Bacteria, Plant Nutrients and Plant Population Following Gas Flare in Oloma Community, Rivers State, Nigeria

***UKOIMA, H.N; CHUKUNDA, F.A; NGEREBARA, O.D and HALLIDAY, S.**

Department of Forestry and Environment,
Faculty of Agriculture,
Rivers State University of Science and Technology,
Nkpolu-Oroworukwo, Port Harcourt
Nigeria
*ukoima.hudson @ust.edu.ng ; rijmanconsult@yahoo.com

Abstract

This study investigated changes in bacteria, plant nutrients and plant population following gas flare in Oloma community, Rivers State, Nigeria. Standard procedures were used for plant analysis and determination of plant population. Bacterial populations were ascertained using conventional methods such as serial dilution. Plant and soil samples were collected at 50m, 100m, 150m and 1km away from the flared site. The result on bacteria showed that counts of heterotrophic bacteria were lowest at 50 meters (2.4 x 10^5 cfu/ml) while total heterotrophic bacteria was however highest (5.8 x 10^5 cfu/ml) at 150 meters. However, at 1 kilometer there was a reduction (3.0 x 10^5 cfu/ml) in bacteria population. The findings on plant nutrients indicated that calcium, nitrogen and magnesium were lowest at the distance of 50 m – 100m and highest at 150m – 1km. Paspulum jaminance , Sporobolus pyramidalis, Euphorbia hirta, Acrosticum aereum, Nypa fructicans, Rhizophora mangle, Elaesis guineensis, and Mimosa pudica were common around the flared site. However, the most abundant plants (++++) were, Rhizophora mangle and Paspulum jaminance at 50m- 1Km. Species richness was low at 50m but high at 150m and 1km away from the flared site. This study demonstrated that gas flare has effect on bacteria, plant nutrients and plant population.

Key words: *Flared site, Plant nutrients, Heterotrophic bacteria, Plant population*

Introduction

The importance of mangrove plants to the Bonny people in the Niger Delta of Rivers State ,Nigeria cannot be over emphasized (Ukoima et al, 2014; 2009a,b,c,d and Ukoima et al, 2007) However, gas flaring has been ongoing since the discovery of crude oil in the late 1950s in Nigeria and studies have shown that it has grave economic, social and health implications for Nigeria and the world in general, because of its negative environmental impacts and its contribution to climate change (Abere and Ukoima, 2014; Edino *et a*l, 2010; Alakpodia 1989, 2000; Ishisone, 2004; Omokaro,2009; Nwaugo *et a*l, 2005). Besides, it has been said to affect plant nutrients in flaring vicinity (Abulkareem, 2005) and decrease chlorophyll content in plants near flare sites (Isichei and Sanford, 1976; World Bank, 2002, 2007). Bonny is an area of global importance because of the establishment of the Nigerian liquefied natural gas project (NLNG).Therefore, biodiversity conservation will be under threat due to the rapid rate of environmental degradation occasioned by oil and gas exploration activities. Furthermore, since the inception of gas flaring in Nigeria, there have been very little empirical studies on its impacts over time on the mangrove. It is therefore, very important to determine the impact of gas flaring on the bacteria, plant nutrients and plant population in Oloma community in Bonny Local Government Area of Rivers State, Nigeria. This will help to protect the livelihood of the inhabitants of the Bonny people. Furthermore, this research will provide evidence based information with respect to the damage caused by gas flaring in the fragile Niger delta ecosystem of Nigeria.

Materials and methods

Location of Study:

The study was carried out in Bonny in Bonny Local Government Area of Rivers State located at latitude $4^0$26N and longitude $7^0$10'E . Bonny has population of 214,983.The area is characterized by heavy rain fall, high temperature and relative humidity. The vegetation is dominated by the red mangrove *Rhizophora racemosa* and *Rhizophora mangle*. In some areas the white mangrove *Avicennia africana* is interspread with Nypa palm, hence dominated by mangrove forest system. The area has open coast, sand beaches, intertidal flats and creeks. The low intertidal zone is usually bare of vegetation, with clay, peat and sand deposit .The area is predominantly salt water, extensive mangrove swamps, tidal flats, influenced by semi-diurnal tidal regime (NASRDA,2005)

Isolation and identification of bacterial in soils

Bacterial Growth Medium: The medium used for cultivation and enumeration of bacteria was Nutrient agar. This was prepared according to manufacturer's specifications: 28g of the nutrient agar was dissolved in 1 litre of distilled water in a conical flask and then shaken thoroughly for proper mixing. The set up was autoclaved at 15psi and allowed to cool at 40^0C - 50^0C before use.

