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PHYSICO-CHEMICAL ANALYSIS OF SOILS PROXIMATE TO ARTISANAL REFINING PLANTS IN SOUTHERN NIGERIA

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ABSTRACT: *The physico-chemical analysis of the impacted soil in Bodo community was carried out due to severe degradation of the environment and the aesthetic destruction of the terrestrial environment, the need to access the effect of non-conventional refining plants on the physico-chemical parameters of the soil. The pH, conductivity, total nitrogen, phosphate, cation exchange capacity and so on were analyzed using the standard method. From the result, it was observed that the impacted soil recorded mean and standard error as 54.1258 and 24.162 respectively while the non-impacted soil recorded 18.4176 and 6.323 respectively. Amongst the physical parameters, soil textural analysis revealed that the soil is mainly sandy loamy and small percentage of clay loamy. This therefore requires appropriate remediation measures to avoid infiltration into the groundwater.*

KEYWORDS: Impacted, physico-chemical, artisanal

INTRODUCTION

Refining of petroleum is hardly an environmental friendly operation. This is due to the release of different greenhouse gases into the atmosphere resulting to substantial air pollution (Carla, 2002). Aside air pollution impacts; there are also waste water concern, risk of industrial accidents such as fire and explosion (Adeniyi and Afolabi, 2002).A non-conventional refining plant is not concerned with the chemical changes in crude oil rather it involves the physical changes found in simple distillation. It has been reported that petroleum refining contributes to solid, liquid and gaseous wastes in the environment (Nwankwo and Irrechukwu, 1998).

Soil quality is an account of soil's ability to provide ecosystem and social services through its capacity to perform its function under changing conditions (Doran and Parkin, 1994). The concept of soil quality expressed by this function allows practical applications with regards to targeted social or ecosystem services. Targeted application maybe linked to special soil functions like in the case of soil productivity ranking, evaluation of carbon sequestration potential in accounting peat stock etc. The simplest case of soil quality evaluation therefore is to assess the performing potential of soil by single function. On higher levels of aggregation soil quality can express the sum capabilities (Arshad and Martin, 2002).

The non conventional refining plant has more devastating effects because of the absence of process control and waste treatment facilities found in conventional refining plants to mitigate

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and minimize environmental hazards. This non conventional refining plants has degraded the terrestrial environment of the study area.

MATERIALS AND METHODS

Delimitations and Description Of Study Area

Bodo community lies on the coastal low land of the Niger Delta, and in the Southern part of Gokana Local Government Area of Rivers State. The community is about 56 kilometers by road from Port Harcourt, the capital of Rivers State. It is located between latitude $4^{0}36^{1}$N and longitude $7^{0}21^{1}$E of the equator. Bodo is bounded on the North by K-Dere and B-Dere (both in Gokana) on the East by the Andoni people, on the West by the Bolo people of Okirika kingdom and on the South by the Bonny people and the Atlantic ocean. Bodo occupies an approximate area of about one hundred thousand hectares of land, with a considerable population which spread over major 36 villages and numerous fishing settlements (RIVGIS, 2010). According to the 1991 National population Commission, Bodo had a population figure of 14,000 people establishing it as the largest settlement in Ogoni Division. From 1991 to 2006, the figure rose 30,000 (Oguntoyinbo, 2008). The major occupations of the people are fishing and farming.

