SOIL ASSESSMENT REPORT
FOR
MM PORT FZE PROJECT

Executive Summary

A total of fourteen (14) soil samples (topsoil and subsoil) were collected and analyzed for physiochemical, heavy metal and microbiological parameters. The analysis results revealed pH values range between 6.00 to 7.40 and 5.80 to 7.50 for subsoil indicating a slightly acidic to alkaline soil. The soil physical properties such as porosity, permeability, and particle size distribution revealed good soil property indicating no form of soil compaction, good aeration and moderate permeability for good water movement along the soil profile. The soil textural class were classified sandy soil supporting the good soil physical properties earlier mentioned. Hydrocarbon analysis revealed low concentration with THC level between 0.75-2.46mg/kg and 0.65-1.75mg/kg for topsoil and subsoil respectively indicating hydrocarbon source as biogenic. Heavy metals result revealed that heavy metal concentration recorded during the study period is typical of the Niger Delta soil environment indicating no form of pollution. Consequently, the analysis of these parameters provide insights into the soil's physical and chemical properties, helping to assess soil quality, fertility, and potential environmental concerns as it relates to proposed project. Moreso, comparison of the current laboratory results with previous study within the study area showed no significant variation in soil quality.

Introduction

Soil assessment is an integral part of any environmental impact assessment study. The aim and objective of studying the soil component is to establish and benchmark the existing soil condition in the proposed project site against any future occurrence. It also gives an insight for a better understanding of interaction effects between project activities (e.g., construction) and the soil environment for effective impacts analysis, management, and mitigation.

Scope of study

The scope of the study is basically to establish existing soil condition within the proposed project site through field sampling and laboratory analysis. Furthermore, to analyze possible impacts that may occur to soil component in all phases (Pre-construction, Construction and Operation) of the project life cycle and proffer the mitigation measures.

Field Approach

The study adopted both onsite and offsite approach. The onsite is majorly for soil sample collection in the field and submission of sample to laboratory, while the offsite include laboratory analysis of samples and report writing.

Methodology

The study adopted standard international best practice in all aspect of the study execution ranging from field data gathering and laboratory analysis. Specifically, soil samples were collected through the use of stainless steel soil sampling auger at two depth 0-15cm and 15-30cm, Samples for physico-chemical analysis were collected into plastic bags after being wrapped in aluminum foil and packed into containers made of high UV (Ultra Violet) resistant material. Sample labeling was done at the point of sampling with the correct Station ID, depth and date of sampling. A total of fourteen (14) soil samples were collected comprising topsoil (7samples) and sub-soil (7 samples). During the field study, some morphological properties of soil were achieved by physical observation.

Plate 1: Soil sampling supervised by the officer from Federal Ministry of Environmental Abuja

The coordinates of soil sampling locations are shown in table 1, whereas the map in shown in figure below.

Table 1 Soil Sampling Stations

S/No	Station Code	Environmental Sphere	WGS 84	
			LATITUDE (N)	**LONGITUDE (E)**
1	SS1	Soil	4^{0} 39′ 59.6″	7^{o} 08′ 45.6″
2	SS2	Soil	4^{0} 40′ 01.8″	7^{o} 08′ 36.4″
3	SS3	Soil	4^{0} 40′ 07.2″	7^{o} 08′ 25.0″
4	SS4	Soil	4^{0} 40′ 05.7″	7^{o} 08′ 34.4″
5	SS5	Soil	4^{0} 40′ 03.9″	7^{o} 08′ 48.2″
6	SS6	Soil	4^{0} 40′ 07.0″	7^{o} 08′ 31.7″
7	SSC1	Soil	4^{0} 40′ 03.9″	7^{o} 08′ 48.6″

Soil Sampling Map

Results and Discussion

Results

Table 2 present summary result of soil quality within and around the proposed project site during the wet and dry season, while comprehensive results for wet season is attached as appendix 1.

Table 2: Present summary results of soil physiochemical properties within and around proposed project site.

