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Evaluation of Heavy Metal Levels and the Distribution of Rhizophora racemosa and Nypa fruticans in the Niger Delta Mangrove Forest, Nigeria

*Gbosidom, V. L. Obute, G. C. Tanee, F. B. G.
Department of Plant Science and Biotechnology, University of Port Harcourt, Nigeria

Abstract
Plants react differently to pollutant levels in their substratum, and pollutant levels either positively or negatively influence their distribution. In this study, soil levels of Cr, Ni, Cd, Pb and Zn on the distribution of *Rhizophora racemosa* and *Nypa fruticans* was investigated. Soil samples were collected randomly closer to the roots at growth sites and the non-growth sites of the study plants at four selected stations in the study area and analyzed using standard laboratory methods. Findings showed that *N. fruticans* grew well in soils with high levels of soil Cr, Pb and Zn over *R. racemosa* whose growth was associated with soils with lower levels of the referenced metals and the above metals influence their distribution. The above observation was attributed to the high tolerance level of *N. fruticans* to Cr, Pb and Zn toxicity above *R. racemosa.* It is thus concluded that *R. racemosa* and *N. fruticans* distribution are influenced by the levels of soil heavy metals.
Keywords: Pollutant levels, Distribution, Mangrove.

Introduction

Nigerian mangrove forest is classified as the largest in Africa and by extension, the third largest globally, covering an area of 105,000 hectares of land (Anon, 1997; Ndukwu and Edwin-Wosu, 2007). The largest proportion of the Nigerian mangrove forest is located in the Niger Delta, situated between longitude 50^0 E to 80^0 E and latitude 40^0 N to 60^0 N (Opufusu, 2007). This forest is viewed as the most exploited in the world (FAO, 1997).

The Niger Delta mangrove ecosystem consists of three main types of endemic mangroves occupying 6,000Km^2 of land mass (Maffat and Linden, 1995), with three species of Rhizophora *(Rhizophora racemosa, Rhizophora mangle and Rhizophora harrisoni)* dominating the region. Among these species, *Rhizophora racemosa* occupies 90% of the total area. The three endemic mangrove species of the region are distributed with *Rhizophora species* fringing the water fronts, while *Avicennia germinans* occupy slightly higher elevations. *Laguncularia racemosa* has no specific geographic restriction in the ecosystem (Ohimain, 2006b). In a bid to control coastal erosion in the coastal shores of Calabar and Oron in the eastern flank of Niger Delta, *Nypa fruticans* an alien mangrove species, a native of South East Asia was introduced from Singapore in 1966. This species after establishment has spread west ward across the region to Ondo State, invading expands of land, with the displacement of the valuable endemic mangrove species. The trend of displacement cuts across the Niger Delta of Nigeria and Cameroon forming mono specific stands, competing against the native mangrove species (Saenger, *et al*., 1995).

Niger Delta is noted for the production of light crude with associated adverse negative impacts on mangrove forest (Duke, *et al*., 2000). Due to processes involved in exploration and exploitation of crude oil, the region is exposed to incessant oil spillages that have caused widespread deforestation and environmental degradation (Idoniboye and Odu, 1981; Nwangwu and Okoye 1981; Odu, 1982; Baker, 1982). The United Nations Environmental Programme report on Ogoni environment showed that oil impacted on mangrove vegetation causing disastrous effects which varied from extreme stress to total destruction of leaves and stems, leaving roots that are completely coated with oil up to 1cm or more thick layers of bituminous substances (UNEP, 2011). Oil spillage in mangrove ecosystem has been reported to causes adverse effects (Marmiroli, *et al*., 2006), and these effects are based on the types of oil, level of spill, the area covered, oil composition and the season of occurrence (Pezeshki, *et al*., 2000). In some cases, it can result to changes in the colour of foliage, low quality in canopy formation, low productivity and mortality of plants (Akwiwu, *et al.*, 2002, Nkwocha and Duru, 2010). In other cases, germination, growth and development of plants are inhibited (Ekundaro 2007, Ekpo *et al*., 2012, Eze *et al*., 2013). Other reports has indicated negative effects such as germination inhibition, poor growth in stem diameter and height, reduction in the rate of photosynthesis and death of plants (Pezeshki, 2000, Tanee and Anyanwu, 2007, Anyanwu and Tanee, 2008). Heavy metals constitute a major threat to mangrove forest (Wong and Tam, 1997; Agoramoorthy *et al*., 2008,). The understanding of varying concentrations of heavy metals, the nature of their distribution coupled with their relative toxicity and persistence in the environment has bestowed it as a priority pollutant for environmental management globally (Don- Pedro *et al*., 2001). Mangrove forest is known for predisposition to frequent flooding, especially during raining seasons when heavy metals from various sources get into the forest. Upon deposition, sediments and soil act as a sink for pollutants which

persists in the environment (Maria-Santos *et al*., 2012). The concern for heavy metal pollution had been attributed to its characteristics non- biodegradability, accumulation capability as well as the toxicity to life forms (Henry, 2000; Ghosh and Singh, 2005, Neff *et al*., 2006, Erakhrumen, 2012 & 2014). All heavy metals have been shown to cause strong toxic effects at high concentrations and are therefore regarded as environmental pollutants (Chehregani *et al*., 2004, Yousefi *et al*., 2011; Mohsenzadeh *et al*., 2011). However, metals with very high bioavailability and low concentration do not constitute serious risk rather it is those with lower bioavailability fractions and high concentration that cause significant environmental risk (Liu *et al*., 2009). In respond to the toxicity of pollutants, plants exhibits tolerance mechanism in order to overcome them. Subodh and Abhiroop, (2013) in their study reported the dominance of *Avicinnia marina* growth in patches which they attributed to pollution and the tolerance of the mangrove species. Some other plants have shown the capacity for tolerating Ni, Pb, and Zn toxicity by accumulating higher concentrations in their tissues (Frietas *et al*., 2004).

