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Gas Flaring: Impacts on Temperature, Agriculture and the People of Ebedei in Delta State Nigeria

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This study is about gas flaring and its impacts on temperature, agriculture and the people of Ebedei in Delta State, Nigeria. The study utilized empirical research design.The stratified sampling technique was used to stratify the area into six layers using distance from the flare site as a yardstick, thus the strata include 150m, 250m, 350m, 450m, 550m, 650m from the flare site. Analysis of Variance (ANOVA) was used for the analysis of data. Findings include: majority of respondents (93.75%) suggest that the temperature in Ebedei was cooler than it is now as compared to the 6.25% that responded otherwise; the effects of gas flaring on the environment include acid rain (73.3%), air pollution (92.1%), temperature rise (84.6%), and deforestation (82.1%). The following crops are currently being affected by Gas flaring in Ebedei; yam 94.6%, cassava 90%, Okra 98.75%, plantain 50.4%, potatoes 5%. Places closer to the flare site were hotter than places further from the flare site (mean annual temperature at 150m from the site is 29.1 ^{0}C at 650m it is 28.1^{0}C). The ANOVA model was significant at P>0.000. This implied that the variation in temperature in terms of distance from the flare site within Ebedei area is significant.

Key Words: Ebedei; gas-flaring; Niger-Delta; temperature

Background to the Study

Ebedei is found in the Niger Delta Region, and the Niger Delta region is located in the southern half of Nigeria. This area is the center of oil and gas production and associated activities in Nigeria (World Bank, 1995; Ukpaka, 2012; Egwurugwu, Nwafor, Oluronfemi, Iwuji and Alagwu, 2013) and the region is also said to be the richest portion of Nigeria in relation to natural resources such as oil and gas deposits, widespread forests, agricultural lands for sustainable agriculture and abundant fish resources (Ukpaka, 2012; Ana, 2011). The region has the biggest natural gas reserve in Africa, and has the second largest oil reserve in Africa and is the African continent's primary oil producer (Kadaya, 2012; Egwurugwu et al, 2013). The Niger Delta region of Nigeria has about 606 oil fields with 355 situated onshore; 251 situated offshore with 5,284 drilled oil wells and 7,000km of oil and gas pipelines (Anifowose, 2008; Onuoha, 2008). Furthermore, it has more than 123 flaring sites, thus making Nigeria one of the top emitter of greenhouse gases in Africa (Onuoha, 2008). It has therefore been asserted by Witter, Stinson, Sacket, Putter, Kinney, Teitelbaun and Newman (2008); Egwurugwu, et al (2013) that exposure to dangerous substances, emissions and toxins related with oil and gas production is more likely to affect those that live close to the facilities, than those that live far from it.

Atuma and Ojeh (2013); Nwaogu and Onyeze (2010) have explained that, the danger to human, animals and plants life posed by pollution as a result of gas flaring cannot be under estimated. Thus, the effect of gas flaring has generated both global and national concerns (Abdulkareem, 2005). Gas flaring is the irrational burning of superfluous hydrocarbons gathered in an oil/gas production flow domain. The flaring of gases, releases huge volumes of greenhouse gases into the atmosphere, and therefore has severe environmental impacts both on crops and on man (Ikoro, 2003). Associated natural gas is one of the products of oil extraction process and is often considered more of a nuisance than an economic resource in developing countries (Guven, Hariss and Hertzmark, 2010), of which in the developed countries are converted to other energy options.

In some previous studies (Turner, Kerperson, Meyer, Dow, Golding, Mitchell and Ratick, 1990; Atuma and Ojeh, 2013), it has been confirmed that

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the soils found in the Niger-Delta region are some of the worst soils in Nigeria and that this poor soils come about as a result of the environmental pollution through oil industry activities in the Niger delta region. However, Soil is basic for life and productivity in the ecosystem, especially in an agrarian society. Furthermore, the vegetation and wildlife depend on soil for support and effective productivity (Ojeh, 2012). However, oil production entails the discharge of constituents and elements that are noxious and have negative impact on the environment, so that the people living near flare points are seriously affected.