S/N	Parameter(s)	MM FZE & IA 2023 (Wet)			
		Min	Max	Ave	SSC
	Topsoil 0-15cm)				
1	Sand (%)	83.28	86.54	84.93	85.10
2	Silt (%)	5.39	8.28	6.67	6.50
3	Clay (%)	7.46	9.46	8.40	8.40
4	Texture	0.00	0.00	~	SS
5	Porosity	37.30	41.00	39.18	37.60
6	Colour	~	~	~	Dark Brown

S/N	Parameter(s)	MM FZE & IA 2023 (Wet)			
		Min	Max	Ave	SSC
7	Permeability (cm/sec)×10	0.13	0.17	0.15	0.15
8	Bulk Density (g/cm3)	1.16	1.42	1.33	1.56
9	pH	6.00	7.40	6.58	6.50
10	Moisture Content (%)	7.55	12.45	9.69	7.64
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01
12	Sulphate, SO42- (mg/kg)	4.00	12.00	6.17	11.00
14	Nitrate, NO3- (mg/kg)	1.50	2.30	1.98	3.40
15	Total Nitrogen (%)	0.015	0.034	0.03	0.024
16	Phosphate, PO43- (mg/kg)	0.65	2.50	1.40	1.81
18	TOC (%)	0.27	0.59	0.36	0.27
19	THC (mg/kg)	0.75	2.45	1.73	2.46
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	1.66	12.18	4.93	32.57
24	Iron, Fe (mg/kg)	695.3	1613.8	1070.21	3,068.8
25	Zinc, Zn (mg/kg)	2.60	7.71	3.92	17.06
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	0.08	0.41	0.25	<0.001
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	<0.001	<0.001	<0.001	0.61
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 103	0.30	0.80	0.57	0.60
34	HUF (CFU/g) x 103	0.20	0.50	0.33	0.30
35	THB (CFU/g) x 105	1.10	2.80	2.10	3.50
36	THF (CFU/g) x 105	0.30	1.10	0.67	1.20
Subsoil (15-30cm)					
1	Sand (%)	82.64	86.72	84.62	84.38
2	Silt (%)	5.14	9.09	7.11	9.31
3	Clay (%)	7.42	8.75	8.27	9.31
4	Texture	0.00	0.00	~	SS
5	Porosity	36.80	40.20	38.83	37.00
6	Colour	~	~	~	Dark Brown
7	Permeability (cm/sec)×10	0.10	0.16	0.14	0.14
8	Bulk Density (g/cm3)	1.25	1.58	1.38	1.45
9	pH	5.80	7.50	6.67	6.60
10	Moisture Content (%)	8.12	12.31	10.39	8.50
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01
12	Sulphate, SO42- (mg/kg)	2.00	16.00	7.67	10.00
14	Nitrate, NO3- (mg/kg)	1.40	2.80	2.00	1.90
15	Total Nitrogen (%)	0.016	0.041	0.03	0.014
16	Phosphate, PO43- (mg/kg)	0.75	1.85	1.37	1.65

S/N	Parameter(s)	MM FZE & IA 2023 (Wet)			
		Min	Max	Ave	SSC
18	TOC (%)	0.19	0.47	0.29	0.17
19	THC (mg/kg)	0.65	1.75	1.24	1.40
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	2.03	5.77	3.48	17.38
24	Iron, Fe (mg/kg)	358.1	2109.2	988.10	2,713.0
25	Zinc, Zn (mg/kg)	1.97	3.05	2.60	8.32
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	<0.001	<0.001	<0.001	0.46
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	0.14	0.14	0.02	0.19
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 103	0.10	0.40	0.20	0.30
34	HUF (CFU/g) x 103	0.10	0.20	0.17	0.10
35	THB (CFU/g) x 105	0.70	1.90	1.37	2.00
36	THF (CFU/g) x 105	0.20	0.60	0.43	0.80

