keywords:** Temperature, distance, gas flare, environment, Umutu-Ebedei, thermometer, elevation, tape.

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## INTRODUCTION

Nigeria is a nation highly endowed with natural resources among which are oil and gas. In the year 2000, Nigeria's total crude oil and condensate production stood at 2.3million barrels per day, this shows an increase of 9.1% over the previous year (Ugbana, 2004).

According to Chijoke, (2002), Nigeria has an estimated 180 billion cubic feet of proven natural gas, making it the ninth largest concentration in the world. Due to unsustainable exploration practices coupled with the lack of gas utilization infrastructure in Nigeria. The country flares 73 percent of the gas it produces and reinvests only 12 percent to enhance oil recovery. The remaining 13% is used for meager commercial purposes, mainly power generation. Current statistics indicates that Nigeria account for about 28% of the total amount of gas flared globally (Abiodun, 2004).

The effects of oil exploration in the Niger-Delta region is very clear in terms of its negative effect on the region. Oil exploration has over the last four decades impacted disastrously on the socio- physical environment of the Niger-Delta oil bearing communities, massively threatening the subsistence peasant economy and the environment and hence the entire livelihood and basic survival of the people (Adewoye, 1998).

Gas flaring, which is the combustion of the unutilized excess gas during oil exploration and exploitation which lead to the emission of carbon (iv) oxide, nitrogen (iv) oxide, nitrogen (ii) oxide, hydrogen suiphide, sulphur (iv) oxide sot, smoke, light and being an exothermic reaction also produces heat according to the equation below;

$$CH_4 + 20_2 - 2H_20 + CO_2 \qquad H = -89OKj$$

Gas Flare Products are the gases that are emitted during gas flaring due to complete and/or incomplete combustion of carbon compounds which are harmful to communities. These include:

Carbon (II) oxide produced by an incomplete combustion process of carbon compounds such as octane $C_8H_{18}$, found in petrol.

$2C_8H_{18} + 17_2 \longrightarrow 16C0\ 18H_20$

Carbon (ii) oxide occurs in traces as impurity in the atmosphere but is higher in areas where gas is flared. It is odorless, colorless, poisonous gas and as little as 0.5 of it in air may cause a person to die (Ababio, 2005).

Hydrogen suiphide a colourless but very poisonous gas with a repulsive smell like that of a rotten egg. Hydrogen sulphide in air often causes the change of colour of paints due to its reaction with a metallic pigment (Ababio,2005).

The presence of substantial amounts of Sulphur (iv) Oxide in the atmosphere is one of the major causes of acid rain. It is a colourless and poisonous gas with a very irritating smell like that of

burning matches. It is about 2.5 times denser than air and is very soluble in water producing trioxosuiphate (IV) acid $H_2S0_3$, (Ababio, 2005).

Carbon (iv) oxide a colourless and odourless gas with a sharp refreshing taste. Its non-inflammable and is about 1.5 denser than air. It is contained in the atmosphere about 0.03% by volume (Abablo, 2005). It is soluble in water and dissolves in water to yield trioxocarbonate (IV) acid according to the equation below.

$CO_2+HO—>H_2C0_3$.

Carbon (iv) oxide gas, when released during gas flaring combine with rain water to form this trioxocarbonate (iv) acid, which result in acid rain. This acid rain causes corrosion of metals and roofing sheet amongst other things.

Nitrogen (iv) oxide is a reddish brown gas with an irritating smell and is poisonous. It is much denser than air and can be poured downward.

Soot is black particles formed during incomplete combustion, which takes place during gas flares and is accompanied by smoke. Smoke and soot has dark and tiny physical characteristics.

The dark characteristics make them good absorbers of sunlight. In absorbing sunlight, layers of air are heated and radiated, thus increasing temperature around flaring surrounding.

The tiny characteristic make them act as nuclei for cloud formation resulting in acid rain.