Furthermore, Ebedei is plagued with the problem of gas flaring which is carried out every hour around the clock every day, and this is already having effects on man and agriculture in the area, through temperature rise and discharge of greenhouse gases. According to Alakpodia (1989); Atuma and Ojeh (2013), introduction of greenhouses into the atmosphere causes a different micro-climate around the area where such gases are flared and this has manifested by rendering the farms, vegetation and animals in Ebedei unproductive so that at a mere glance at the vegetal and plant cover (especially around the flare site) shows that the plants are malnourished. Rather than solve the problem, the government and the company contracted to handle operations in the area are playing cheap politics with the lives and the livelihood of the people living there by postponing the date of stoppage of gas flaring; and bribing of community leader so that they could help prevent riots.

Several studies have investigate the problem of gas flaring in Ebedei (Oseji, 2011; Anomohanran, 2012; Ojeh, 2012; Atuma and Ojeh, 2013). While the first three looked only into the problem of temperature rise as a result of gas flaring; the last looked at the problem of gas flaring in Ebedei area, and how it affects cassava yields. However, none of these studies attempted a questionnaire survey in the area. This current study is thus instigated to go beyond mere measuring of the temperature variation in Ebedei to carrying out a questionnaire survey, so that other effects of the gas flaring on the people of Ebedei can be documented.

Study area

Ebedei is located in Delta State in the Niger Delta region of Nigeria. It lies between latitude 6°16'N and 6°22'N and longitude 6°07'E and 6°22'E of Ukwuani Local Government Area of Delta State (see fig 1). The area is drained by the River Ethiope and one of its tributaries, the Orogodo River which only flows into the River Ethiope during the rainy season(Ojeh, 2012). The climate that prevails in the area is the tropical equatorial climate with an average annual temperature of 27.32℃, mean relative humidity of about 60%-80% and mean annual rainfall of 4205mm. Furthermore; two major wind systems impacts the climate of the area which are the northeast trade wind gusting cold dry air from the Sahara and the southwest trade wind gusting warm moist air from the Atlantic. The South-West wind exercise influence in the area throughout the year, so that rains are experienced in the area all year round (Ozabor, 2014), however the northeast trade wind, brings in harmattan(any period from November, December, January, or February) into the area for a bit unspecified periods in recent decades due to climate change (Ozabor, 2014). These winds systems thus, brings about two types of seasons within a year; the rainy and dry seasons, respectively (Atuma and Ojeh, 2013). The vegetation displays the outlook of a typical tropical rainforest which is characterized by dense vegetation cover comprising of evergreen forest of tall trees together with undergrowth. However, the anthropogenic activities in the area have depleted the vegetal cover so that what is seen in the area for the most part now, is that of secondary regrowth, characterised with sparse tree population and large expanse of savannah. In terms of economic activities the area is largely agrarian. They thus engage in planting of crops for subsistence and commercial benefits. However the recent spate of gas flaring in the Ebedei area is beginning to have impacts on the people's crop output hence this study.