Microbiological Analysis of the Samples

For the purpose of cultivation and enumeration of the bacteria, serial dilution (19) was employed. This was done by taking 1.0ml of the supernatant (10^0dilution) of each prepared sample and adding into 9.0ml of sterile normal saline (diluents) in different test tubes to give 10^{-1} dilution. From the 10^{-1} dilution, further dilutions were made up to 10^5. About

0.lml aliquot of the appropriate dilutions was inoculated onto freshly prepared nutrient agar plates in triplicate. The inocula were spread evenly on the surface of the medium using a sterile bent glass rod. The inoculated plates were incubated at 37^0C for 24 to 48 hours. Discrete colonies that develop were counted and recorded. These were taken as the total number of bacteria enumerated. Also, colonial morphology of representative colonies were observed and recorded.

Isolation, Characterization and Identification of Bacterial Isolates

Pure cultures of bacteria were obtained by aseptically transferring representative colonies of different morphological types which developed onto freshly prepared nutrient agar plates and incubated at 28°C for 24 hours. Isolated colonies, which developed were sub-cultured onto nutrient agar slants and incubated at 28°C for 24 hours. These served as pure stock cultures for biochemical test which included gram reaction, motility, methyl red, Voges proskauer, catalase, coagulase, indole, citrate utilization and sugar fermentation tests (Cruickshank *et al*, 1975). The characterized bacteria were identified by reference to (Ofunne,1999;Buchanan and Gibbons, 1974; Cowan and Steel, 1976).

Plant tissue analytical methods

Total nitrogen, magnesium and calcium in plant tissues were determined by the modified method of Kjeldahi technique (Dupreez and Bale,1989).

Mangrove Vegetation Studies

The study was done using random sampling based on standard procedure for ecological assessment (Leahey,2001) along the specific transect at a distance of 50m, 100m,150m and 1km from the flare point. Predominant plant species within the sample plots were enumerated and identified in the field. Unknown species were collected and identified at the Forestry and Environmental department, Rivers State University of Science and Technology. The plant species richness was determined using the methods of (Kershaw, 1975). Where ++++ indicates very abundant species; +++ abundant species; ++ scarce and + very scarce. However, species richness was determined using (Whiltaker, 1965) method as shown below:

d =

Where

d = Species Richness Index

s = Numbers of species in sample standard size

A = Sample Area (m^2)

Results

Determination of Bacteria population at flared site.

This result on bacteria count and frequency of occurrence is shown on table 1 and figure 1. The findings showed that counts of heterotrophic bacteria were lowest at 50 meters (2.4 x 10^5 cfu/ml) while total heterotrophic bacteria was however highest (5.8 x 10^5 cfu/ml) at 150 meters. However, at 1 kilometer there was a reduction (3.0 x 10^5 cfu/ml) in bacteria Population. The common bacteria found around the flared sites were, *Acinnebacter*(6), *Aerococcus*(3), *Alicaligenes*(4), *Bacillus*(21), *chromobacterium*(2), *Citrobacter*(2),*Corynebacterium*(2), *Enterobacter*(2),*Flavobacterium*(4),*Klebsiella*(4),*Micrococcus*(4),*Proteus*(7),*Pseudomonas*(2), *Serratia*(2),*Stapylococcus*(5),*Streptococcus*(4) and *Streptomyces*(3).*Bacillus* (21) and *Proteus*(7) were the most prevalent at the flared soil site (Tables 1, 2 and figure 1).

Table 1 : Counts of heterotrophic Bacteria isolated from the flared site

S/N.	Distance from the flared site	Total heterotrophic bacteria(X 10Cfu/ml)
1.	50m	2.4×10^5 cfu/ml
2.	100m	4.7×10^5 cfu/ml
3.	150m	5.8×10^5 cfu/ml
4.	1 Km	3.0×10^5 cfu/ml

Kilometers (Km) and Meters (m)

Table 2: Frequency of occurrence of bacteria isolated from flared soil site

S/N	Type of Bacteria	Frequency of Occurrence at 0-15 (cm)	Frequency of occurrence 15-30 (cm)	Frequency of occurrence at 30-45 (cm)	Distance from flare (M)
1.	*Acinetobacter*	2	1	1	50
		-	-	-	100
		1	-	-	150
		-	1	-	1km
	Total	3	1	1	
2.	*Aerococcus*	-	1	1	50
		-	1	-	100
		-	-	-	150
		-	-	-	1km

	Total	**3**	**2**	**2**	
3.	*Alcaligens*	-	-	-	50
		-	-	1	100
		1	-	1	150
		-	-	1	1km
	Total	**4**	**2**	**5**	
4.	*Bacillus*	3	4	1	50
		1	1	1	100
		1	2	3	150
		3	1	1	1km
	Total	**8**	**8**	**6**	
5.	*Chromobacterium*	-	-	-	50
		1	-	1	100
		-	-	-	150
		-	-	-	1km
	Total	**1**	**-**	**1**	
6.	*Citrobacter*	-	-	-	50
		-	1	-	100
		-	-	-	150
		-	-	-	1km
	Total	**-**	**1**	**-**	
7.	*Corynebacterium*	-	1	-	50
		-	1	-	100
		-	-	-	150
		-	-	-	1km
	Total	**-**	**2**	**1**	