The emission of carbon (iv) oxide and carbon (ii) oxide, nitrogen (iv) oxide, nitrous oxide and hydrogen sulphide from gas flaring stations constitute what environmentalist call primary pollutants (Ademoroti, 1996).

Agoawike (1995), in an article “OUR DYING ENVIRONMENT’ summarized that in oil producing areas from Warn in Delta State to Ogoni in Rivers State and Oguta in Imo State, the story is the same, farmlands are rendered useless, rivers depleted of aquatic lives and the air polluted by gas emissions. Ahiakwo (1990) opined that oil industry in Nigeria is the foundation of under-development in Ogba-land where cases of atmospheric, thermal and surface pollution abound. In the past decades, efforts have been multiplied in Nigeria to reduce gas flaring and eventually end the practice altogether. Most of the companies are also in the process of setting up power plants that utilize gas. With all these projects, both Nigerian Government and oil company officials expressed hope that gas flaring would end by 2011. But up till now, gas flaring has not been stopped.

**Scope and objectives of the study**

This study is limited to Umutu-Ebedei areas located within latitudes $6.400^0$ – $6.285^0$ and longitudes $5.823^0$ – $6.212^0$ in Ukwuani Local Government Area of Delta-State, Nigeria. The plant manages the production of oil from the numerous wells in Umutu-Ebedei oil fields. Recent reservoir stimulation studies of these fields revealed significant crude oil potential. Oil produced at the plant is sent through booster stations in Umusadege marginal oil field and kwale/Okapi gas

plant to Brass terminal for export and some of the associated gas is re-injected into the formation to enhance oil recovery while a greater quantity of the gas is flared to the atmosphere due to lack of gas utilization infrastructures.

The main objective of this study is to highlight the environmental effects emanating from the gas flared at Umutu-Ebedei gas plant and hence determine the minimum distance away from the flare point residential buildings should be sited in other to minimize the effects. The base map of the study area showing the flare stack and communities close to the field is shown in figure 1 below.