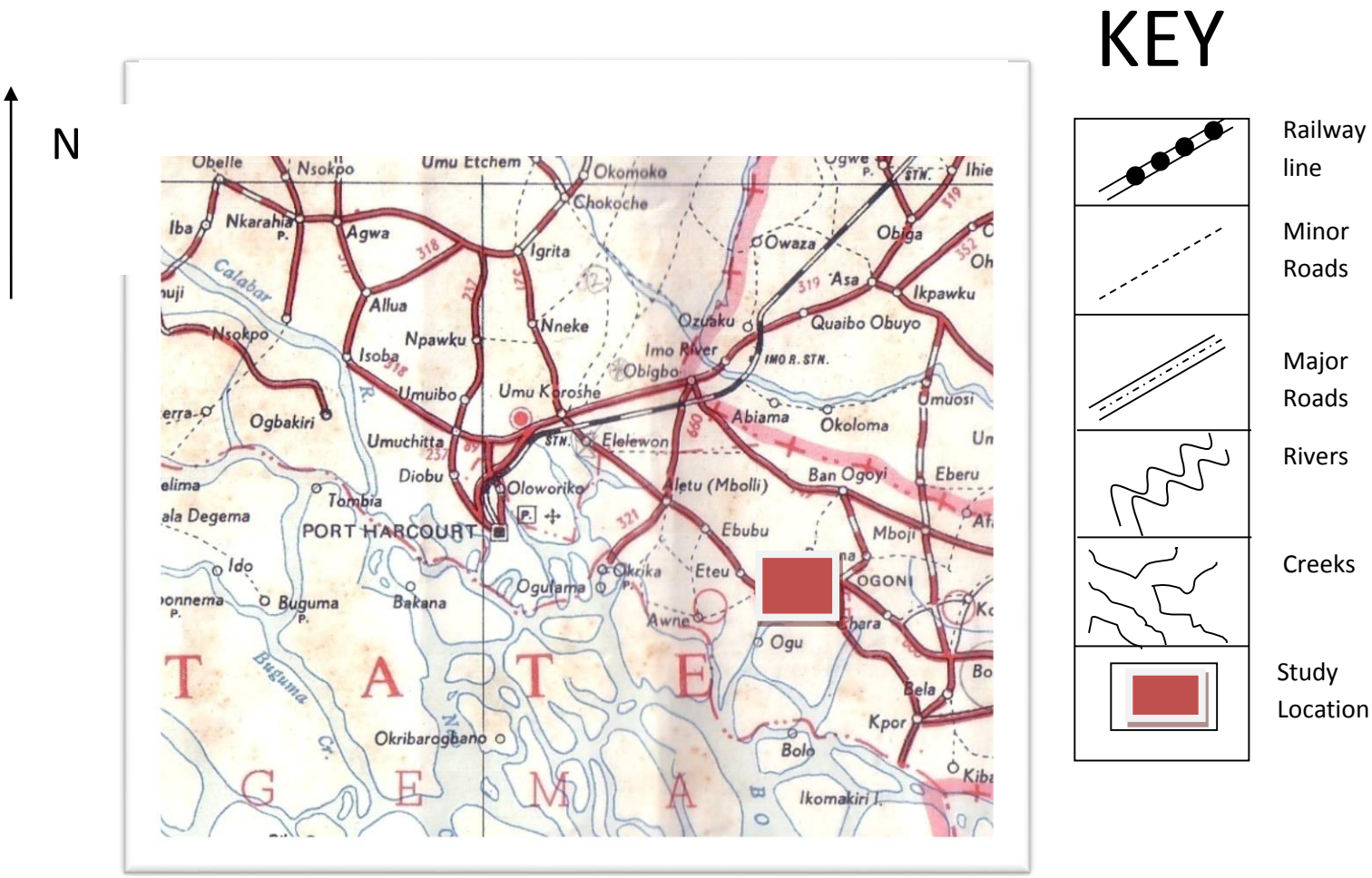

Figure 3.1 Schematic drawing of parts of Rivers State showing the study site,Bodo In Gokana Local Government Area Rivers state.

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Determination of Soil Conductivity

10 g of the crushed soil sample was put in a sterile container and mixed thoroughly with 5 ml of distilled water and allowed to settle. Then the conductivity meter was used to take the reading.Furthermore, walkey-black method was used to determine the total organic carbon and total organic matter while Dumas method was used for nitrogen.

Determination of Nitrate and Nitrite

About 1.0g of soil sample was taken in a 25ml beaker and extracted with 3ml portion of 0.5% sodium carbonate solution.

The extract was filtered through whatman no. 41 filter paper.

Then the filtrate was then collected and diluted to 25ml and appropriate aliquots of 1-2ml of the solution was transferred into 10ml calibrated flask and analyzed.

More also, flame photometer was used to determine K, Na, P, Ca, Mg and Mn.