8.	*Enterobacter*	-	-	-	50
		-	1	-	100
		-	-	-	150
		-	-	-	1km
	Total	**-**	**1**	**1**	
9.	*Flavobacterium*	-	-	-	50
		-	-	-	100
		1	1	1	150
		1	-	-	1km
	Total	**2**	**1**	**1**	
10.	*Klebsiella*	1	-	-	50
		1	-	-	100
		1	1	-	150
		-	-	-	1km
	Total	**3**	**1**	**-**	
11.	*Micrococus*	1	-	-	50
		1	1	-	100
		-	1	-	150
		-	-	-	1km
	Total	**2**	**2**	**-**	
12.	*Proteus*	1	3	1	50
		1	-	1	100
		-	-	-	150
		-	-	-	1km
	Total	**2**	**3**	**2**	
13.	*Pseudomonas*	-	-	-	50

		-	-	-	100
		-	-	-	150
		-	-	1	1km
	Total	**-**	**-**	**1**	
14.	*Serratia*		-	-	50
		-	-		100
		-	-	-	150
		-	1	-	1km
	Total	**-**	**1**	**-**	
15.	*Staphylococcus*	1	-	1	50
		1	-		100
		-	1	-	150
		1	1	-	1km
	Total	**3**	**2**	**1**	
16.	*Streptococcus*	2	-	-	50
		1	-	1	100
		-	1	1	150
		-	-	1	1km
	Total	**3**	**1**	**3**	
17.	*Streptomyces*	1	-	-	50
		1	-	1	100
		-	1	1	150
		-	-	-	1km
	Total	**2**	**1**	**2**	

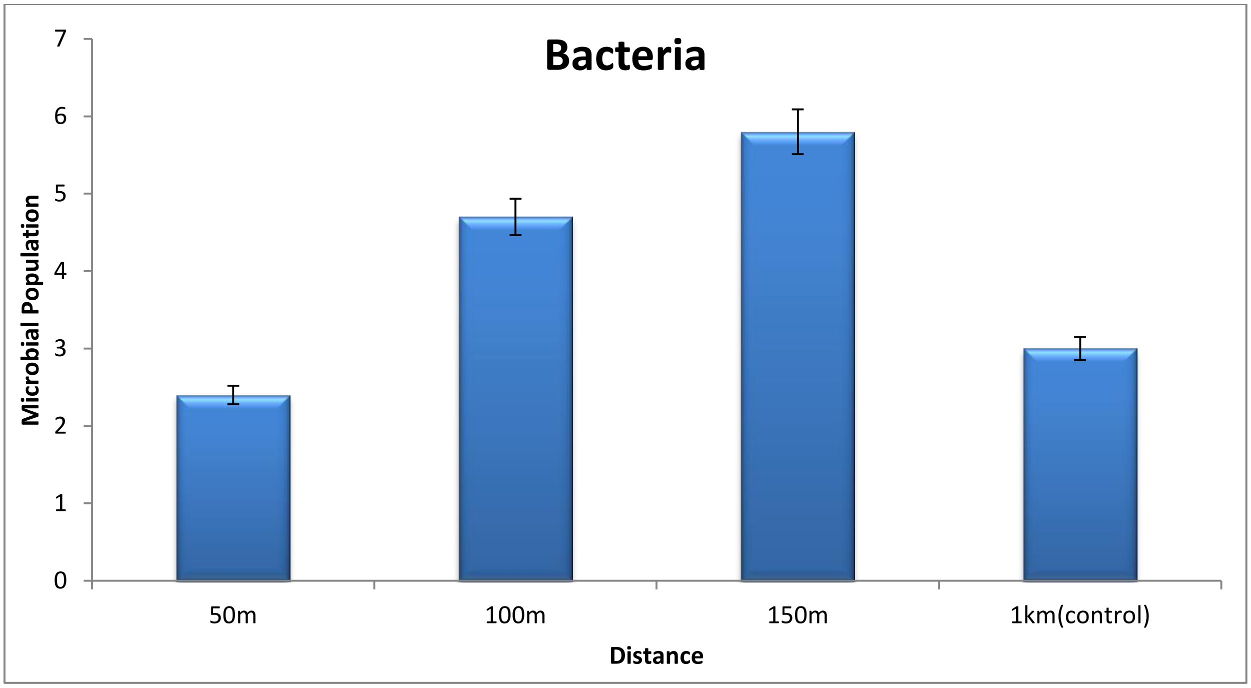

Figure 1: Bacteria population of soil at various distances apart.

Determination of the plant nutrients at the flared site

The results showed that calcium, nitrogen and magnesium were lowest at the distance of 50 m - 100 m. The nutrients were highest at 150 m – 1km (Figures 2-7 and Table 3). N, Mg and Ca were significant at $P<0.05$ at 1km.