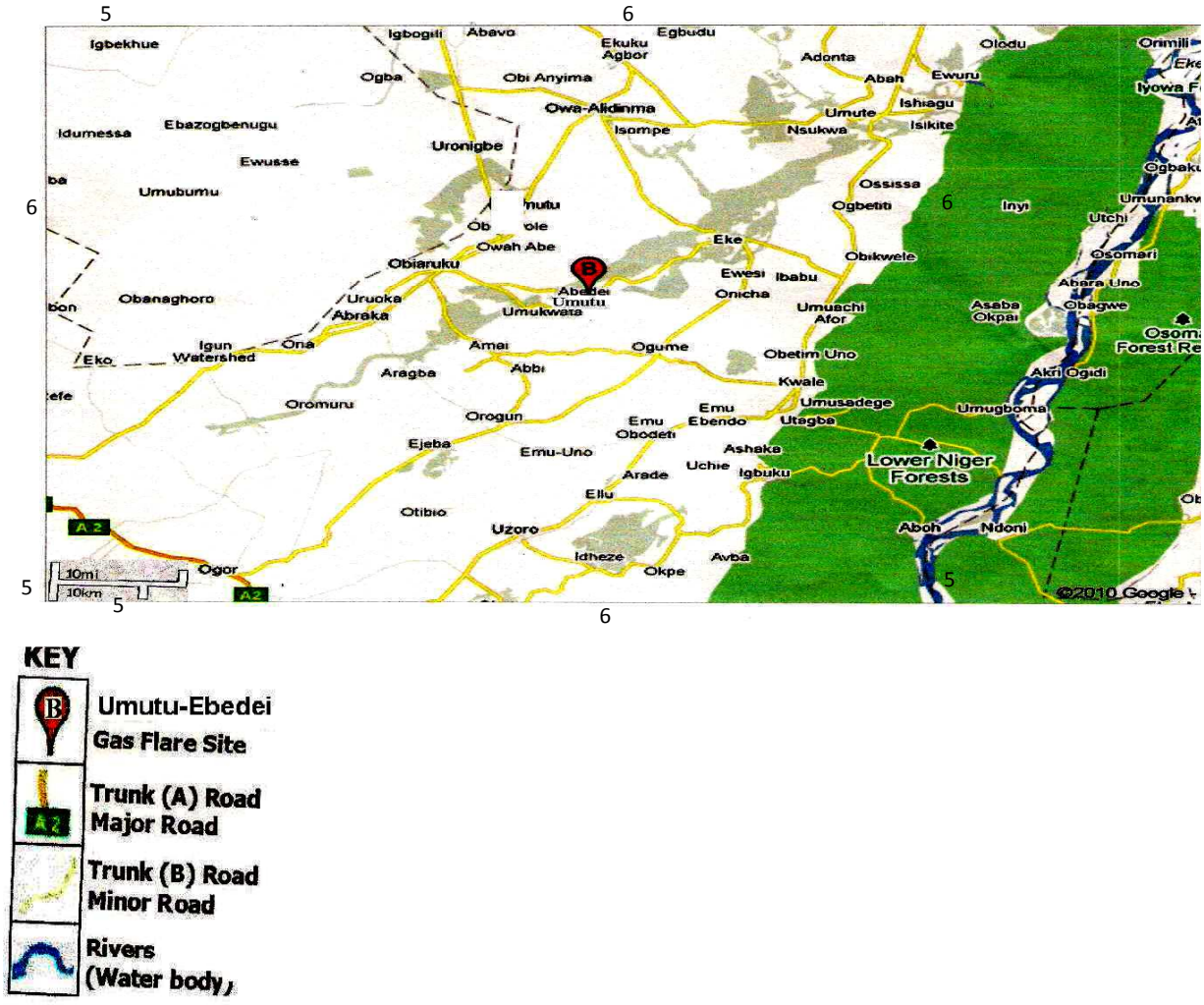





**FIGURE 1: The Geographical Location Umutu – Ebedei in Ukwuani Local Government Area of Delta State located between latitude latitudes $6.400^0$ – $6.285^0$ and Longitudes $5.823^0$ – $6.212^0$**

## MATERIALS AND METHODS

The routine procedures of data acquisition on land were employed (Avwiri and Ebeniro 1995; Avwiri and Ebeniro 1996). Measurements were carried out within a radius of 40 m away from the flare stack for safety reasons. The use of a metal tape was excluded in this research to avoid

errors that may arise from the expansion and contraction of the metal due to high temperature of the environment. During the cause of this study, temperature readings were taken with the aid of a digital thermometer and length were measured with a fibrous tape. With the aid of the Global Positioning system (GPS), the latitudes and longitudes of each locations were recorded Readings were taken twice when walking away from the flare stack and another two sets of reading were taken also when walking toward the flare stack. Temperature measurements were carried out at a constant height of 1.68m from the ground level and between 9.00h and 11.00h GMT to minimize the effect of vertical temperature gradient and for uniformity of weather conditions respectively.

## RESULTS AND DISCUSSION

Figure 2 show the variation of temperature ($T^0$ c) with distance (m) while figure 3 show the contour lines of temperature on the latitudes and longitudes due North, East, South and West directions of the flare stack respectively The curves revealed a decrease in temperature with increasing distance away from the flare point while that of latitude and longitude show a decrease in latitude with increasing longitude away from the flare point. This temperature decrease with increasing distance obeys the known theory of temperature distribution associated with heat transfer over a temperature gradient (Oseji 2007)

From the graphs, surface temperature along the four cardinal directions normalized at $31.5^0$C within a distance of 800m away from the flare point and at latitude $6.3^0$ and longitude $6.09^0$.