Previous studies have investigated the effect of pollutants on mangrove plants. However, studies on the relationship of heavy metal levels on the distribution of mangrove species especially *Nypa fruticans* and *Rhizophora racemosa* has not been established. In this study heavy metal levels at the growth and non-growth soils of *Nypa fruticans* and *Rhizophora racemosa* was investigated in Khana and Gokana Local Government Area of Ogoniland with respect to their distribution.

2. Materials and methods

2.1. Study area

The study area stretches from Bomu located at longitude 7.37 and latitude 4.58 to Kono, located at longitude 7.514 and latitude 4.591. Landsat 2013 imagery was acquired over the study area. The image was geo-posed and geo-processed for further analysis. Supervised classification was used to delineate area of species location in line with information derived using Geosat Position System (GPS) device. The coordinate of different species location was used to conduct supervised classification of the area, ensuring appropriate representation of species in accordance to information received on ground. The sampling stations stretches across two local government area of Rivers state, namely Khana and Gokana local government area of Ogoni (Fig 1).

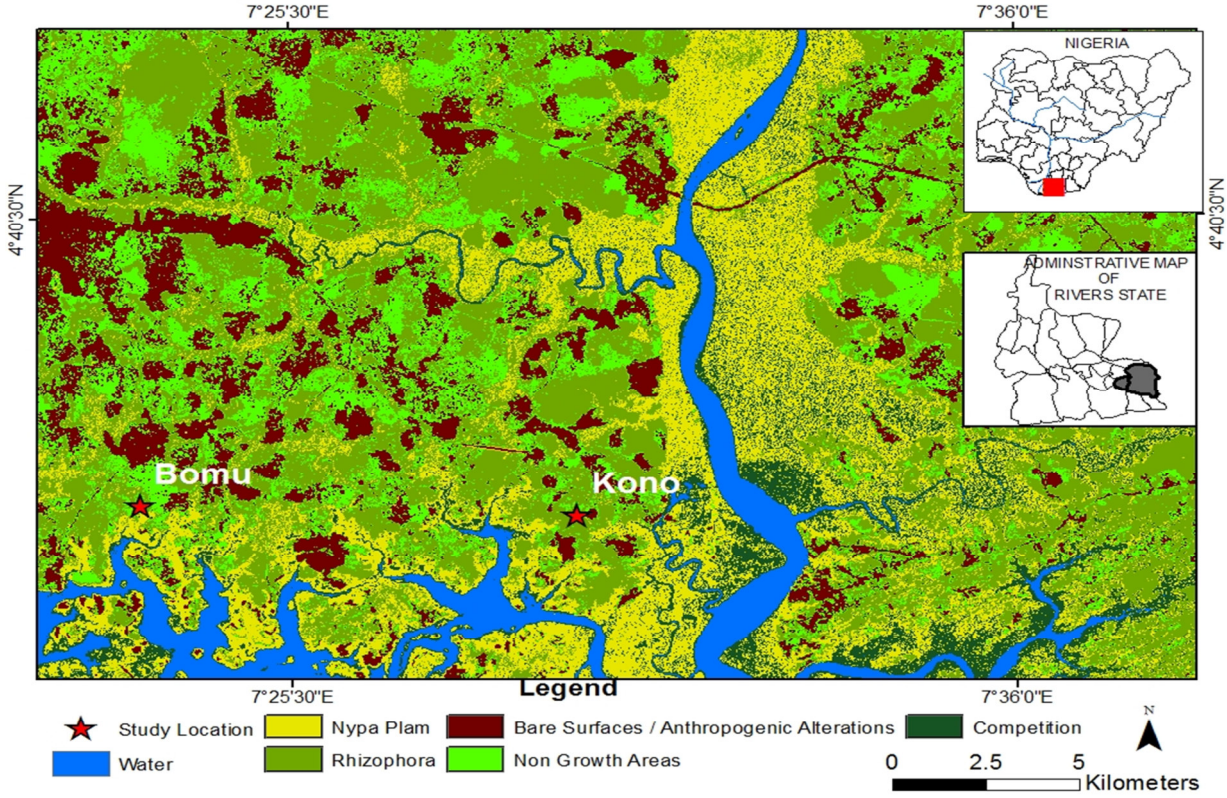

Figure 1: Map showing study area

2.2. Sampling

Field samples were collected during wet and dry seasons. The wet season samples were collected in the months of July and August 2015 while dry season samples was collected in the months of January and February, 2016. Samples were collected by the completely randomized block design method. Various soil samples of top soils

were collected randomly at 0 - 30 cm closer to the roots of *Rhizophora racemosa* and *Nypa fruticans* at their respective growth sites, and the non-growth sites of both plant species in three
replications each from the two established stations in the study area, using soil auger. Soil samples were stored in clean cellophane bags, tied and labelled using masking tape and marker pen. Samples were preserved in plastic cooler and transported to the laboratory for heavy metals analyses. Samples for deferred analysis were stored in the refrigerator and regulated at 4˚C.