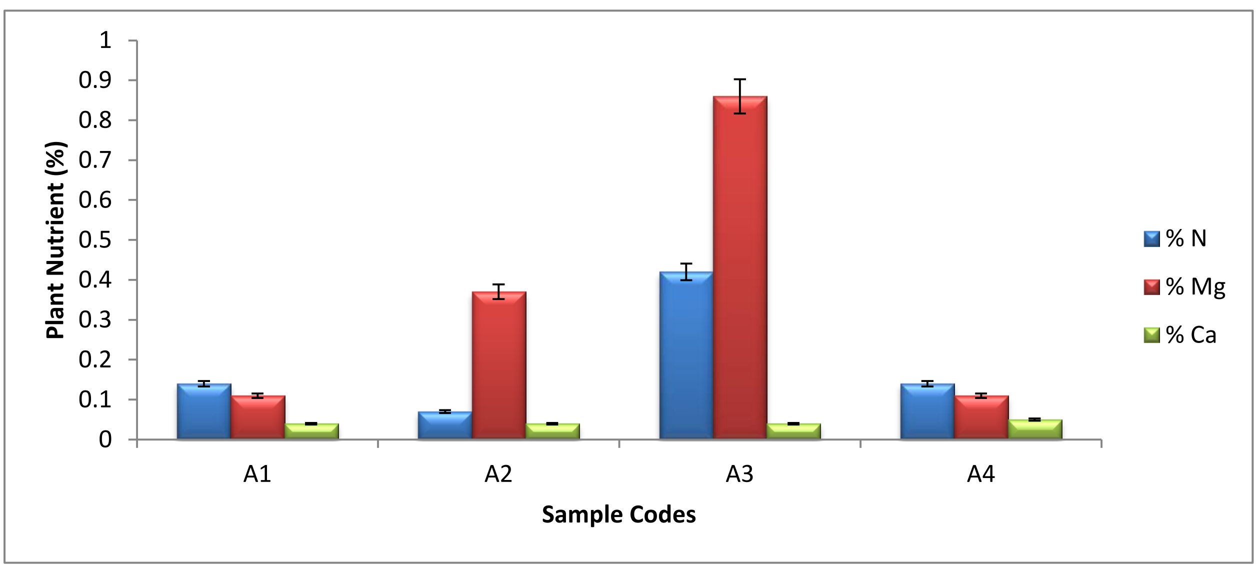

Figure 2: Plant nutrient at 50m distance apart.

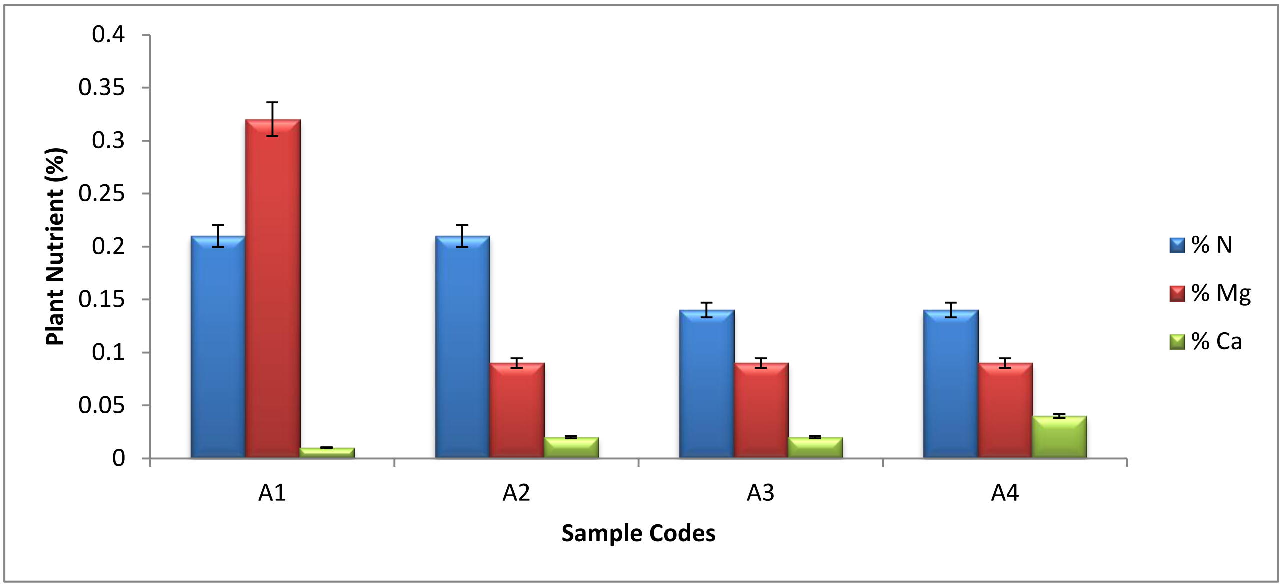

Figure 3: Plant nutrient at 100m distance apart.