Source Fieldwork 2023

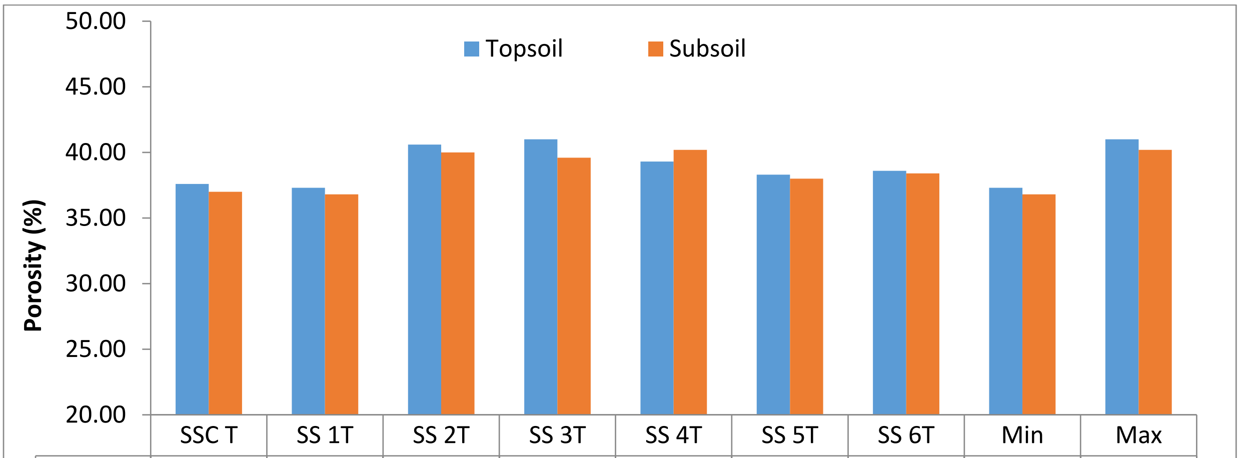
Discussion

Morphology

Morphologically, the soils of the region are classified as coastal plain sand (ultisoil), friable when dry and sticky when wet. However, observation from the field revealed the soil of the proposed project site is reclaimed with river sand, which dominated soil aggregates as recorded from the particle size distribution analysis, making it friable both at wet and dry within the two depths sampled. The soil colour were generally grey due to river sand used in site reclamation. Site topography were observed to be generally flat with some minor slope close to the River shore.

Physical Properties

Porosity refers to the volume percentage of pore spaces in the soil. It influences the soil's ability to retain water and facilitate root growth. The porosity values for topsoil range from 37.30 to 41.00 and 36.80 to 40.20 for subsoil, indicating varying levels of pore space within the soil samples, thus indicating soil capability to encourage good soil aeration. Moreso, same range of porosity was observed at the control station. Figure 1 present the mean distribution of soil porosity.



	SSC T	SS 1T	SS 2T	SS 3T	SS 4T	SS 5T	SS 6T	Min	Max
Topsoil	37.60	37.30	40.60	41.00	39.30	38.30	38.60	37.30	41.00
Subsoil	37.00	36.80	40.00	39.60	40.20	38.00	38.40	36.80	40.20

Fig 1 Porosity distribution across topsoil for subsoil

Permeability measures the soil's ability to allow water and air to pass through it. It is crucial for drainage and water movement in the soil. The permeability value ranged from 0.13 to 0.17cm/sec x10^3 for topsoil and 0.10 to 0.16 for subsoil cm/sec x10^3 suggesting moderate permeability in the soil samples and soil's ability to transmit water. Similar permeability results were observed at the control stations indicating no soil compaction at project site.