The mean maximum and minimum air temperature of the study area vary between $28^0$C – $34^0$C and $21^0$C - 24°c with mean daily temperature of 26.8°c (Oseji, 2010). Therefore, the surface temperature has increased by 4.7°C within the vicinity of Umutu-Ebedei gas flare when compared with the mean normal daily temperature. Hence the thermal equilibrium has been altered. This increase in temperature has enormous influence on the socio-economic lives and activities of the inhabitants. Some of the general effects of the gas flared at Umutu-Ebedei 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. Also Observed in Umutu-Ebedei is the migration of the inhabitants who are mainly farmers to other towns such as Obiaruku and Agbor for settlement.

Physical observation revealed that most building in Umutu-Ebedei especially those with corrugated iron sheet roof experienced massive damage resulting in frequent changes and leakages. Apart from the burning and “die-back” effect of gas flare and hydrocarbon, which were visible in cassava, plantain and yam leaves, Irritations of the eye and body were also experienced It could be conveniently 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 DPR (Department of Petroleum Resources), 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 rooting 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 1km away from the flare point. This information obtained will be useful to both the government and individuals.

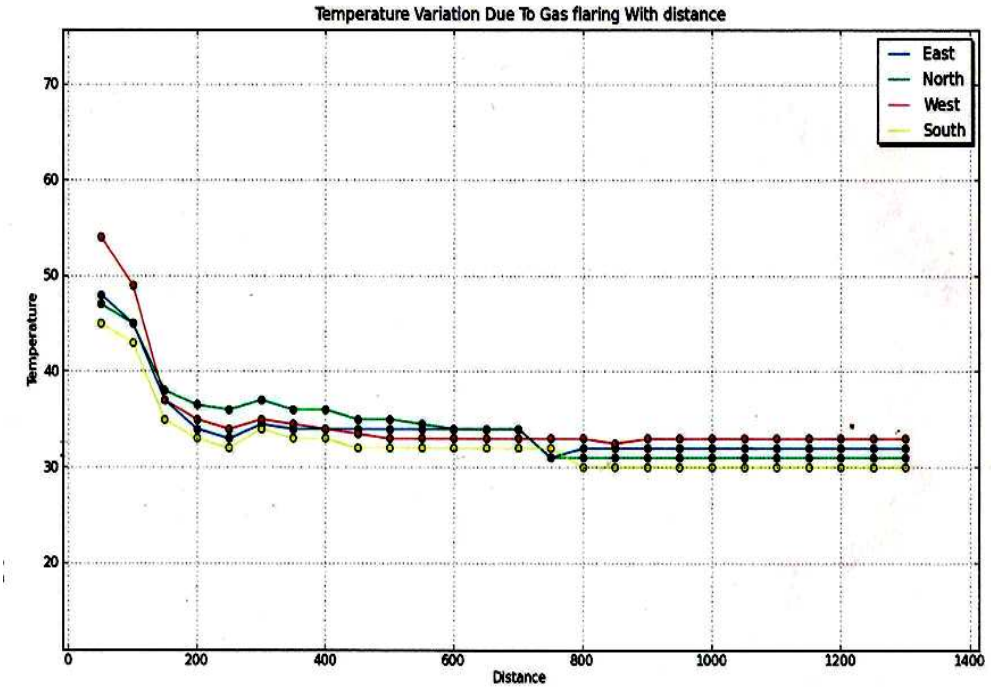


**Figure 2: Temperature variation due to Gas flaring for North, South, East and West Direction of the flare stack.**

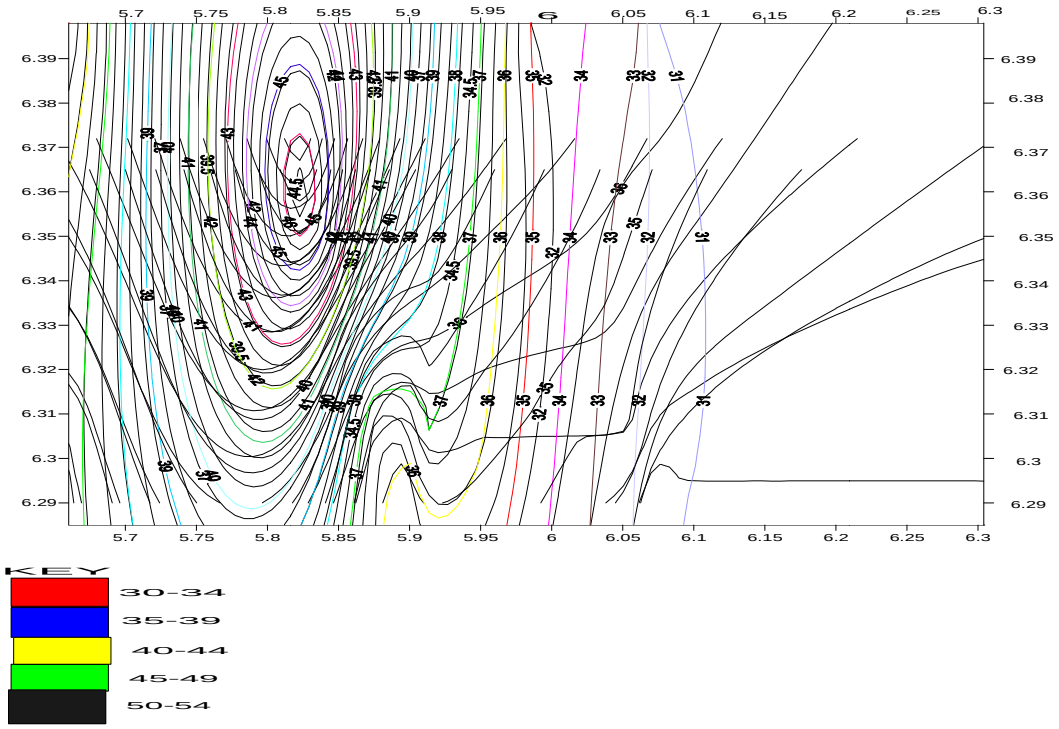


**Figure 3: The Contour lines of temperature on the latitude and longitude for the gas flared due north, south, east and west when superimposed.**

## CONCLUSION

Based on the deduction from the graphs of distance temperature at Umutu-Ebedei gas plant, the study revealed that, the surface temperature increased by 4.7°C when compared with the mean normal daily temperature. Hence the thermal equilibrium has been altered. This increase in temperature has enormous influence on the socio-economic lives and activities of the inhabitants.