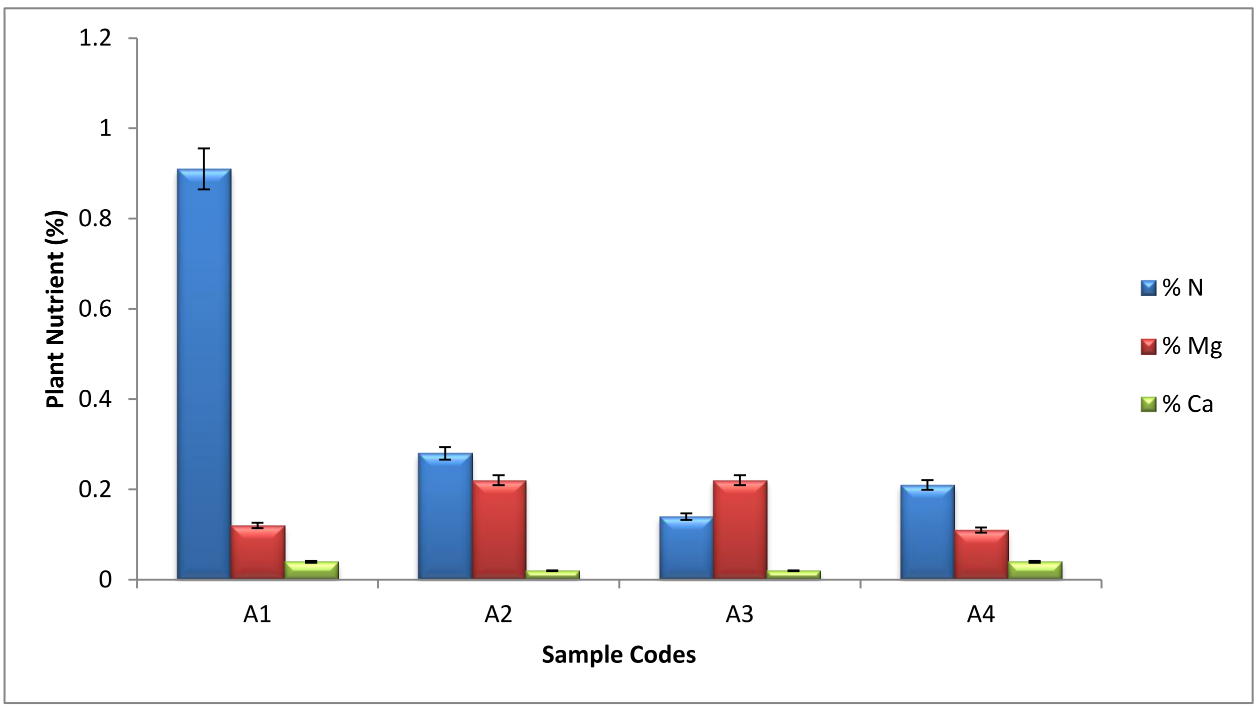

Figure 4: Plant nutrient at 150m distance apart.

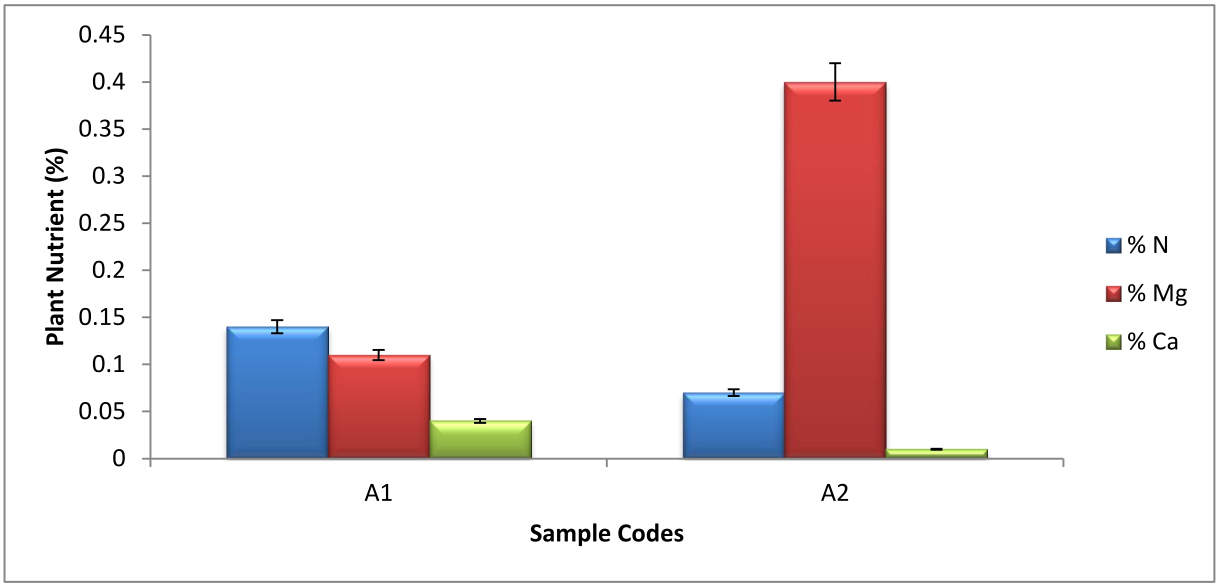

Figure 5: Plant nutrient at 1km distance apart.