2.2.1. Sample Preparation

Soil samples were oven dried in the hot air oven model T 5028 at 100^0 C and pulverized using mortar and pestle. Pulverized samples were sieved using skitter and stored in cellophane bags, labelled according to sample identity.

2.2.1.2 Digestion of Samples

The pulverized soil samples were weighed at 1g each and digested using 5 ml HNO_3 (70% v/v), 5 ml $HCLO_4$ (70% v/v) and 10 ml HF (48% v/v) and heated using mantle (model MY 6403) until dryness. The residue was allowed to cool and re-dissolved in 5 ml HCL (36% v/v) and 20 ml distilled water filtered and washed using cotton wool into different pre-labelled 100 ml volumetric flask and made up to 100 ml (Eduardo *et al*., 2005).

2.3. Heavy Metal Analysis

Heavy metal content of soil was determined using the Perkin Elmer Analysist 200 and Buck 210 Atomic Absorption Spectrophotometer (AAS). Chromium, Nickel, Cadmium, Lead and zinc were determined based on their respective wave lengths

2.4. Statistical Analysis

The data obtained from laboratory analysis of field samples were subjected to the general linear model analysis of variance (ANOVA) to test subject effects at (p = 0.05), while the post hoc test of least significant differences was applied for separation of significant means at (p = 0.05), using the SPSS statistical package. Descriptive statistics was also used to illustrate the distribution of field data. Result were presented in bar charts of Mean = SEM.

3. Results

3.1. Soil Chromium Content

There was presence of Chromium in the two stations at both wet and dry seasons. Cr peaked at non-growth site at the dry season and at *N. fruticans* growth site (dry season) at station 1 and 2 respectively. The highest concentration of Cr was recorded at station 2 (dry season at *N. fruticans* growth site) while the least was recorded at station 1 (wet season *R. racemosa* growth site) (Fig. 2).

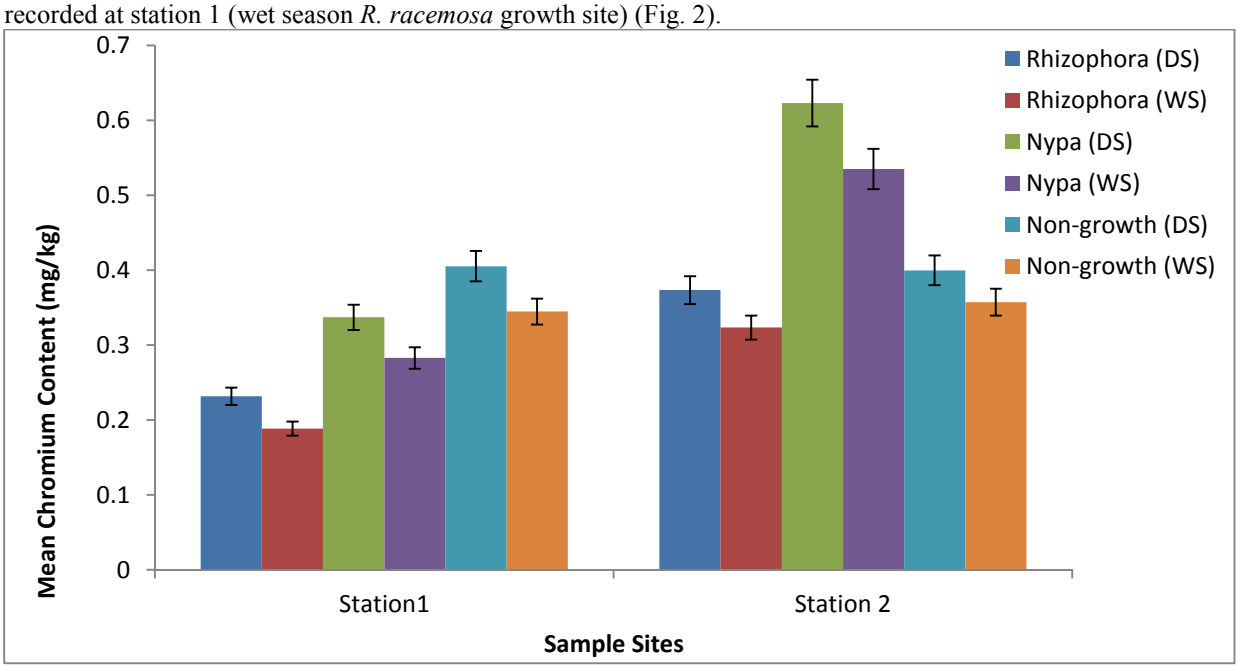

Figure 2: Soil Chromium distribution at the different sites. WS= Wet Season, DS= Dry season

3.2. Soil Nickel Content

Nickel was present in the study stations at both wet and dry seasons, with peak levels at dry season *R. racemosa* growth site and *N. fruticans* growth soils in station 2 respectively. The highest Ni levels were observed at station 2 dry season *R. racemosa* and Non-growth sites, while the lowest level was recorded at wet season *R. racemosa*

growth site (Fig. 3). At the wet season, result showed significant differences at station 1 between *N fruticans* and *R. racemosa* and between non-growth and *R. racemosa*, while dry season showed significant difference at station 1 between *R. racemosa* and *N. fruticans* growth soils at p = 0.05.