RESULTS AND DISCUSSION

Magnesium, Calcium, Sodium and Potassium varies from 0.32 to 14.89, 0.03 to 2.02, 0.20 to 5.33 and 0.20 to 3.27 respectively. Magnesium has the highest range of 14.57 followed by sodium with 5.13, potassium 3.07 and 1.99 for calcium.Exchangeable aluminum and exchangeable acidity varies from 0.19 to 2.21 and 0.32 to 1.75. They had a range of 2.02 and 1.43 respectively. Cations Exchange Capacity (CEC) varies from 2.52 to 18.33 with range of 4.328. Also, some of the physiochemical parameters measured exerted significant influences on the hydrocarbons. Furthermore, at $p<0.05$, PAH correlated positively with nitrate ($r=0.593$) and phosphate ($r=0.630$) while TPH correlated positively with nitrate ($r=0.534$). Nitrite correlated positively with PAH ($r=0.7550$ and TPH ($r=0.712$) at $p<0.01$.

A comparison of the levels of the physiochemical parameters in the impacted and non-impacted (control) locations revealed significant difference (sig.t=0.04) at $p<0.05$ (Table 3.1). Results also revealed significant correlation (sig.r=0.00) between the two locations.

However, the impacted locations recorded mean value of 54.12 ($\pm$ 24.16) while the non-impacted location (control) recorded a mean value of 18.41 ($\pm$ 6.32).

Table 3.1:Comparison of the Physicochemical Parameters in Impacted and Control Locations using the Student t-test of Significance ($p<0.05$)

Pair	Mean	SE	r	Sig.r	t	Sig.t
Impacted	54.125820	24.162	0.713	0.000	1.772	0.041
Non Impacted	18.4176	6.323				

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The results from this study revealed that there were different concentration of hydrocarbons and physiochemical parameters within the impacted and control stations at different depths (0-15 and 15-30cm). The concentration of polynuclear aromatic hydrocarbon (PAH) and total petroleum hydrocarbons (TPH) showed that PAH recorded maximum concentration of 6899.4287ppm at station III at the depth of 0-15cm and minimum concentration of 37.6942ppm at control station at the depth of 15-30cm. TPH recorded maximum concentration of 21873.1149ppm in station III at the depth of 0-15cm and a minimum concentration of 83.1469ppm at the control station at the depth of 15-30cm. These figures represent high concentration of hydrocarbons when compared with the control station.

A review of the existing data on Niger Delta Environmental Survey NDES (1999),Osuji *et al*., (2006) and UNEP (2011) affirms that such high concentration of hydrocarbons shows severe hydrocarbon contamination. BTEX were below detectable limit and it might be as a result of high volatility. It is suspected that BTEX compounds might have volatilized during the destruction of the refining plants.The results also showed that the whole area under investigation recorded highest pH value of 5.99 in control station at the depth of 0-15cm while minimum value of 4.12 was recorded at the depth of 0-15cm in sampling station III. This revealed that the soil of the study area were slightly acidic.

Results for conductivity measurement were quite high with values ranging from 118.00 to 361.00µs/cm with range of 234.00µs/cm. This may be due to the increase in the concentration of some soluble salts in the soil. It is also worthy to note that maximum level of conductivity occurred at station I at the depth of 15-30cm. Particle size composition showed that the soil composition of the soil is mainly sandy. Sand ranges from 48% to 81% and a range of 33%. Clay ranges from 12% to 33% with range of 21% while silt ranges from 5% to 19%. The sandy nature of the soil of the study area aids infiltration of contaminants and increases the pollution pathway for contaminants. The texture also allows for free drainage and ease of mobility of ions within the soil.