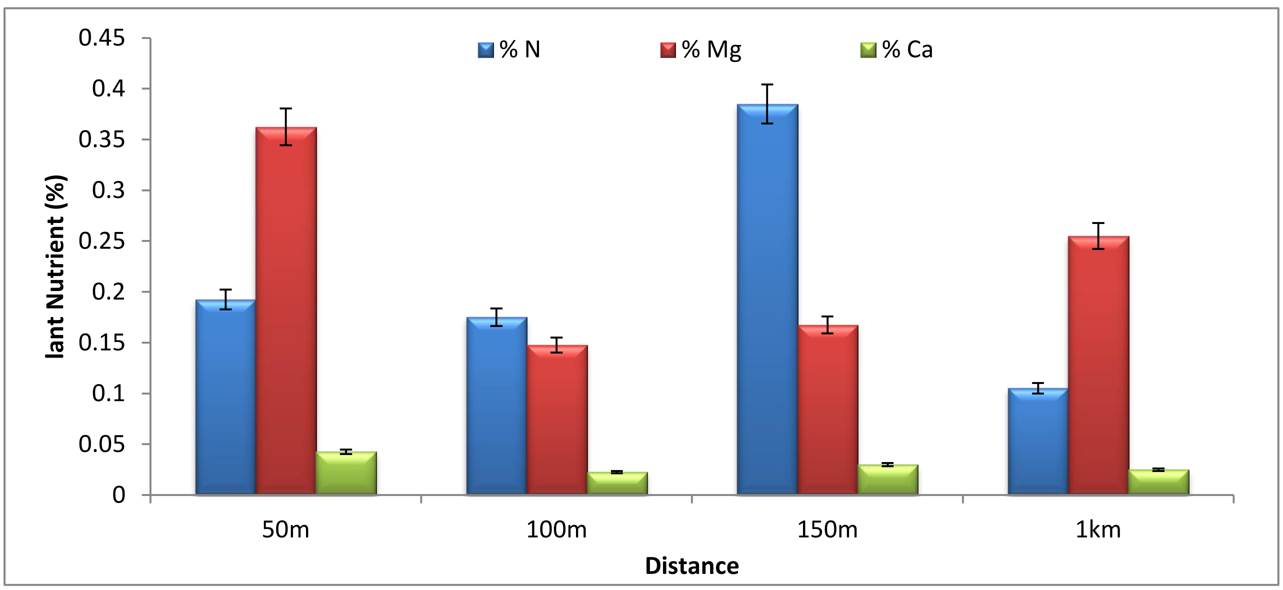

Figure 6: Plant nutrient at various distances apart.

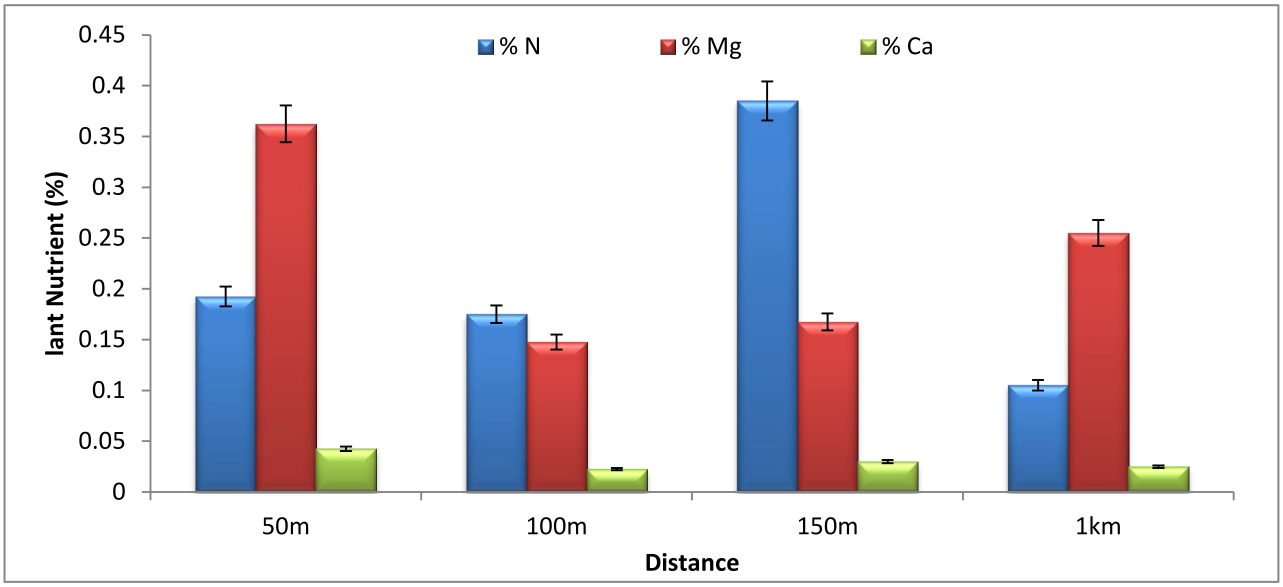

Figure 7: Plant nutrients at various distances apart.