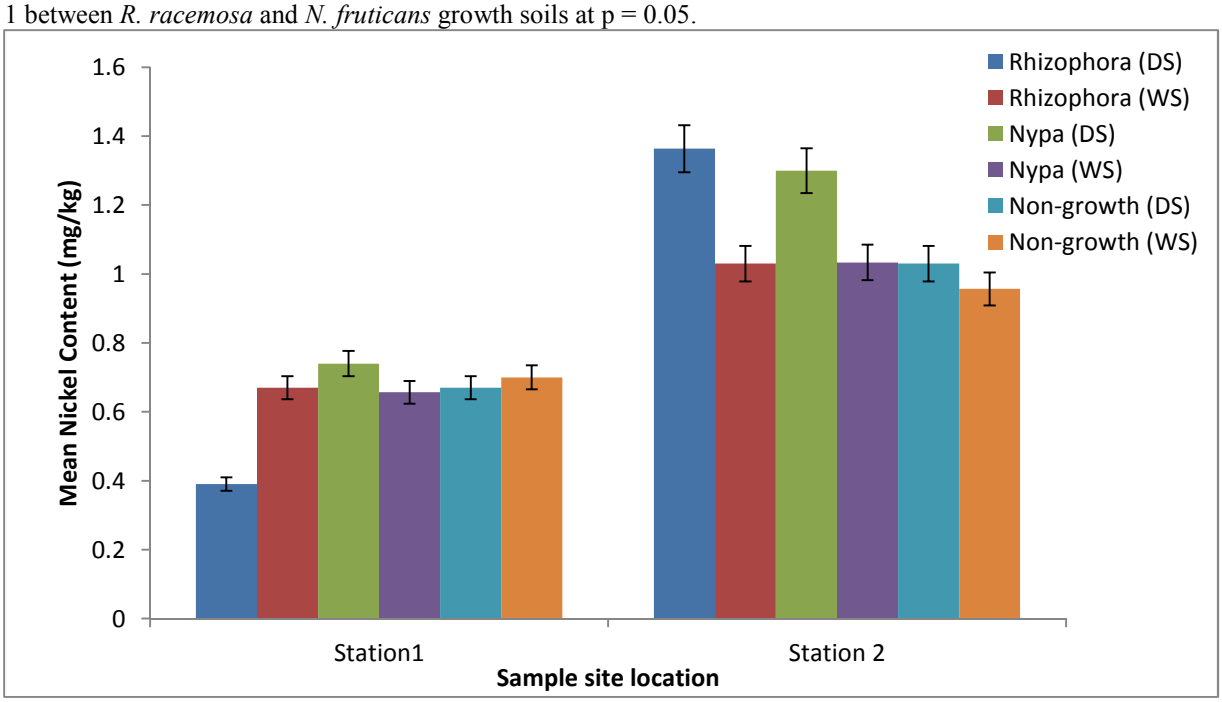

Figure 3: Soil Nickel distribution at the different sites. WS= Wet Season, DS= Dry season

3.3 Soil Cadmium distribution

Low levels of Cadmium were recorded at wet and dry seasons in the study stations. The result showed highest level of Cd in soil at *N. fruticans* growth sites (dry season) in both study stations, while the least Cd levels were recorded *R. racemosa* wet season in both study stations (Fig 4). There was no significant difference at wet and dry season Cd for each growth site.

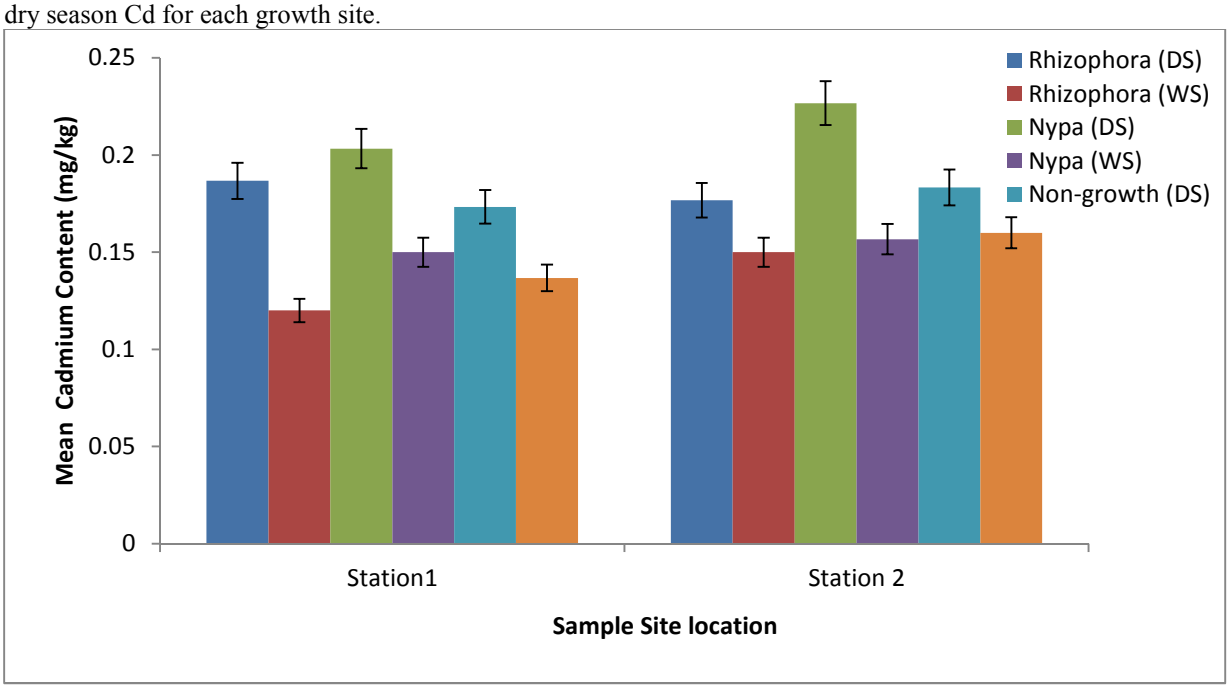

Figure 4: Soil Cadmium distribution at the different sites. WS= Wet Season, DS= Dry season