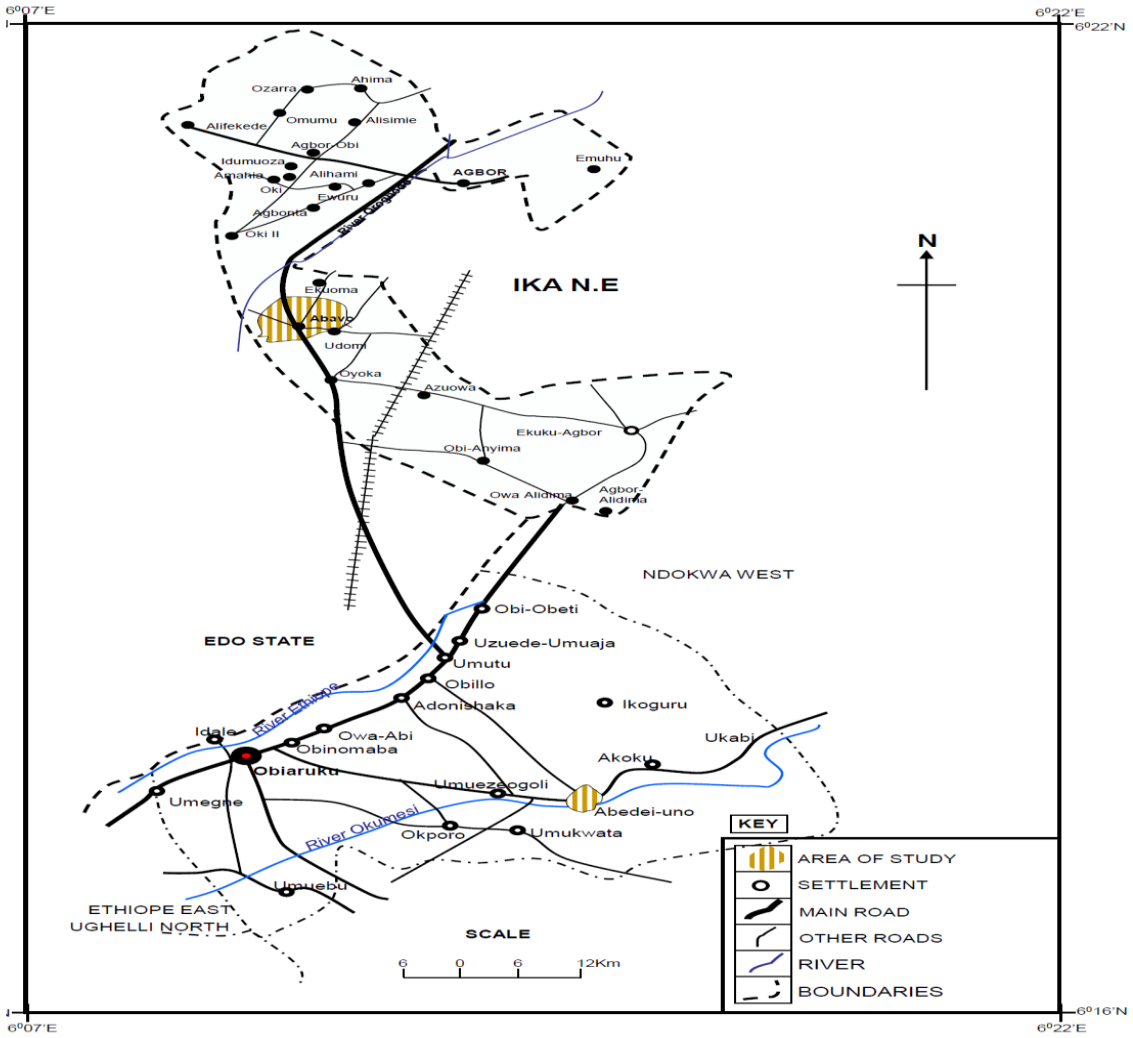

Figure 1. Map Showing Study Area. Source: Modified After Ojeh (2012)

Materials and Methods

The concept of the distance decay has is employed to pilot this study. The distance decay concept has been used for spatial process analysis in the past and more recently, researchers have found the concept relevant in both climatological and environmental studies (Efe, 2010, Ozabor and Obaro, 2015). The crux of the distance decay concept is that as distances increase from the center of influence, interaction will reduce. This concept has been a while ago termed one of the most important geographic concepts (Zhao, Li, Liu, Peng and Wang, 2015),since it summarises the ‘‘First Law of Geography’’: Everything is related to everything else, but near things are more related than distant things (Tobler 1970; Sui 2004). This law proposes that the comparisons among two interpretations often reduce or decays as the distance between them rises (Zhao, et al 2015; Nekola and White 1999). The early study of distance decay raised great interest among researchers in spatial autocorrelation, and led eventually to the field of geostatistics (Cressie 1993; Nekola and White 1999; in Zhao et al, 2015). Lately, spatial reliance, which designates the co-variation of properties within geographic space, has reached one of the most relevant terms in geography (Prates-Clark, Saatchi, and Agosti, 2008; Chen and Henebry 2010; Martinez, Cassiraga, Camacho, and Garcia-Haro, 2010; Viedma,Torres , Perez, and Moreno, 2012). The negative relationship between similarity and distance covers many subjects in the fields of geography and ecology and is related to some important theoretical subjects such as what determines diversity, distribution, and abundance of species, and the way in which analyses in ecology are performed (Bjorholm , Svenning, Skov, and Balslev, 2008; Zhao et al, 2015). However, in this study, the application of the distance decay concept relate to the fact that places nearer to the gas flaring plant (whether farm or people) will receive more impact from the flares than place further away from the gas plant.

