Journal of Agriculture and Ecology Research International
4(1): 10-17, 2015; Article no.JAERI.2015.047
ISSN: 2394-1073

SCIENCEDOMAIN *international*
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The Impact of Gas Flaring on Plant Diversity in Ibeno Local Government Area

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Authors' contributions

This work was carried out in collaboration between all authors. Both authors went to the field. Author AMA designed the study, wrote the protocol, and the first draft of the manuscript. Author ASW performed the analysis, discuss the conclusion. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2015/12335
Editor(s):
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(4) Anonymous, Delta State University, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1186&id=37&aid=9113

Original Research Article

Received 27th June 2014
Accepted 15th December 2014
Published 4th May 2015

ABSTRACT

The study examined the impact of gas flaring on plant diversity in Qua-Iboe Terminal (Q.I.T). A Purposive sampling technique was adopted in choosing the direction of transects for data on plant species. A quadrant of 50 mx50 m was gridded into 10 m^2. On each transect, five quadrants were laid at an interval of 50 m. From the flare site, the first quadrant at an interval of 50 m, the second at 100 m, third at 150 m, and so on to the fifth at 250 m on both sides of the transect respectively. Plant species diversity were obtained by counting the different species found within the quadrant. At flare site; 21, 27, 34, 38 and 42, while at control site; 101, 102, 106, 107 and 109 respectively. The means of the plant species at flare site is 32.40, at the control site is 105.00. The standard deviation for the flare site is 8.44 and for the control site is 3.39. Paired Sample Statistical technique was employed to analyzed the data. The results showed strongly positive correlation co-efficient of 0.97 between plant species diversity at gas flare site and those at the control site. It was

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observed that at Qua-Iboe flare site, great lost of plant species had taken place than the control site. Field Observation revealed that some plant species proved more resistant to gas flaring than others. Furthermore, from the analysis, we can conclude that there is statistically significant difference between plant species diversity in the flare site and the control site due to gas flaring. The results of the study is in line with theoretical postulations that increase in distance leads to a corresponding increase in plant species from the flare site. The study recommended that; they should be massive afforestation programme, gases should be harnessed for use as liquefied natural gas or re-injected into the (source) earth, and government should enforce laws against gas flaring.

Keywords: Impact; gas flaring; Niger delta; Ibeno; plants diversity loss.

1. INTRODUCTION

The Niger Delta mangrove and rainforest belt is one of the most fragile ecosystems in the world. It is the most oil- impacted environment and polluted area in the world [1,2]. Everywhere in the world, plant species are used for medicinal purpose, food, ornamentals, carbon sinkers and as building materials. In this vein, the essence of plants to man cannot be underscored. Plant species diversity is the measure of the number of different plant species present in an area with reference to their physical characteristics and genetics composition [3]. The plant species in the Niger Delta region are undergoing serious threat for more than forty years owing to the exploration and exploitation of oil and gas by multinational companies domiciled in the area [2].

Though, natural gas is an important source of energy to man, its extraction has impacted negatively on the environment. Flaring is adopted during the process of petroleum refining and chemical processing for safe disposal of waste gases, process upsets, plant start-up or shutdown and process emergencies. Flaring is a high-temperature oxidation process used to burn combustible components, mostly hydrocarbons, of waste gases from industrial operations. Gas flaring is the combustion of associated gas produced with crude oil or from gas fields [4,5]. The process or act of burning away associated gas into the atmosphere during the drilling of crude oil is called gas flaring. Natural gas can be found separately or in association with oil. Nigeria has immense reserves of both association and un-association natural gas [6]. Nigeria is known to be one of the highest countries on the earth for flaring gases. Recent report put the rate of gas flaring in Nigeria at 32.6 percent, against 0.6 percent and zero percent by U.S.A and Netherlands respectively. This menace is evident during exploration and exploitation activities of multinational oil and gas companies like Shell, Chevron, ExxonMobil, Total and Elf (Friends of the [7]. Nigeria and Russia are the highest gas flaring countries in all the world. Gas flaring is a major source of greenhouse gases (GHG) contributing to global warming which could accelerate the problem of climatic change and harsh living conditions on earth, if not checked. Flaring releases carbon dioxide and methane, the two major greenhouse gases. However, of these two, methane is actually more harmful than carbon dioxide. Gas flaring for instance, has negative effects on the immediate environment, particularly on plant growth and wildlife.