3.4 Soil Zinc distribution

Zinc was present at the two study stations at both wet and dry seasons. The highest peak level of Zn was

recorded in *N. fruticans* growth sites at both wet and dry seasons of the two study stations. The lowest level of Zn was recorded at station 2 in *R. racemosa* growth site for both wet and dry seasons (Fig. 4). Zn levels interaction with plants at wet season showed significant differences at station 1 between *N. fruticans* and *R. racemosa*; *N. fruticans* and non-growth growth sites. Station 2 showed significant differences between *N. fruticans* and *R. racemosa;* between *N. fruticans* and non-growth sites

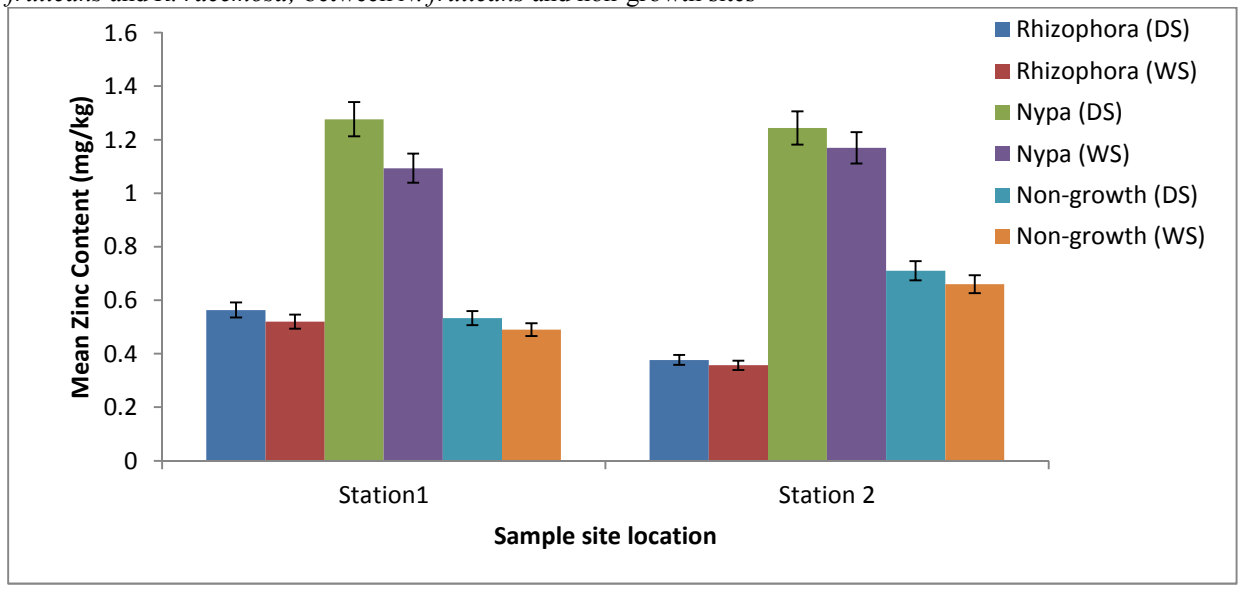

Figure 5: Soil Zinc distribution at the different site. WS= Wet Season, DS= Dry season

3.5 Soil Lead distribution

The Pb contents of the soil at the various growth sites were generally low. However, station 2 recorded higher ($p = 0.05$) level of Pb than station 1. At both stations, the highest Pb level was recorded at *N. fruticans* growth site during the dry season (fig 6). The highest concentration of Pb was recorded at *N. fruticans* growth site (station 2 dry season) followed by *N. fruticans* growth site (station 2 wet season). The least Pb concentration was recorded in station 1 *R. racemosa* (wet season) growth site.