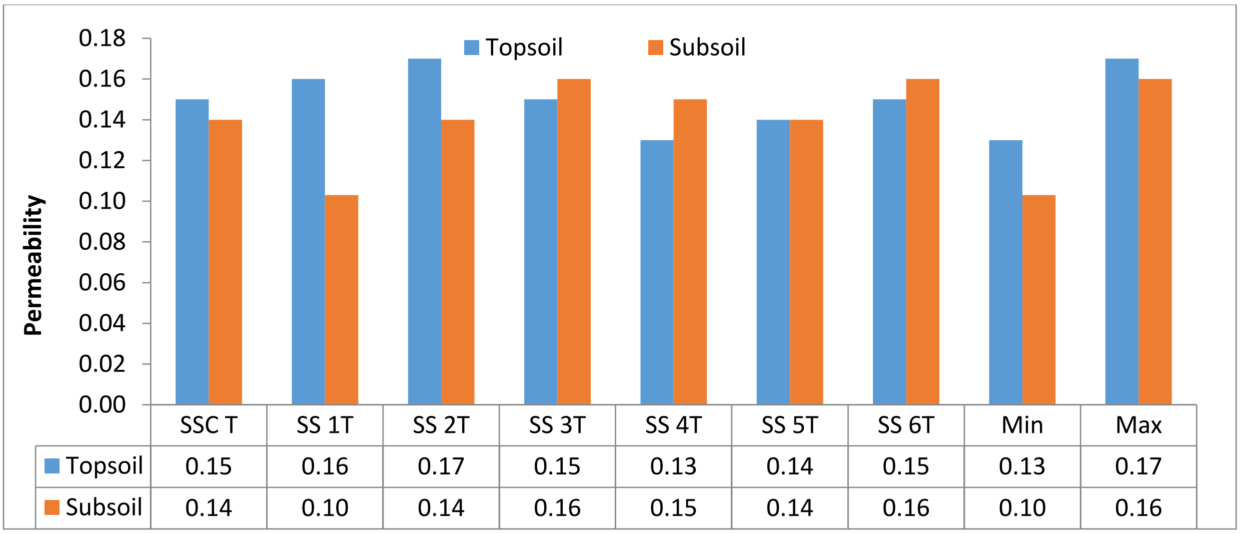


Fig 2 Permeability distribution across topsoil and subsoil within the study area

Texture describes the relative proportions of sand, silt, and clay in the soil. It has implications for soil structure, water retention, and nutrient availability. The soil texture within and around proposed project is sandy soil which can be deduced from the high percentage sand (83.28 -86.54% and 82.64-86.72%) for topsoil and subsoil respectively, observed from the particle size distribution and physical observation from feel method in the field.

Chemical properties

pH is a measure of the soil's acidity or alkalinity. It ranges from 0 to 14, with values below 7 indicating acidity, 7 being neutral, and values above 7 indicating alkalinity. The pH values of the topsoil range from 6.00 to 7.40 and 5.80 to 7.50 for subsoil indicating a slightly acidic to alkaline soil.

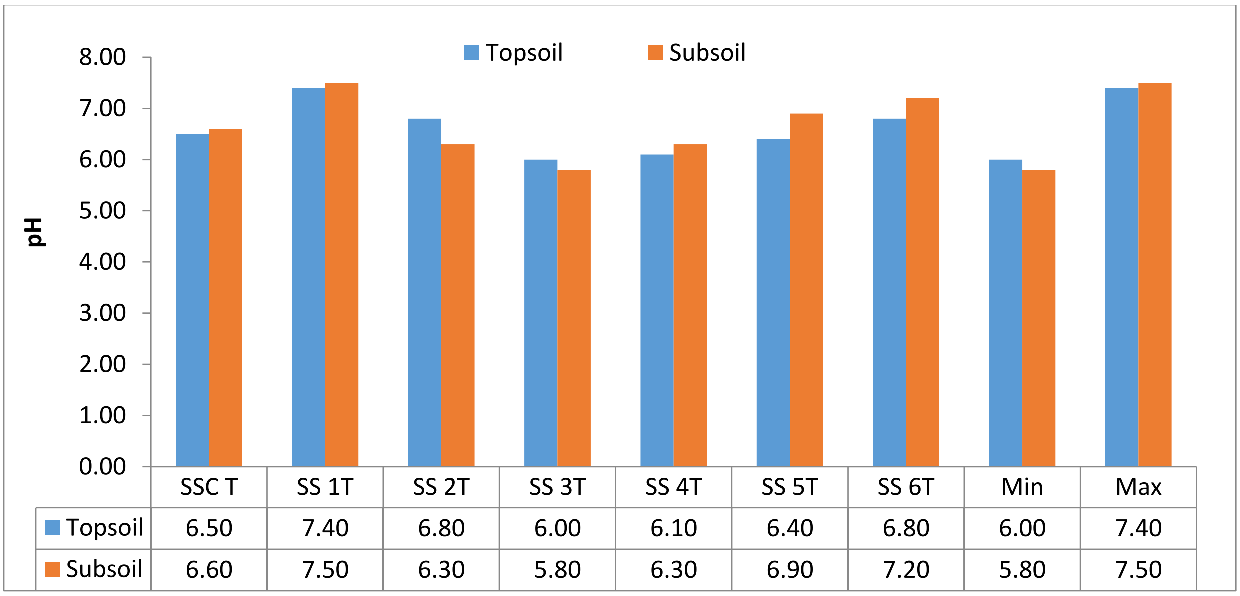


Fig 3 pH distribution across topsoil and subsoil

Phosphate, Sulphate and Nitrate

Phosphate ranged between (0.65-2.50mg/kg) and 0.75 – 1.85mg/kg; Sulphate (4.00 – 12.00mg/kg) and (2.00 – 16.00mg/kg); Nitrate (1.50 – 3.40mg/kg) and (1.40 – 2.80mg/kg) for top and subsoil respectively. These parameters represent the presence of various ions in the soil, which can positively affect plant growth and soil health. Higher values indicate higher nutrient availability and fertility.