Total organic carbon content appears very low with minimum value of 0.16% and maximum value of 2.19% with range of 2.03. Total nitrogen, nitrate, nitrite, ammonia and phosphate recorded low values as was shown in Table 3.2. Magnesium recorded higher levels in all stations including control station than the other nutrient elements. The fact that there was lower EC values in station II,III,IV and VI confirms that organic compounds like crude oil cannot conduct electrical current very well Osuji *et al.*, (2006)

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Table 3.2 Descriptive Statistics of the physicochemical Parameters of Impacted Soils in Bodo Community

Parameters	Minimum	Maximum	Range	Mean	SE
PAH	37.6942	6899.4287	6861.7345	1844.8400	534.9329
TPH	83.1469	21872.1149	21788.9680	5913.381529	1.71662003
pH	4.12	5.99	1.87	5.1179	0.13987
Conductivity	118.00	361.00	234.00	213.7857	19.31866
Sand	48.00	81.00	33.00	68.2857	2.21491
Silt	5.00	19.00	14.00	10.7143	1.01866
Clay	12.00	33.00	21.00	20.7143	1.64560
TOC	0.16	2.19	2.03	1.3036	0.14509
Total Nitrogen	0.069	1.500	1.431	0.29500	0.106846
Nitrate	2.02	4.40	2.38	2.9450	0.17358
Nitrite	2.10	3.01	0.91	2.5657	0.07619
Phosphate	1.17	2.67	1.50	2.0729	0.10569
Ammonia	0.03	0.17	0.14	0.1157	0.00906
TOM	1.20	3.70	2.50	2.2314	0.20359
Magnesium	0.32	14.89	14.57	7.2671	0.91359
Calcium	0.03	2.02	1.99	0.2857	0.13686
Sodium	0.20	5.33	5.13	1.0029	0.43531
Potassium	0.20	3.27	3.07	0.5093	0.21318
Ex. Al	0.19	2.21	2.02	0.4736	0.13843
Ex. Acidity	0.32	1.75	1.43	1.0107	0.11518
CEC	2.52	18.33	15.81	10.5492	1.15331

Ex. Al= Exchangeable Aluminum, Ex acidity= Exchangeable acidity, T/N= Total Nitrogen, CEC= Cation Exchange Capacity, and TOM= Total Organic Matter, SE= Standard error

Table 3.3: Correlation (r) matrix between the physiochemical parameters and Hydrocarbons

Parameters	PAH	TPH
pH	-0.654*	-0.614
EC	-0.438	-0.483
Sand	-0.427	0.425
Silt	0.525	0.465
Clay	0.286	0.323
TOC	-0.418	-0.430
Total Nitrogen	-0.240	-0.219
Nitrate	0.593*	0.534*
Nitrite	0.755**	0.712**
Phosphate	0.630*	0.639
Ammonia	-0.349	-0.317
TOM	-0.694**	-0.712**
Magnesium	0.747**	0.768**
Calcium	-0.103	-0.090
Sodium	-0.333	-0336
Potassium	-0.195	-0.190
Ex. Al	-0.050	-0.031
Ex. Acidity	-0.033	0.096
CEC	0.409	0.0442

*=significance at $p<0.05$, **=significance at $p<0.01$, EC= Electrical conductivity
TOC=Total organic carbon, TOM=Total organic matter, EX. Al=Exchangeable Aluminum
Ex=Exchangeable