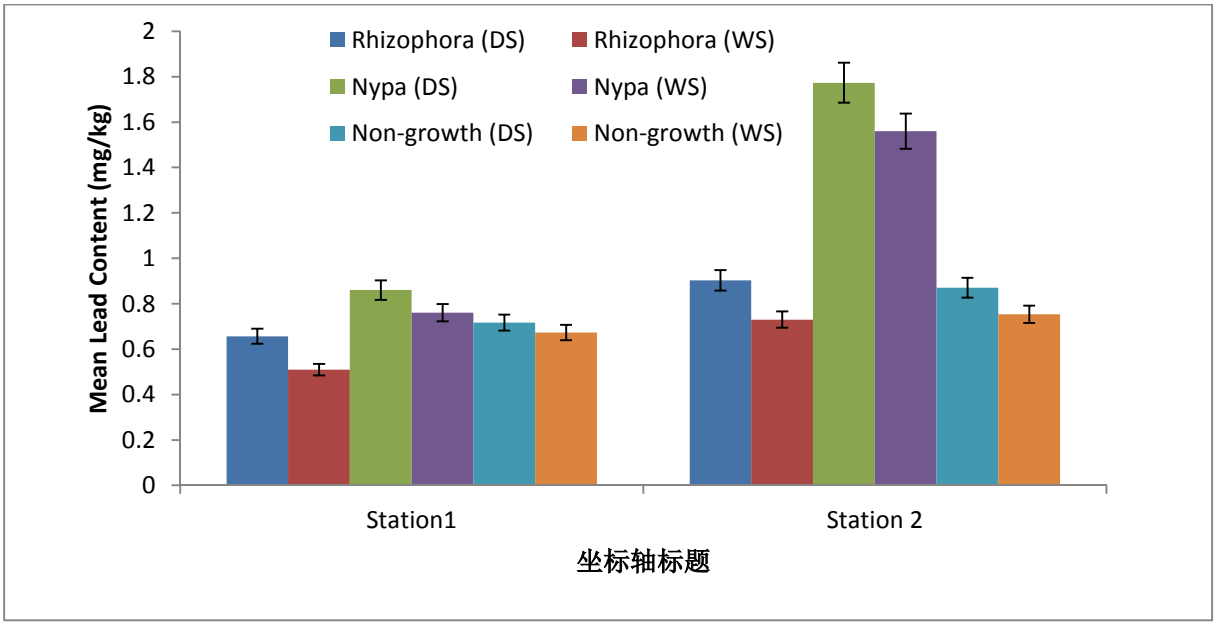

Figure 6: Soil Lead distribution at the different sites. WS= Wet Season, DS= Dry season

4. Discussion

This study on the relationship between pollutant levels and the distribution of *Rhizophora racemosa* and *Nypa fruticans* compared the soil pollutant levels at of *R. racemosa and N. fruticans* substratum as well as those of the Non-growth soils.

Findings in this study showed that the concentration chromium in soil was in the order *N. fruticans* growth soil >*R. Racemosa* growth soil > non-growth soil, which showed that chromium levels in the soil influences the distribution of *R. racemosa* and *N. fruticans*, as

N. fruticans is observed to be more tolerant and grows in soils with high levels of Cr than *R. racemosa.* The above finding is consistent with the finding of Subodh and Adhiroop (2013), which observed the dominance of *Avicinnia marina* in different mangrove patches and attributed it to pollution and the tolerance of mangrove species. Chromium does not play any role in plant metabolism rather than being toxic (*Dixit et al,* 2002). Chromium had also been shown as be phytotoxic either at low concentration or when the concentration is above certain threshold levels (Nieboer and Richardson 1980). The presence of chromium at *N. fruticans* and *R. racemosa* growth stations is therefore attributable to the tolerance levels of both plant species.

Result of soil Nickel and Pb content in this study showed variation at *R. racemosa, N. fruticans* and Non-growth soils at the respective stations with no significant differences. This shows that these metals do not play any role in the distribution of the study plants. This is an indication that Ni is not a major pollutant of this area. This is justified since the major anthropogenic pollution activity in Ogoni area is crude oil with no industrial chemical activities. Ni as an essential micro- nutrient of plants, its presence in the sites may have contributed to the growth of mangroves.

Soil Cadmium (Cd) levels at *N. fruticans*, *R. racemosa* and Non-growth soils were not statistically significant. Cadmium had earlier been observed as a metal of primary importance in the environment when considering metal toxicity (Ghnaya *et al*, 2007), and Cd toxicity effects can be observed in plants at low concentration (Barcelo and Pochenrieder, 1997). Contrary to the above finding, the low levels of Cd in this study did not show significant difference at the respective study stations. Consequently, the distribution of *N. fruticans* and *R. racemosa* were not influenced by soil cadmium levels.

The concentration of soil zinc in the study showed the trend of *N. fruticans* growth site >*R. racemosa* growth site > Non-growth site, with significant differences. The findings clearly showed that zinc levels in the soil environment significantly influenced the growth and distribution of study plants, especially *N. fruticans* where Zn concentration peaked. It is thus inferred that *N. fruticans* was more tolerant to high levels of Zn than *R. racemosa.* The above finding corroborate the earlier observation by Subodh and Abhiroop, (2013) who reported the dominance of *Avicinnia marina* in different mangrove patches, and attributed it to tolerance of the mangrove species. Earlier Freitas *et al*., (2004) reported that some plant species possessed the capacity of tolerating the toxicity of Ni, Pb and Zn by accumulating higher concentrations of these metals in their tissues. Also Shen *et al*; (1997) reported that *Thlasp caerulescens* tolerated 0.5mg of zinc in solution without noticeable reduction in its growth, or toxicity symptoms at 1mg zinc level. The findings of Bert *et al*., 2003, Radwan and Salama, (2006) showed that at higher concentration, plant shows zinc toxicity symptoms such as inhibition of root growth. The potential for zinc tolerance in *N. fruticans* than *R. racemosa*, may have inferred a competitive advantage on *N. fruticans* leading to the displacement of *R. racemosa* by *N. fruticans.*

5. Conclusion

R. racemosa and *N. fruticans* in this study reacted differently to pollutant levels in their growth substratum, which consequently positively or negatively influenced their distribution. The study have shown that high levels of soil Cr and Zn positively influenced the distribution of *N. fruticans* over *R. racemosa*, as *N. fruticans* was observed to grows in soils with high levels of Cr and Zn. This finding shows that *N. fruticans* possessed high tolerance for Cr and Zn toxicity than *R. racemosa*. The non-growth of both study plants at some stations may be attributed to Cr and Zn toxicity. The study also showed that soil levels of Ni, Cd and Pb did not influence the growth and distribution of the study plants. Therefore, soil pollutant levels of the area should be monitored to reduce the displacement of *R. racemosa* by *N. fruticans.*

Reference

Agaromoorthy, G., Chen, E. A. & Hsu, M. J. (2008). Threat of heavy metal pollution in halophyte and mangrove plant of Tamil Nadu, India. *Environmental Pollution*, 155(2): 320- 326.