Total Nitrogen and Total Organic Carbon

Figure 4 and 5 present concentrations of Total Nitrogen and Total Organic carbon within and around the study area. Figure 4 revealed Total nitrogen level ranged between 0.015 – 0.034% and 0.014-0.041% for topsoil and subsoil respectively. While figure 5 revealed total organic carbon ranged between 0.27-0.59% and 0.17-0.47% for topsoil and subsoil respectively. These parameters are indicators of the amount of decomposed plant and animal materials in the soil. They contribute to soil fertility, water holding capacity, and microbial activity.

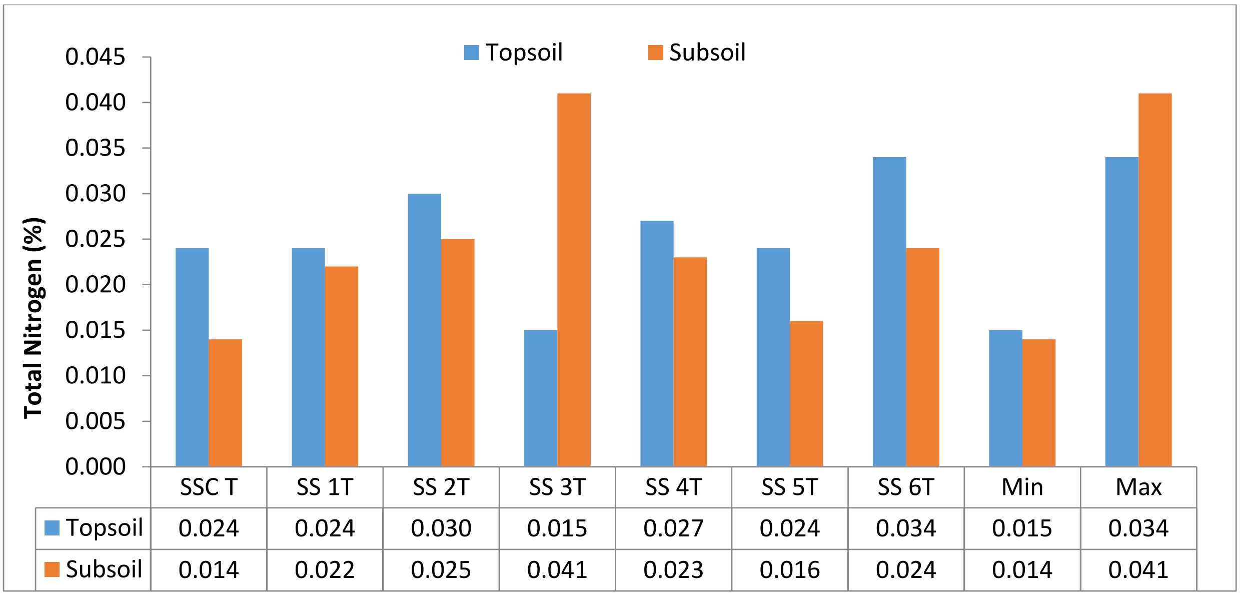


Fig 4: Total Nitrogen distribution across topsoil and subsoil within the study area