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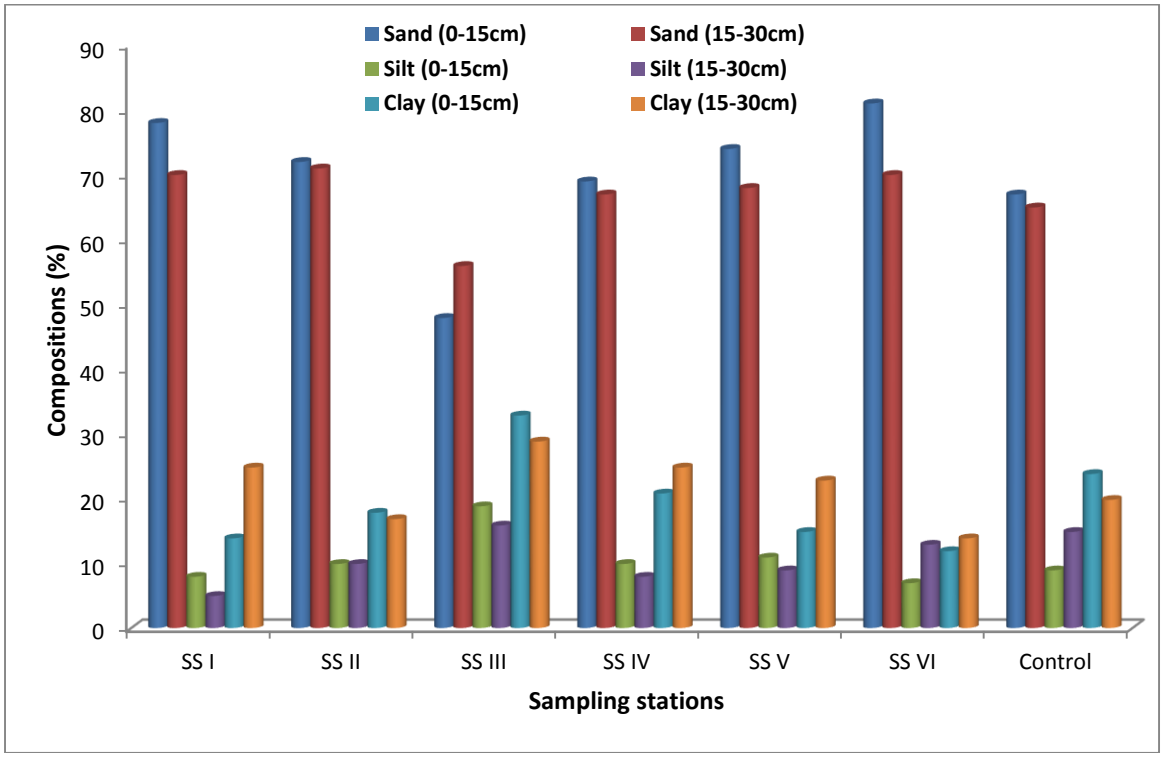

Figure 3.1:Spatial variations in levels of sand, silt and clay compositions of impacted and control soils of Bodo community.