Akwiwu, C. D., Nwajiuba, C.U. & Nnadi, F. N. (2002). Pollution and agro-forestry practices of farmine in Imo State. Implications for house hold livelihood. Paper presented at 36th Annual Conference of the Agricultural Society of Nigeria held at Federal Uni. of Tech.Oct. 20-24 Owerri.

Anon (1997). Status of forest cover, Forest survey of India, Dehra Dun: In Singh H. S 2001 Mangroves in Gujarat on path of recovery – A success story. Indian Forester, April 2001.

Anyanwu, D. I. & Tanee, F. B. G. (2008). Tolerance of cassava (Var. TMS 30572) to different centrations of post- planting crude oil pollution. *Nigerian Journal of Botany*, 21:203-207.

Baker, N.R, Fernyhough, P. & Meek, I,F, (1982). Light dependent inhibition of photosynthetic electron transport by Zinc, *Physiologia of plantarum*, 56 (2): 217-222.

Barcelo, J. & Poshchenrieder, C (1997).*Chromium in plants* In: Carati S, Tottarelli F, Seqmi P (eds), Chromium

environmental issue, PP101-129. Francotangati Press, Milan.
Bert, V, Meerts, P, Saumitou-Laprade, P, Salis P, Gruber, W. & Verbruggen, W. (2003). Genetic basis of Cd tolerance and hyper accumulation in *Arabidopsis halleri*. Plant soil, 249:9-18.
Chehregani, A., Malayeri, B. & Golmohammadi, R. (2004). Effect of heavy metals on the development stages of ovules and embryonic sac in *Euphorbia macroclada*. Pakistan J. Biol. Sci, 8: 622-625.
Dixit, V., Pandey, V. & Shyam, R. (2002). Chromium ions inactivate electron transport and enhance superoxide generation in vivo in pea (*Pisum sativum* L. CV: Azad) root mitochondria. Plant cell Env. 25:687-693.
Don-Pedro, K.N. Oyewo, E.O. & Otitoloju, A.A. (2001). Trend of heavy metal concentration in Lagos Lagoon ecosystem, Nigeria. West African Journal of Applied Ecology, 5:103-114.
Duke, N.C. Burns, K.A, Swannell, R.P.J., Dalhaus, O. & Rupp, R.J. (2000). Dispersant use and a bioremediation strategy as alternate means of reducing impacts of large oil spills on mangroves: the Gladstone field trails. Marine pollution Bulletin, 41(7-12): 403-412.
Ekundayo, L. O. (2007). The impact of Shell Petroleum Development Company on socio-economic development of Port Harcourt. *International Journal on Environmental Issues,* 9:5-6.
Ekpo, I. A., Agbor, R. B., Okpako, E. C. & Ekanem, E. B. (2012). Effect of crude oil polluted soil on germination and growth of soybean (Glucine max). *Annals of Biological Research*., 3:3049-3054.
Erakhrumen, A. A. (2012). Studies on phytoextraction processes and some plant's reactions to uptake and hyperaccumulation of ubstances.In:'Phytotechnology: Remediation of Environmental Contaminants'edited *by* Anjum, N. A., Pereira, M. E., Ahmad, I., Duarte, A.C., Umar, S and Khan, N.A. *Taylor & Francis*, 521-540 pp.
Erakhrumen, A. A. (2014). Potential of *Rhizophora racemosa* for Bio-indication and dendroremediation of heavy metal contamination in a mangrove forest, Ondo State Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 10(4): 1-5.
Eze, C. N., Maduka, J. N., Ogbonna, J. C. & Eze, E. A. (2013). Effect of Bonny light crude oil contamination on the germination, shoot growth and Rhizobacterial flora of *Vigna unguiculata* and *Arachis hypogea* grown in sandy loam soil. *Scientific Research and Essays*, 8:99-107.
FOA (Food and Agricultural Organization of the United Nations) (1997). Asia-pacific forestry sector outlook study. Country Report-Malaysia. Asia-pacific forestry outlook study. Working paper Series (FAO), No. 7/FAO, Bangkok (Thailand). Regional office for Asia and the Pecific, 30 pp.
Freitas, F., Prasad, M. N. V. & Pratas, J. (2004). Plant community tolerant to trace elements growing on the degraded soil of Sao Domingo's mine in the South East of Portugal. environmental implications. *Environment International*, 30: 65-72.
Ghnaya, A., Charles, G., Hourmant, A., Hamida, J. & Branchard, M. (2007). Morphological and Physiological characteristics of rape seed plant regenerated in vitro from thin cell layers in presence of Zinc. *Comptes Rendus Biol*., 330(10): 728- 734.
Ghosh, M. & Singh, S. P. (2005). A review of phytoremediation of heavy metals and utilization of it's by-products. *Applied Ecology and Environmental Research*, 3(1): 1-18.
Henry, J. R. (2000). An overview of phytoremediation of Lead and Mercury. Washington, D.C NNEMS Report, pp 3-9.
Idoniboye & Odu, B (1981). Damage assessment following an oil spill. The petroleum industry and the Nigerian Environment, Proceeding of Seminar by the NNPC/Ministry of Petroleum Resources pp140.
Liu, J., Li, Y., Zhang, B., Cao, J., Cao, Z. & Damagalski, J. (2009). Ecological risk of heavy metals in sediments of the Luan river source water. *Ecotoxicology,*18: 748-758.
Liu, W., Liu, J., Wu, M., Li, Y., Zhao, Y. & Li, S. (2009). Accumulation and translocation of toxic heavy metals in Winter wheat (*Triticum aestivium* L) growing in Agricultural soil of Zhengzhou, China. *Bull. Environ. Contam. Toxicol*., 82(3): 343-347.
Maffat, A.S, (1995). Plants proving their worth in toxic metal cleanup, science, 9(2):302-303.
Maria-Santos, L. C., Cunhoi- Lignom, M., Schaeffer-Noveli, Y. & Cintron- Molero, G. (2012).Long term effects of oil pollution in mangrove forest (Baixada Santista, South east Brazil detected using a Gis-based multi-temporal analysis of aeriel photographs. *Brazillian Journal of Oceanography*, 60(2). Sao Paulo Apr./ June.
Marmiroli, N., Marmiroli, M. & Maestri, E (2006). Phytoremediation and phytotechnologies: A review for the present and the future. In: Twardowska, I., Allen H.E and Hagglom M. H (ed), *soil and water pollution monitoring, protection and remediation*. Springer, Netherland.
Mohsenzadeh, F., Chehregari, A. & Yousefi, N. (2011). Effect of the heavy metals on developmental stages of ovule, pollen and rood proteins in *Reseda lutea* L. (Resedaceae). *Biological Trace Element Research DOI 10.1007/s12011-009-8386-x*.
Neff, J. M., Johnson, S., Frost, T. K., Utvik, T .I. R. & Durell, G. S. (2006). Oil well produced water discharges to the North Sea, part 11 comparison of deployed Mussels (*Mytilus edilus*) and the Dream Model to predict ecological risk. *Marine Environmental Research*, 62: 224-246.