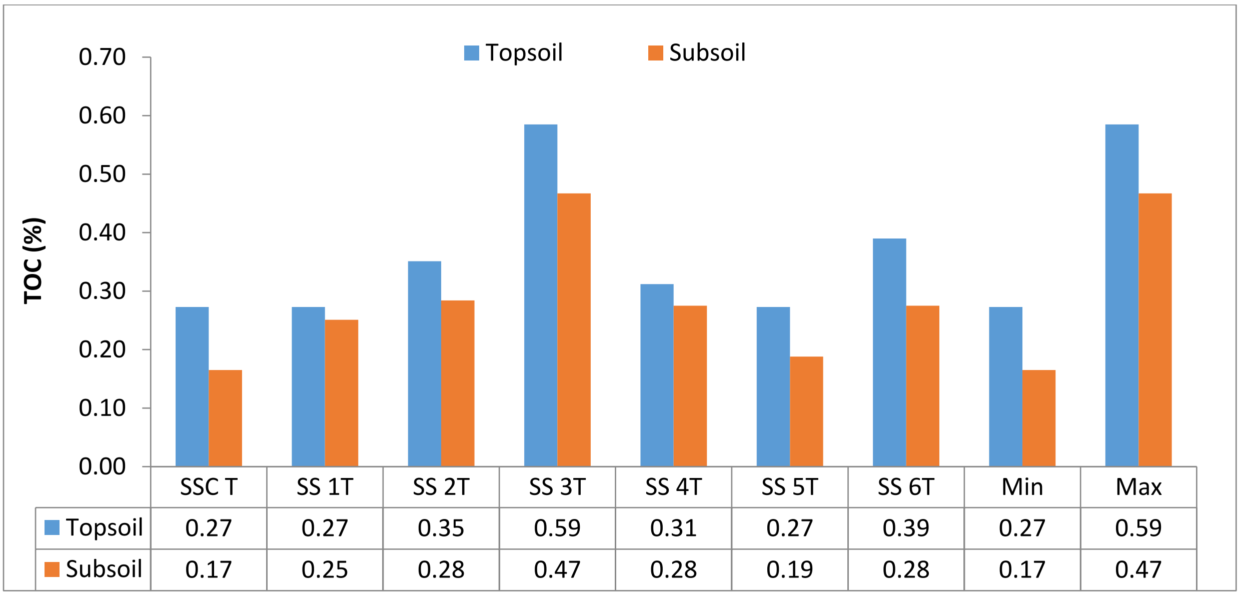


Fig 5: Total Organic Carbon distribution across topsoil and subsoil within the study area

Hydrocarbon

Figure 6 presents the concentration of total hydrocarbon within and around the study. The figure revealed THC ranged between 0.75-2.46mg/kg and 0.65-1.75mg/kg for topsoil and subsoil respectively with highest concentration been observed at topsoil except for SS6T. The observed THC could be attributed to biogenic process and not as a result hydrocarbon spillage.