In terms of methods of study, the study utilized the empirical research design. Types of data used for this research work includes primary and secondary data. The primary data were generated via empirical measurements using thermometer (to generate air temperature); and administration of questionnaire (to generate the impact of the gas flaring on agriculture and the people of Ebedei). The stratified sampling technique was used to stratify the area into six layers using distance from the flare site as a yardstick, thus the strata include 150m, 250m, 350m, 450m, 550m, 650m from the flare site. This method of stratification has been used in the same area by Ojeh (2012) with reasonable result realised. Based on the assertion that the effects of gas flaring reduce with distance of at least 1500-2000m (Onuorah, 2008; Odjugo, 2007; Ojeh 2012), control site was picked at Abavo (2200m away from the flare site). The need to select a control site arose from the fact that the researchers wanted to be able to show how gas flaring can change the weather characteristics of a place even if they belong to the same climatic belt. On the basis of these stratifications min and max thermometers were placed in the area to decipher the daily temperature reading for a period of one year (reading were taken hourly based on the World Meteorological Organisation (WMO) standard). On the other hand, 240 questionnaires were administered in the area stratified to help generate information on the effects of gas flaring on both agriculture and the people of Ebedei. 240 questionnaires were administered because it represents 10% of the total households within the area stratified.

The data for the study were presented in statistical diagram and tables, and the arithmetic means; Analysis of Variance (ANOVA) was used for the analysis of generated data.

Data Presentation and Discussion of Results

Table 1. Sex Distribution of Respondents

Sex	No	%
Male	143	59.6
Female	97	40.4
	240	100

Source: Authors field work, 2014

From table 1 above, the male respondents are more (59.6%) than the female respondents (40.4%). This implies that there are more male than female in the area.

Table 2. Marital Status of Respondents

Options	No	%
Single	38	15.8
Married	180	75
Divorced	22	9.2
Total	240	100

Source: Authors field work, 2014

From table 2, 15.8% of the total respondents are single, 75% are married and only 9.2% are divorced. The implication of this is that majority of the respondents are married. And thus need food for sustenance both for their children and for themselves.

Table 3. Education Distribution of Respondents

Options	No	%
Primary	45	18.75
Secondary	105	43.75
Tertiary	45	18.75
No formal Education	45	18.75
Total	240	100

Source: Authors field work 2014

From table 3, the education distribution of respondents is presented. From it, 18.75% of respondents have primary education, secondary education accounts for 43.75%, tertiary education accounts for 18.75%, while no formal education accounts for 18.75%. This implies that majority of the total respondents are secondary education degree holders. This also play a significant role in the type of occupation that engages them in Ebedei. See table 4.4 below

Table 4. Ocupation Distribution Of Respondents.

Options	No	%
Farming	113	47.1
Business	30	12.5
Trading	60	25
Craft	37	15.4
Total	240	100

Source: Authors field work, 2014

From table 4 above, 467.1% of the total respondents are farmers. While business men accounts for 12.5% of the total respondents, trading accounts for 25% of the total respondents and craft accounts for only 15.4% of the total respondents. It is therefore evident from the table above that the majority of the respondents are mainly farmers (46.95%) and traders (25%). Thus the effects arising from the gas flaring in the area (Ebedei) are high on the people, as the environment they have to rely on to go about their daily activities is now being affected by gas flaring.

Table 5. State 0f Temperature in Ebedei Before the Siting of the Gas Plant.

Options	No	%
Hotter	15	6.25
Cooler	225	93.75
Total	240	100

Source: Authors field work, 2014

From table 5, the perception of the respondents on temperature before the siting of the gas plant is shown. From the table, majority of respondents

(93.75%) agree that the temperature in Ebedei was cooler than it is now (before the siting of the gas plant) as compared to the 6.25% that responded otherwise. This means that the gas plant has some impacts on the temperature characteristics of Ebedei.