Ndukwu, B.C. & Edwin-Wosu, N.L (2007). Changes in species diversity due to dredge spoils inthemangrove forest of Niger Delta, Nigeria. Africa J. of Nig. Env. Soc. (JNES). 4(1):113-119

Nieboer, E. & Richardson, D. H. S. (1980). The replacement of non-descript term heavy metals by a biologically and chemically significant classification of metal ions. *Environ. Pollut, Ser. B*,1:3-26. (ed), *soil and water pollution monitoring, protection and remediation*. Springer, Netherland.

Nkwocha, E. E. & Duru, P. O. (2010). Micro-analytic study on the effect of oil pollution on local plant species and food crops. *Advances in Bioresearch,* 1: 89-198.

Nwangwu, U & Okoye, N.V (1981). Environmental pollution in the Nigerian oil industry. Proceedings of seminar on the petroleum industry and the Nigerian Environment NNPC/FMW&H, Warri, Nigeria 164-170 pp.

Odu, C.T. (1982). Study of environmental and social impact of oil spillage in the Oykama area, Snamprogetti PATETEC/AMB/59/82 Milarn.

Ohimain, E. I. (2006). Oil and Gas exploration poverty and environmental unsuitability in the Niger Delta. A paper presented at the International Association for Impact Assessment Conference in Stavanger, Norway (May 2006).

Opafunson, Z.O (2007). 3 D formulation evolution of an oil field in the Niger Delta Area of Nigeria. Journal of Engineering and Applied Science. 2(11): 1651-1660.

Pezeshki, S. R., Hester, M. W., Lin, Q. & Nyman, J. A. (2000). The effect of oil spill and clean-up on dominant US Gulf coast marsh macrophytes. A review. *Environ. Pollut*., 108: 129-139.

Radwan, M. A. & Salama, A. K. (2006). Market basket survey of some heavy metals in Egyptian fruits and vegetables. Food and chemical Toxicology 44:1273-1278.

Saenger, P. & Bellan, M.F.(1995). The mangrove vegetation of Atlantic coast of Africa. University de Toulouse press, Toulouse.

Subodh, K. M. & Abhiroop, C. (2013).Effects of anthropogenic pollution on mangrove biodiversity. *A review Journal of Environmental Protection*, 4: 1428-1434.

Tanee, F. B. G. & Anyanwu, D. I. (2007). Comparative studies of the growth and yield of two cassava lines (TMS 30572 and TMS 30555) in a crude oil polluted habitat. *Scientia Africa,* 6:81-84.

UNEP, (2011).*Environmental assessment of Ogoniland report*. United National Environmental Programme, Nairobi, Kenya. Wong, Y.S., Tam, N.F.Y. (1997). Accumulation and distribution of heavy metals in a simulated mangrove system treated with sewages. Hydrobiology. 352:67-75.

Yousefi, N., Chehregani, A., Malayeri, B., Lorestani, B. & Charaghi, M. (2011). Investigating the effect of heavy metals on developmental stages of Author and pollen in *Chenopodium botrys* L. (Chenopodiaceac). Biological Trace Element Research, 148: 368-376.

Wong, Y.S. & Tam, N.F.Y. (1997). Accumulation and distribution of heavy metals in a simulated mangrove system treated with sewages. *Hydrobiology*. 352:67-75.