Scholars like [8-19] have attempted to address the perennial problems associated with the causes of gas flaring and oil spills. Some international institutions like the [20-22], and the [23], have equally reported facts on what constitute the causes and effects of oil and gas on a particular environment like the Niger Delta region. [24] have shown that gas flaring significantly affects not only the microclimate but also the soil physico-chemical properties and maize yield size. For optimum yield of maize within the Niger Delta, cultivation must be within 2kilometres of the bund wall of the flared site. They further observed that the sand content of the soil, pH, bulk density, air and soil temperatures increased toward the flare site. Research findings show that there is indeed a correlation between gas flaring and change in maize yield [24]. This study explores the impact of gas flaring on plant species diversity in Ibeno, Akwa-Ibom State, South-South, Nigeria.

2. MATERIALS AND METHODS

2.1 Sampling Technique and Analytical Tool

A reconnaissance survey was carried out to identify the flare site for easy transect and quadrant laying. A cutlass was used to open up the transect and the tape was used to determine the distance of the quadrant. The quadrants were established at 50m interval along the transect. A Purposive sampling technique was adopted in choosing the direction of transect. Four transects were established in each of the sampling site (that is, the flare site, the control site, against the prevailing wind and the wind direction. While, a quadrant of 50 mx50 m was measured. The quadrant size was further gridded into 10 m^2 by measuring dimensions of 10 mx10 m with a measuring tape and pegs to subdivide the sampled area from which the gridded cells were randomly sampled. The procedure was repeated for all the sampled quadrants based on the interval of 50 m. The average of each variable measured was calculated from the 20 sampling units. Also, a plant taxonomist assisted in identifying and naming plant species found within the quadrant. A Data on plant species diversity were collected. While a quadrant of 50 mx50 m was gridded into 10 m^2. On each transects, five quadrants were laid at the interval of 50 m. From the flare site, the first quadrant at the interval of 50 m , the second at 100 m, third at 150 m, and so on to the fifth at 250 m on both side of the transect respectively. Data on plant species diversity were counted on each quadrant and recorded. The means of plant species counted in the each quadrant were obtained. Names of plant species identified are found in Table 3

The paired t' test statistics was employed to analyze the means difference in plant species between the flare site and the control site. The Simpson's index of diversity was used to measure the extent of homogeneity or otherwise of plant community with respect to its floristic composition. This index was used to compare two or more sampled areas of vegetation for similarity or diversity and is given in the form:

$$Si = 1-D$$

Where:

Si = Simpson's index of Diversity

$$D = \sum(n_1/N)^2$$

Where:

n_1 = some specified importance value for a species
N = Importance value for all species
D = is an index of dominance or homogenity.

3. THE STUDY AREA

The study area is Ibeno local Government area in Akwa-Ibom State, South-South region of Nigeria. It lies within the Niger-Delta oil-rich region. The area is located between Longitude 7°.35[1]E and 7°.45[1]E of the Greenwich meridian; Latitude 6° .10[1]N and 8°.11[1]N of the equator. The climate falls within tropical equatorial (Af) type, characterized by longer wet season and shorter dry season. Temperatures and relative humidity are high throughout the year with abundance annual rainfall [25,26]. The mangrove and rainforest vegetation stretched outward along the Atlantic coast to the land (Fig. 1).