Table 3: Correlation of distance from flare on plant nutrients

	Plant nutrient
50m-%N	$P>0.05^{NS}$
P-value	1.000
%Mg	$P>0.05^{NS}$
P-value	0.157
Mg	$P>0.05^{NS}$
P-value	0.202
Ca	$P>0.05^{NS}$
P-value	0.775
100m-%N	$P>0.05^{NS}$
P-value	0.349
%Mg	$P>0.05^{NS}$
P-value	0.775
%Ca	$P>0.05^{NS}$
P-value	0.910

150m-%N	P>0.05 [NS]
P-value	0.629
%Mg	P>0.05 [NS]
P-value	0.610
%Ca	P>0.05 [NS]
P-value	0.609
1km-%N	P<0.05*
P-value	0.001
%Mg	P<0.05*
P-value	0.001
%Ca	P<0.05*
P-value	0.001

***Significant Difference at Probability level of 0.05.** NS-**Not significant difference (P>0.05). P-value-probability values**

Vegetation studies

Paspulum jaminance , *Sporobolus pyramidalis*, *Euphorbia hirta*, *Acrosticum aereum*, *Nypa fructicans*, *Rhizophora mangle*, *Elaesis guineensis*, and *Mimosa pudica* were common around the flared site. However, *Sporobolus pyramidalis*, *Euphorbia hirta* and *Nypa fructicans* were the least abundant (+) in all distances (50 M- 1 Km). *Acrosticum aereum* was the abundant (+++) at 100 m. The most abundant plants (++++) were, *Rhizophora mangle* and *Paspulum jaminance* at 50m- 1Km (Table 4).

Table 4: Effect of gas flare on vegetation at Oloma

Distance from the flared site	common plants	species richness
50 M	*Paspulum jaminance*	++++
	Sporobolus pyramidalis	+++
	Euphorbia hirta	+
100M	*Elaesis guineensis*	++

	Nypa fructicans	+
	Acrosticum aereum	+++
	Rhizophora mangle	++++
150M	*Euphorbia hirta*	+
	Sporobolus pyramidalis	++
	Nypa fructicans	+++
	Rhizophora mangle	++++
1Km	*Nypa fructicans*	+++
	Rhizophora mangle	++++

Discussion

Determination of Bacterial population at flared site.

The findings showed that counts of heterotrophic bacteria were lowest at 50 meters (2.4 x 10^5 cfu/ml) while total heterotrophic bacteria was however highest (5.8 x 10^5 cfu/ml) at 150 meters. However, at 1 kilometer there was a reduction (3.0 x 10^5 cfu/ml) in bacteria Population. The results indicated low bacteria population at distances close to the flared sites. It is important to point out that these bacteria most have developed thermophilic properties over time. This may as well account for their survival over time. This work clearly supports the works of (Abulkareem,2005 and Nwaugo *et al*, 2005) that showed that bacterial population Increased away from the flare. Similarly, there results also indicated adverse ecological and bacterial spectrum due to modifications caused by gas flare.

Determination of plant nutrients at the flared site

The result on the plant nutrients showed that calcium, nitrogen and magnesium were lowest at the distance of 50 m – 100m and highest at 150m – 1km. Na, Mg and Ca were all Significant at P<0.05. This research is in consonance with the works carried out by (Alakpodia,1989 and 2000) . Both authors opined that exchangeable cation or base (Ca, Mg, K and Na) in soils under gas flare is low. Alakpodia (20005) also observed that nutrients exhibit an increasing pattern with an increasing distance from flares.

Vegetation studies

Paspulum jaminance , *Sporobolus pyramidalis*, *Euphorbia hirta*, *Acrosticum aereum*, *Nypa fructicans*, *Rhizophora mangle*, *Elaesis guineensis*, and *Mimosa pudica* were common around the flared site. However, *Sporobolus pyramidalis*, *Euphorbia hirta* and *Nypa fructicans* were the least abundant (+) in all distances (50 M- 1 Km). *Acrosticum aereum* was the abundant (+++) at 100 m. The most abundant plants (++++) were, *Rhizophora mangle* and *Paspulum jaminance* at 50m- 1Km. Species richness was low at 50m but high at 150m and 1km away from the flared site. Isichei and Sanford (1976) ; Alakpodia (1989) have demonstrated that gas flare retards vegetation growth.