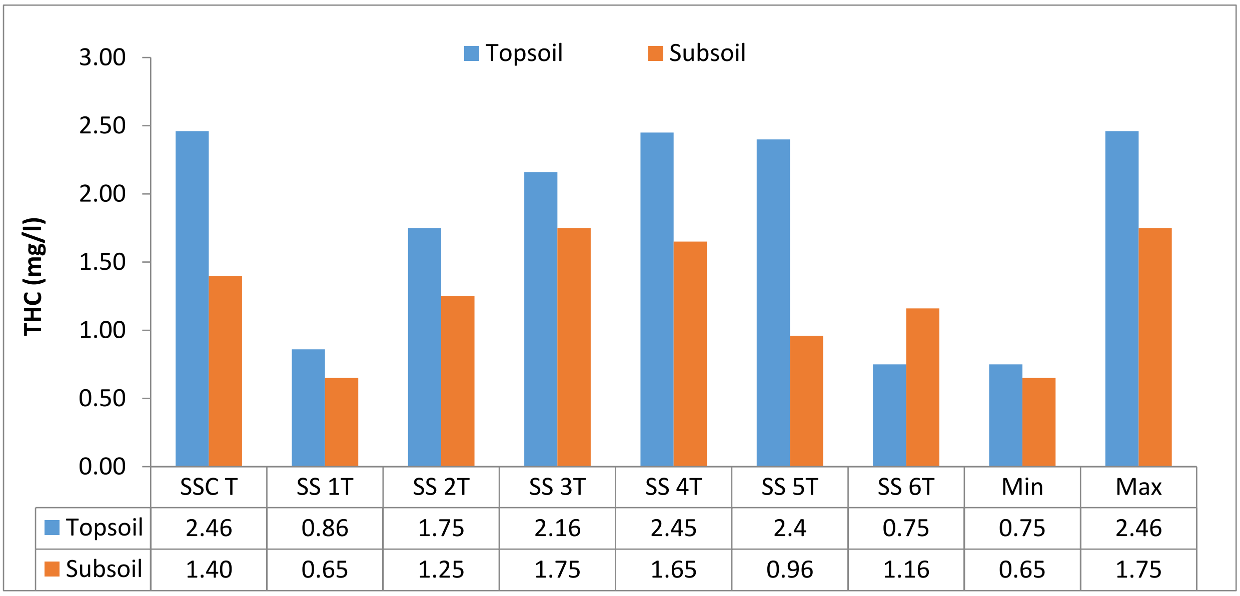


Fig 6 THC distribution across topsoil and subsoil within the study area

Heavy Metal

Heavy Metals (Trace elements) are chemical substances that are required in trace or very small concentrations in soils for plants growth. However, these elements can become hazardous to humans and animals if absorbed in the food chain even in small concentrations as they usually can become biomagnified. Low concentrations of heavy metals occur naturally in most soils. The concentration of these metals can however be increased to become potential pollutants if heavy metals – containing waste products from industrial or domestic activities are introduced into the environment (Bohn *et al.*, 1984). Concern over the presence of heavy metals in an environment arises from the fact that they cannot easily be broken down into non-toxic forms. Thus once ecosystems are contaminated by heavy metals; they remain a potential threat for many years (Isirimah *et al.*, 2003).

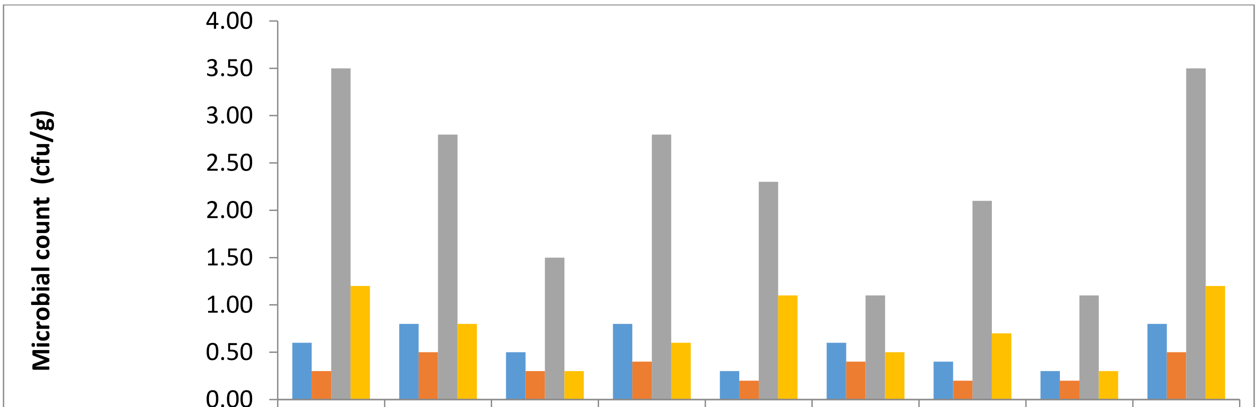
Laboratory analysis results revealed Fe ranged between (695.3 – 3068.8mg/kg) and (358.1 – 2713.0mg/kg) for topsoil and subsoil respectively, which is similar to that recorded at the control stations; Zn ranged between 2.60 – 17.06mg/kg and 1.97-8.32mg/kg for topsoil and subsoil respectively. While V, Ni, Cr, Pb, Cu, Hg and As were below detection limit except Ni and Cu at the control station.

The high iron content observed from the laboratory analysis results is typical of the Niger Delta environment due to high content of iron oxide, which is responsible for reddish and yellowish coloration observed in some soils within the region.

The analysis of these parameters provide insights into the soil's physical, and chemical properties, helping to assess soil quality, fertility, and potential environmental concerns within the proposed project site.