4. RESULTS AND DISCUSSION

4.1 Impact of Gas Flaring on Plant Density

Table 1 shows measurement of plant species densities at the flare site and control site. Results revealed that the values of species density at Qua-Iboe terminal (Q.I.T.) flared site were 21 plant species at 50 m, 27 plant species at 100 m, 34 plant species at 150 m, 38 plant species at 200 m and 42 plant species at 250 m. while, at the control site measurement were 101 plant species, 102 plant species, 106 plant species, 107 plant species and 109 plant species at 50 m, 100 m, 150 m, 200 m and 250 m respectively about 2 km away fromthe flare site. Plant species density at the direction of the prevailing wind ranges from 20 plant species, 25 plant species, 33 plant species, 36 plant species and 40 plant species away from the flare site (Table 2). This was observed at the distances of 50 m, 100 m, 150 m, 200 m and 250 m. At the opposite direction of the prevailing wind, plant density were 23, 29, 35, 40 and 45 higher than the direction of the prevailing wind, (Table 2). The results in Table 1 and 2 reveals that apart from the control site, plant species density were higher at 250 m and lower at 50 m quadrant zone. At 50m distance from the flare site, the impact of gas flared was more on plants species than quadrant zones farther away from the flare site. In Table 4, the Simpson's index employed to measure the extent of homogeneity of plant community with respect to its floristic composition showed an index less than one across the transects. This implies that the plant species in the study area are heterogeneously distributed. The Simpson's index of plant community against prevailing wind (APW) is 0.997, at wind direction

(WD) is 0.996, at flare site (FS) is 0.997 and at the control site (CS) is 0.911 respectively. In other words, there is no consociation in the plant community. Consociation means all individual plants belong to the same species.

Table 1. Plant species density on flare site and control site

Distance from flare site	Flare site	Control site
50 m	21	101
100 m	27	102
150 m	34	106
200 m	38	107
250 m	42	109

Source: Author's field work, 2011

Table 2. The result of plant species count At Qua Iboe flare (Ibeno)

Distance	Wind direction	Against prevailing wind	Average count
50 m	20	23	21.5
100 m	25	29	32
150 m	33	35	34
200 m	36	40	38
250 m	40	45	42

Source: Author's field work, 2011

Table 5a revealed the mean of 32.40 and 105.00 at the flare site and control site, with the standard deviation of 8.44 and 3.39 respectively. It was also established in Table 5b that a strong positive correlation existed between plant species density and gas flaring at both the flare site and the control site. Plant species density at the flare site was relatively fewer than those found at the control site due to gaseous pollutant released into the air. This finding alludes to the scientific survey of the vegetation, particularly palm trees, which revealed that no plant could survive within 100 m of the flare in Ijaw oil-producing communities. Some plants were found to flower at 120 m, while others survived at 150m from the flare site [2]. In this study, the analysis revealed that plants like; *Acrostichum aureum* L.*, Anthocleista vogelii, Pranch Avicennia specie, Rhizophora species and Eichornia crassipes , Lophira alata* were found to survive around the flare site at distance of 50 m.

The study also revealed that as distance increases away from the gas flare sites, a dramatic increase in plant species were observed [Fig. 2]. Conversely, plant species decrease with proximity to the flare site. Different species responded differently to gas flaring. This was seen in their height, structure, composition and adaptability. Plants like *Nypa fruticans, Lophira alata* and *Rhizophora species proved more resistant and adaptable to gas flaring.* Species density were higher along the control transect than the two sites adjacent to the gas flaring site. Result of analysis with paired sample t-test statistics in Table 4c showed that there is statistically significant difference between plant species in the flare site and the control site. This is consequent upon the nefarious activities of gas flaring activities. Implying that there is significant difference between plant species diversity at the flare site than at the control site of the study area. This is consequent upon the nefarious activities of gas flaring activities going on in the region. It was further observed that plant species density did not vary significantly at the control site. The impact of gas flared were less significant at the control site.

Table 3. Plant species in Ibeno L.G.A. Akwa-Ibom State South-Eastern Nigeria

S/no	Plant species
1	*Dictamoius albus Albiflorus*
2	*Raphia hookeri, Raphia Africana*
3	*Puereria phaseoloides*
4	*Ocimum basilicum*
5	*Nypa fruticans*
6	*Napoleonaea imperialis*
7	*Myrianthus arboreus Beavois*
8	*Musanga R. Brown*
9	*Panicum maximum*
10	*Phoenix reclinata Jacq.Fragm*
11	*Musa paradisiacal*
12	*Aspilia Africana*
13	*Andropogon gayanus*
14	*Allamanda L.*
15	*Acalyphia L.*
16	*Aframomum melegueta*
17	*Encephalartos Lehm*
18	*Elaeis guineenis*
19	*Colocasia esculenta*
20	*Cocos nucifera*
21	*Acrostichum aureum L.*
22	*Anthocleista vogelii Pranch*
23	*Avicennia species*
24	*Rhizophora species.*
25	*Eichornia crassipes*
26	*Lophira alata*