References

Abere,S.A and Ukoima,H.N (2014). Impacts of expansion project of the Nigeria Liquified Natural gas on The wildlife status of Bonny Island. Journal of Biology,Agriculture and Healthcare. 4(13):2224-3208

Abdulkareem, A.S (2005) . Evaluation of Ground level concentration of pollutant due to Gas. Flaring by computer simulation: A case study of Niger-Delta Area of Nigeria. *Leonardo Electronic journal of Practices and Technologies.* 6(1). 29-42

Alakpodia, I.J (1989).The effects of Gas flaring on the micro climate and adjacent vegetation in Isoko Area of Bendel state. Unpublished M.Sc. Thesis, University of Ibadan.

Alakpodia, I.J (2000).Soil characteristics under Gas flare in Niger Delta, Southern Nigeria. *Geo studies forum, An international Journal of Environmental and Policy Studies*.1 (2): 1 – 10

Buchanan, R. E. and Gibbons, N.E (1994). *Bergey's Manual of Determinative Bacteriology,* 8th edition. Williams and Wilkins Co., Baltimore, U.S.A.

Cowan, S.T and Steel, K.J (1976). Cowan and Steel Manual of Medical Bacteriology, Cambridge University press, London.

Cruichshank, R.J.P., Duguid, B.P, Marmion, R and Swan, H.A (1975). *Medical Microbiology*, 12th Edition. Churchill Livingston. New York.

Dupreez,D.R and Bale,G.C (1989) . A simple method for the qualitative recovery of NO3-N During Kjeldani analysis of dry soil and plant samples. *Soil Science Plant Analysis*. 20:345-357.

Edino, M.O., Nsofor, G.N and Bombom, S.L (2010) . Perceptions and attitudes towards gas flaring in the Niger Delta, Nigeria. *Environmentalist.* 30:67-75

Ishisone, M (2004). Gas flaring in the Niger Delta. The potential Benefit of its Reduction on the Local Economy and Environment. *Nature.berkeley.Edu/classes.*

Isichei, O.A and Sanford, W.W (1976) . The effects of waste gas flares on the surrounding vegetation in south-east Nigeria. *Journal of Applied Ecology*. 13(1):177-187

Kershaw, K. A (1975) . *Quantiative and Dynamic Plant Ecology* 2nd Edition, Edward Arnold, London. P.305

Leahey, D.M., Preston, K and Strosher, M. (2001). Theoretical and Observational assessments of flare efficiencies. *Journal of Air Waste Management Association.*51 (12):1610-1616 National Space research and Development Agency, Nigeria. (NASRDA). 2005.

Nwaugo, V.O; Onyeagba, R.A and Nwachukwu, N.C (2005). Effect of Gas Flaring on Soil Microbial Spectrum in Parts of Niger-Delta Area of Southern Nigeria. *African journal of Biotechnology*. 5 (19). 1684-5315

Omokaro, O (2009). Oil and gas extraction I the Niger Delta Region of Nigeria: The social and environmental challenges. *Freiberg Online Geology.* 24: 13-20

Ofunne, J.L (1999) . *Bacteriological Examination of Clinical Specimens*. Achugo Publications. Ama J.K. Recreation Park, Owerri, Nigeria. P. 35

Ukoima,H.N Abere,S.A; and Omokua,G.E (2014). Andoni marine ecology: Emphasis on the biology and Importance of some useful plants. Journal of Environment and Earth Science. 4(18):2224-3216

Ukoima,H.N and Umechuruba,C.I (2009a). Enumeration of fungi on some mangrove plants in Port Harcourt. International Journal of Agriculture. 1(2):126-129

Ukoima,H.N and Umechuruba,C.I (2009b). Effect of relative humidity and temperature on fungi Isolated from marine habitat in Port Harcourt. International Journal of Bioscience. 4(2):104-107

Ukoima,H.N and Amakiri,M.A (2009c). Diversity and abundance of mycoflora in the mangrove Soil in Port Harcourt, Rivers State. Journal of Science and Technology Research Policies. 8(3):30-33

Ukoima,H.N and Amakiri,M.A (2009d).Fungi associated with the roots of some mangrove forest Trees in Port Harcourt. 2009d. Environment and Conservation. 13(1):39-42

Ukoima,H.N; Wemedo,S.A and Morpho,F. (2007) Survey of some bacterial pathogens on Leaves and seeds of white mangrove plants. Indian Forester . 133(1):637-641

Whiltaker, R.H.(1965) Dominance and Diversity in land Plant Communities. *Science*. 147: 250 260

World Bank (2002) . Report on consultations with stakeholders. World Bank – GGFR Report on global gas flaring reduction public – private partnership. Washington, D.C.

World Bank (2007) . A Twelve Year Record of National and Global Flaring Volumes Estimated Using Satellite Data Final Report. www.siteresources.worldbank.org.