Table 6. Perception of The People of Ebedei on the Cause of Temperature Rise

Options	No	%
Gas plant	203	84.4
Not gas plant	37	15.6
Total	240	100

Source: Authors field work, 2014

From table 6, majority of respondents suggests that the gas plant is responsible for the increasing temperature in Ebedei. While 84.4% of the total respondents agree that the gas plant is responsible for the increase in temperature, only 15.6% disagree that the gas plant is responsible for the increase in temperature.

Table 7. Effect of Gas Flaring on the Environment of Ebedei

Options	No	%
Acid Rain	176	73.3
Air pollution	221	92.1
Temperature Rise	203	84.6
Deforestation	197	82.1

Source: Authors field work, 2014

From table 7, effect of gas flaring on the environment of Ebedei is displayed. From the table, the effects of gas flaring on the environment include acid rain (73.3%), air pollution (92.1%), temperature rise (84.6%), and deforestation (82.1%). Thus from the perception and experience of respondents, the gas plant already has impacts on the environment of Ebedei.

Table 8. Effects of Gas Flaring On Crop Yield

Options	No	%
Has effect on crop yield	210	87.5
Has no effect on crop yield	30	12.5
Total	240	100

Source: Authors field work, 2014

From table 8 the effect of gas flaring on crops is identified. From the table 87.5% of the total respondents agree that the gas plant has effects on crops in the area. While only 12.5% of the total respondents disagree that the gas plant has any significant effects on crop yield.

Table 9. Crops Affected By Gas Flaring In Ebedei.

Options	No	%
Yam	227	94.6
Cassava	216	90
Okra	237	98.75
Plantain	121	50.4
Potatoes	12	5
Maize	240	100

Source: Authors field work, 2014

From table 9 crops affected by gas flaring in Ebedei is presented. From the table 94.6% respondents' account for yam, cassava is 90% of respondents; Okra is 98.75% respondents, plantain 50.4% respondents, while potatoes are only 5% respondents. Therefore the inhabitants of Ebedei are seriously being affected by the gas plant, since the major occupation of the people is farming. Similarly, this partly explains the high prices of commodity in markets in the area and the hunger experienced the area.

Air Temperature Characteristics in Ebedei

Table 10. Mean Monthly Temperature Characteristics in Ebedei In ^{O}c

Months of the year	150m	250m	350m	450m	550m	650m	Control (Abavo)
Jan	29.3	29.1	29	28.7	28.5	28.2	26.9
Feb	29.4	29.2	29.1	28.8	28.6	28.0	26.8
Mar	29.2	29.1	29	28.9	28.4	28.1	26.7
Apr	29.6	29.4	29.1	28.7	28.5	28.0	26.8
May	29.1	29.0	28.8	28.6	28.3	28.1	27.4
Jun	29.4	29.2	29	28.7	28.2	28.1	27.6
Jul	29.0	28.9	28.7	28.6	28.7	28.0	27
Aug	29.1	29.0	28.9	28.6	28.6	28.4	26.3
Sept	28.9	29.1	28.9	28.	28	27.9	27.2
Oct	29.3	29.1	29	28.7	28.7	28.5	27
Nov	29.1	29.0	28.7	28.5	28.3	28.1	27.1
Dec	29.4	29.3	29	28.7	28.6	28.4	27.0
Mean	29.2	29.1	28.9	28.6	28.4	28.1	27

Source: Author's Field Work, 2014

From table 10 the temperature variation of Ebedei area is displayed. From the table it is evident that places closer to the flare site are hotter than places further from the flare site. For example while mean annual temperature at 150m from the site is 29.1 ^{0}C at 650m it is 28.1^{0}C (see fig 2 below). this finding agrees with Ojeh (2012) finding in terms of variation in temperature as one moves away from the flare site. On the other hand the finding differs with Ojeh (2012), since temperature observer using the same strata varies (see Ojeh, 2012).