Source: [27]

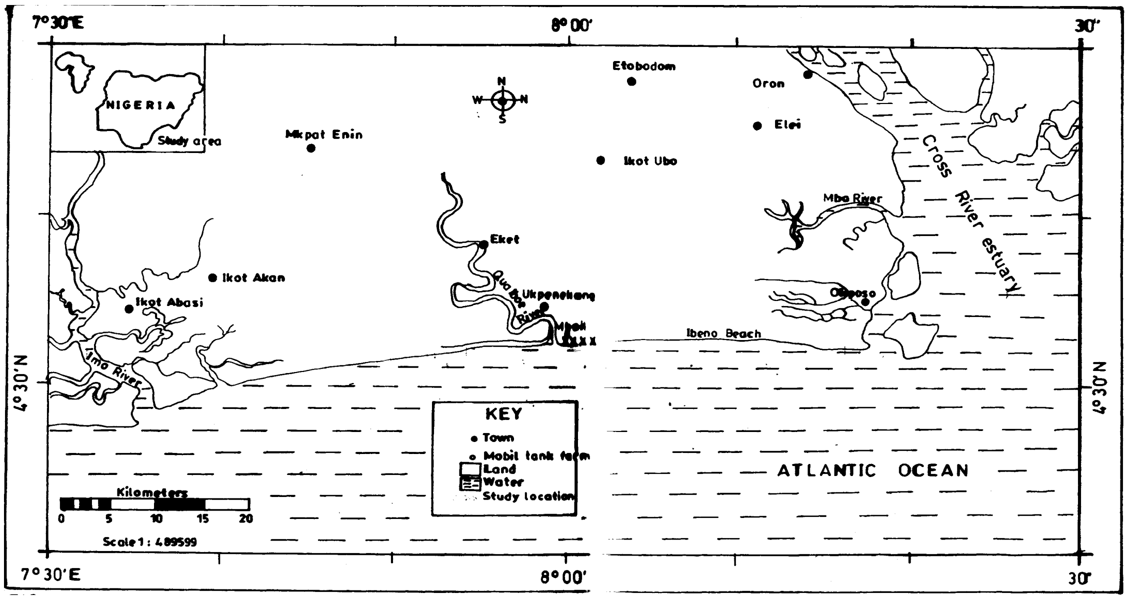

Fig. 1. Map of the study area (Ibeno)

Table 4. Simpson's Index

	Against Prevailing wind (APW)			Wind direction (WD)			Flare site (FS)			Control site (CS)		
S/no	n.	D	1-D	n	D	1-D	n	D	1-D	n	D	1-D
1	5	.001	.999	4	.001	.999	3	.000	1.000	20	.001	.962
2	25	.021	.979	15	.009	.991	16	.010	.990	19	.001	.964
3	5	.029	.999	3	.000	1.000	2	.000	1.000	18	.001	.966
4	6	.030	.999	4	.001	.999	3	.000	1.000	16	.001	.970
5	30	.170	.971	40	.067	.933	22	.018	.982	50	.009	.905
6	2	.090	1.000	1	.000	1.000	1	.000	1.000	21	.002	.960
7	2	.010	1.000	0	.000	1.000	2	.000	1.000	19	.001	.964
8	4	.023	.999	2	.000	1.000	3	.000	1.000	20	.010	.286
9	2	.010	1.000	1	.000	1.000	2	.000	1.000	21	.002	.960
10	5	.029	.999	2	.000	1.000	3	.000	1.000	14	.001	.973
11	3	.017	1.000	0	.000	1.000	2	.000	1.000	12	.001	.977
12	2	.010	1.000	1	.000	1.000	2	.000	1.000	19	.460	.321
13	4	.023	.999	2	.000	1.000	10	.004	.996	22	.002	.958
14	5	.029	.999	4	.001	.999	6	.001	.999	20	.001	.962
15	15	.087	.992	12	.006	.994	17	.011	.989	25	.002	.952
16	9	.052	.997	7	.002	.998	12	.005	.959	17	.001	.968
17	3	.017	1.000	1	.000	1.000	1	.000	1.000	16	.001	.970
18	11	.063	.996	12	.006	.994	12	.005	.995	18	.001	.966
19	7	.040	.998	8	.003	.997	6	.001	.999	19	.001	.964
20	8	.046	.998	12	.006	.994	10	.004	.996	21	.002	.960
21	2	.010	1.000	1	.000	1.000	3	.000	1.000	15	.001	.971
22	4	.023	.999	2	.000	1.000	4	.001	.999	15	.001	.971
23	2	.010	1.000	6	.002	.998	4	.001	.999	16	.001	.970
24	3	.017	1.000	5	.001	.999	6	.001	.999	24	.002	.954
25	2	.010	1.000	4	.001	.999	5	.001	.999	23	.002	.956
26	6	.030	.999	5	.001	.999	5	.001	.999	25	.002	.952
TOTAL	172	.037	.997	154	.004	.996	162	.038	.997	525	.039	.911