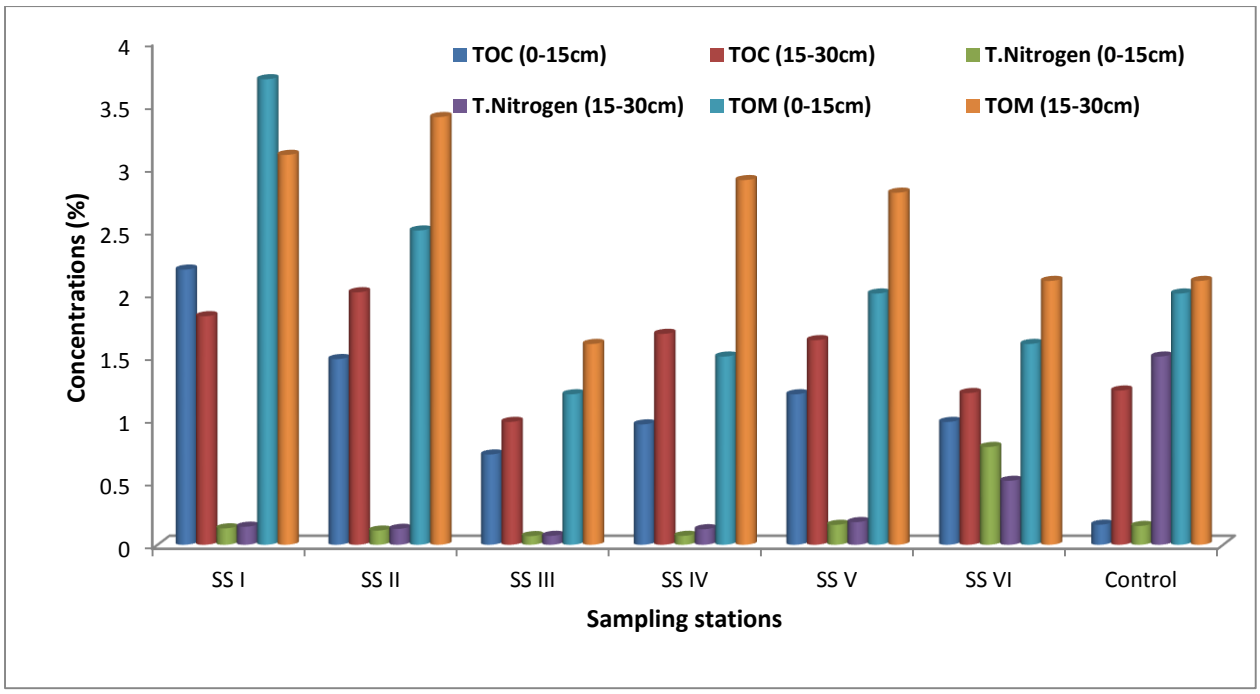

Figure 3.2: Spatial variations in levels of total organic carbon (TOC), total nitrogen and total organic matter (TOM) of impacted control soils of Bodo community

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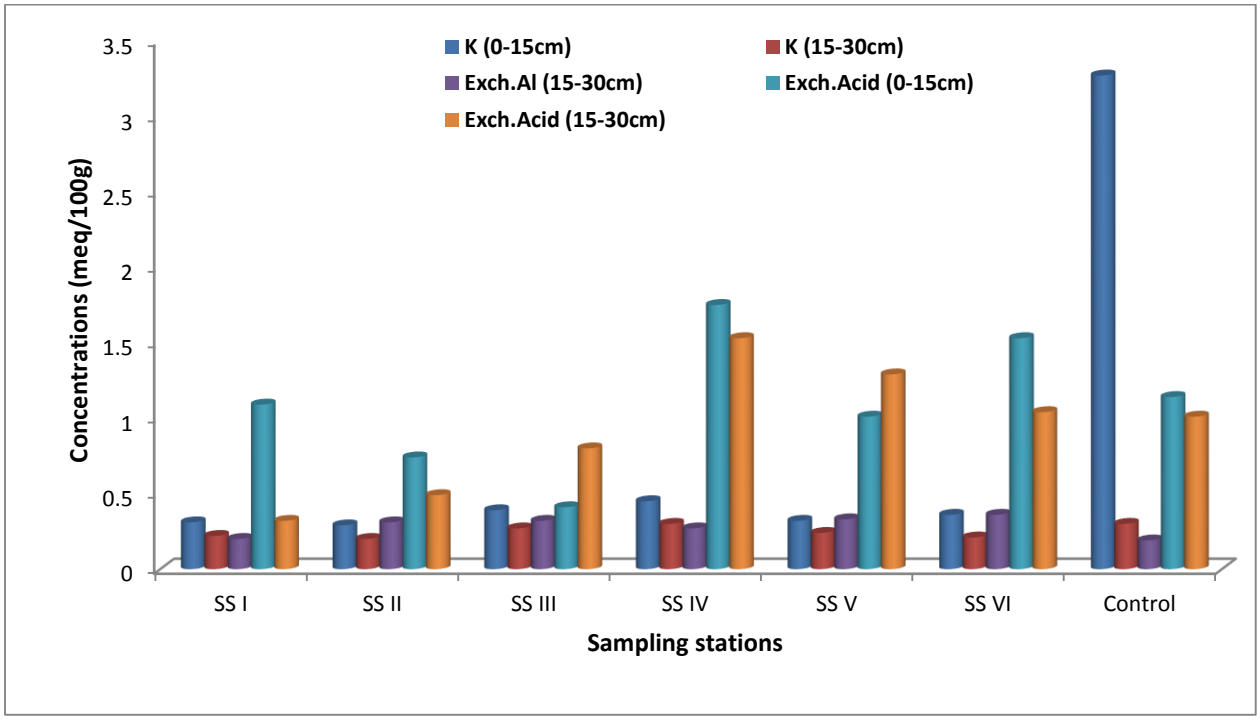

Figure 3.3: Spatial variations in levels of potassium ions, exchangeable aluminum and acidity of impacted soils of Bodo community

Plate 3.1: Non-conventional refining plant 1 at Bodo Community Gokana Local Government Area

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Plate 3.2: Non-Conventional Refining Plant II at Bodo Community in Gokana Local Government Area

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