We can therefore conclude that gas flaring do not only produce excessive heat which alters the temperature of the environment but also causes gaseous pollutants to be present in the environment which has adverse effects on the inhabitants including animals and aquatic lives.

The temperature of the environment is bearable at about800m away from the flare stack. Residential buildings should therefore be located within this range of distance.

As much as the Nigeria oil industry has affected the country positively, by fashioning a remarkable economic landscape and contributing to foreign exchange, earning, it also has a negative impact on the socio-economic life and the environment of the host communities (in the Niger-Delta) and its inhabitants.

In view of the gas flaring situation at Umutu-Ebedei gas plant with respect to the negative socio-economic impact it has on the environment. The followings are recommended.

1. The gas should be pumped in a gas turbine for electric power generation.
2. Companies who intend to flare gas should take care of the communities (basic amenities) where the gases are flared
3. Environmental law Enforcement Agencies, especially Department of Petroleum Resources (DPR), should be more involved in enforcing all existing environmental laws on gas flaring.
4. It should be liquefied and bottled for domestic and industrial purposes.
5. A strong technological bases should be developed to harness Nigeria's gas potentials.
6. With reference to Umutu-Ebedei gas plant, residential areas should be situated at about 800m away from the flare point.
7. Water analysis should be carried out on the area to ascertain the portability of the water.
8. Chemical analysis of the rooting sheets should be carried out within and away from the area to determine the extent of corrosion.
9. All the offices within the gas flaring should be equipped with air condition.

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