Table 5a. Paired samples statistics

		Mean	N	Std. deviation	Std. error mean
Pair 1	Flaresite	32.4000	5	8.44393	3.77624
	controlsite	105.0000	5	3.39116	1.51658

Table 5b. Paired samples correlations

		N	Correlation	Sig.
Pair 1	Flaresite & controlsite	5	.987	.002

Table 5c. Paired samples test

		Paired differences			t	Df	Sig. (2 tailed)
		Mean	Std. deviation	Std. error mean			
Pair 1	Flaresite - controlsite	-72.60000	5.12835	2.29347	-31.655	4	.000

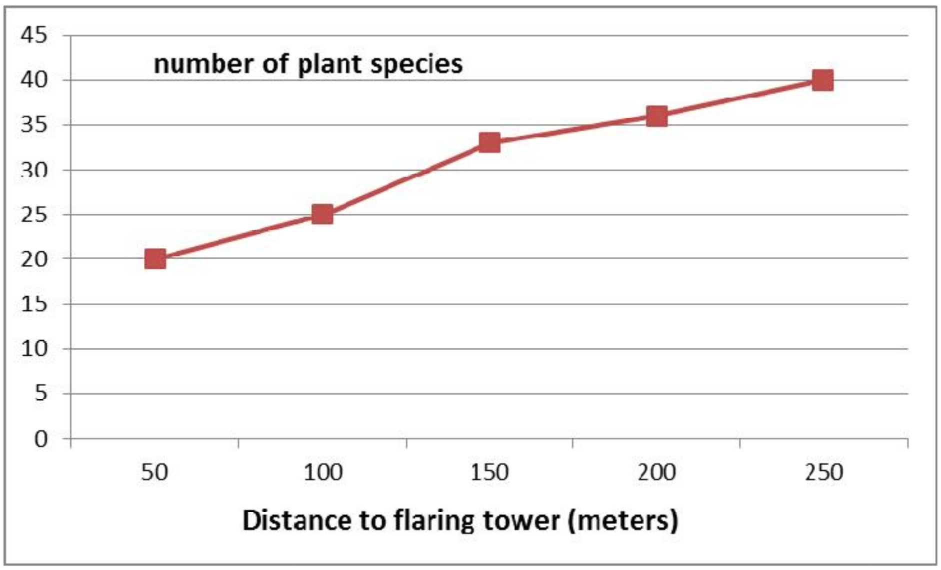

Fig. 2. Distance to flaring tower (meters)

5. CONCLUSION

Analysis of the impact of gas flaring on plant diversity in Ibeno revealed that gas flare has greater impact on plant species closer to the flare site at 50m than at other zones where the quadrant was laid. As distance increases from the flare site, more plants species were found. The study further showed that certain plant species were found to be more resistant to gas flaring at 50 m and 100 m such as; *Nypa fruticans Acrosticum aureum and Eichornia crassipes.* Plant species are heterogeneously distributed in the region as revealed by the Simpson's index analysis of specie diversity.

The Niger Delta environment ecosystem is the most fragile in the world. It has being under serious threat by the nefarious activities of gas flaring carried out there. More awareness campaign should be embarked upon to assuage the long trend of gas flaring. The study further suggests that plant species that prove resistant to gas flaring should be planted, laws against gas flaring must be enforced and re-injection techniques should be implemented.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1186&id=37&aid=9113