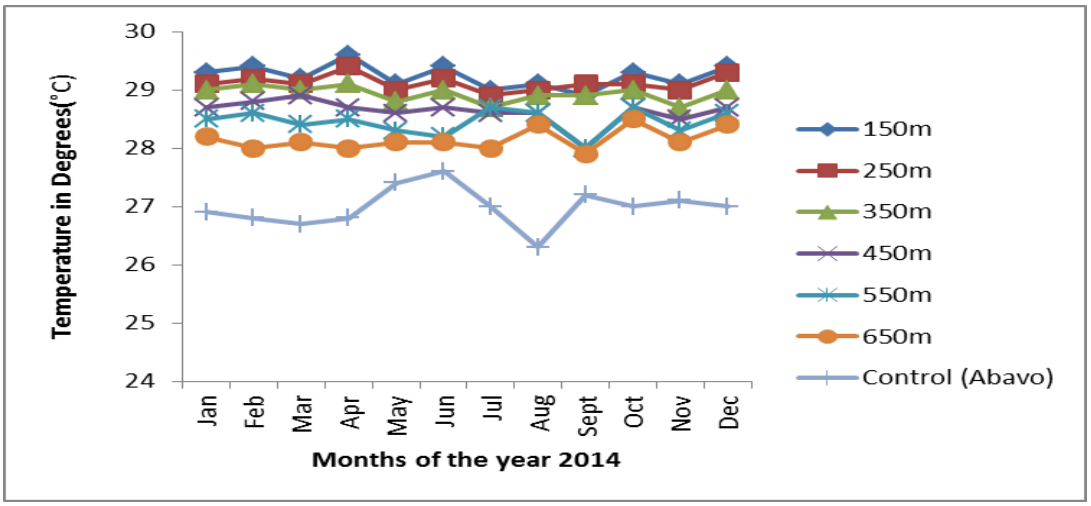

Figure 2. Monthly distribution of temperature in Ebedei based on distance

Table 11: Output of the Anova Statistics

distance_from_site					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	42.561	6	7.093	153.894	.000
Within Groups	3.549	77	.046		
Total	46.110	83			

Source: Author's Field Work, 2014

In table 11 the model is significant at P>0.000. This implies that the variation in temperature in terms of distance is significant. So that as one move away from the flare site temperature reduces vice versa. This finding agrees with that of Ojeh (2012) and the finding is also supported by the distance decay concept. However, the Duncan statistics table below shows how the spatial variation of the temperature of the area is placed. In the table other sample points are varied from each other except that of 150m and 250m from the flare site as the variation within them are not statistically significant at P<0.18

Table 12: Output of the Anova Statistics (Duncan)

distance_from_site							
Duncan[a]							
Identifiers	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
2200m (control)	12	26.9833					
650m	12		28.1500				
550m	12			28.4500			
450m	12				28.6250		
350m	12					28.9333	
250m	12						29.1167
150m	12						29.2333
Sig.		1.000	1.000	1.000	1.000	1.000	.187
Means for groups in homogeneous subsets are displayed.							
a. Uses Harmonic Mean Sample Size = 12.000.							

Source: Author's Field Work, 2014

Conclusion and Recommendation

This study has shown that gas flaring does not only have effect on thermal pollution (rise in temperature as distance progress from the flare area) in Ebedei, but also on the people and their farms, since the following crops are currently being affected by Gas flaring in Ebedei; yam 94.6%, cassava 90%, Okra 98.75%, plantain 50.4% , potatoes 5%. The study also confirmed the applicability of the distance decay concept (as mean annual temperature at 150m from the flare site is 29.1 ^{0}C and different from 650m, 28.1^{0}C from flare site), as a relevant concept in planning for an area plagued with gas flaring problem, since the problems of gas flaring will reduce as distance increases from the flare site. Thus the following short and long term ameliorative recommendations are made:

a) Government should restrict the people of Ebedei from settling around the flare sites at least at 650m from the flare site. While, plans on how to stop flaring by government should be enforced.
b) The people of Ebedei should be taught (via seminars, public orientation and bill distribution in English and local languages) on the dangers of living and farming near the flare sites.
c) Plans should be put in place to help harness the flared gas so that they could be put to other more environmental friendly sources of energy.
d) Plant species in the area should be reviewed to suit the current temperature pattern in the area. Since there seem to be a the prevalence of a micro climate in the area (see table 10)

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