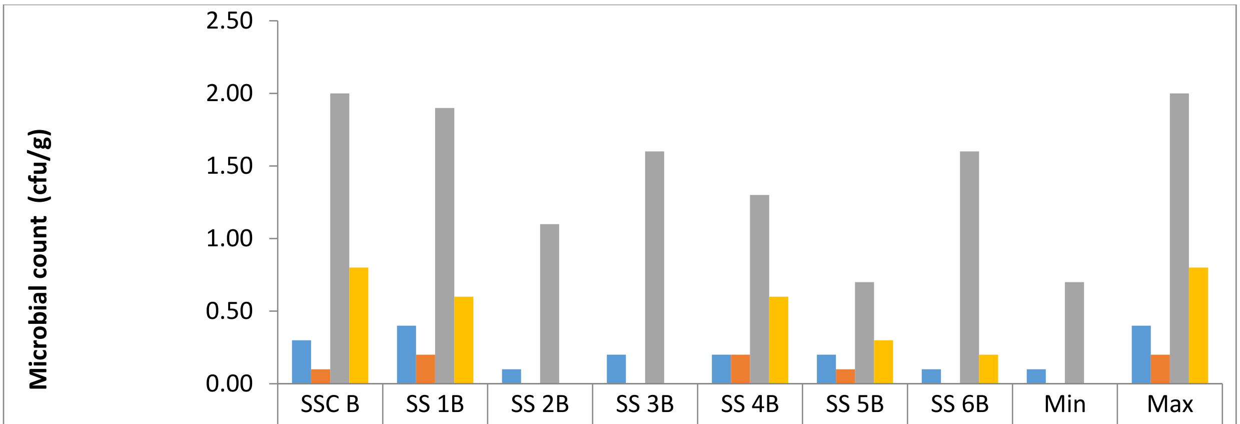
Microbiology

Figure 7 and 8 present microbial count of some microbes (HUB, HUF, THB and THF) within the study area. The figure 7 reveal dominant of these microbes on topsoil compared to subsoil, while THB were seen to have the highest count followed by THF at both depth.



	SSC T	SS 1T	SS 2T	SS 3T	SS 4T	SS 5T	SS 6T	Min	Max
HUB (CFU/g) x 103	0.6	0.8	0.5	0.8	0.3	0.6	0.4	0.30	0.80
HUF (CFU/g) x 103	0.3	0.5	0.3	0.4	0.2	0.4	0.2	0.20	0.50
THB (CFU/g) x 105	3.5	2.8	1.5	2.8	2.3	1.1	2.1	1.10	3.50
THF (CFU/g) x 105	1.2	0.8	0.3	0.6	1.1	0.5	0.7	0.30	1.20

Figure 7: Topsoil Microbial count within the study area



	SSC B	SS 1B	SS 2B	SS 3B	SS 4B	SS 5B	SS 6B	Min	Max
HUB (CFU/g) x 103	0.3	0.4	0.1	0.2	0.2	0.2	0.1	0.10	0.40
HUF (CFU/g) x 103	0.1	0.2	0	0	0.2	0.1	0	0.00	0.20
THB (CFU/g) x 105	2	1.9	1.1	1.6	1.3	0.7	1.6	0.70	2.00
THF (CFU/g) x 105	0.8	0.6	0	0	0.6	0.3	0.2	0.00	0.80

Figure 8: Subsoil Microbial count within the study area

Land use

Land use changes occur constantly and at many scales and can have specific and cumulative effects on air and water quality, watershed function, generation of waste, extent and quality of wildlife habitat, climate, and human health.

The proposed project site is located within the existing Onne Port complex in Eleme Local Government Area currently managed by Nigerian Ports Authority. The Onne Port complex was acquired by the Nigerian Government years back in order to foster industrialization and also to enable international trade via water ways. Currently, the port complex plays host to over two hundred companies. Consequently, the entire port complex is designated as an industrial area to aid international business transaction. The closest community within the Port complex is the Onne and Ogu Community. The Ogu community is located across the water. These communities especially the Onne is more of residential area and is 90% built up, while the Ogu closest community to the proposed project is Owogono is a fishing settlement with majority of the buildings a temporary structure.

A regional land use study covering the greater Eleme Local Government Area (LGA) has been performed.

Table presents the land changes within the Eleme LGA based on a survey carried out between 2006 and 2019. It is no surprise that as the population has grown over the period 2006 – 2019, the largest change in land use has been the built-up area (increasing from approximately 19km^2 in 2006 to 49km^2 in 2019). Figure 9 shows how the built-up area has expanded between 1986 and 2015. The increase in built-up land area has resulted in a decrease in land area covered by vegetation from approximately 93 km^2 in 2006 to 60 km^2 in 2019 (combine light and thick vegetation area).

Table 3 Population Growth and Land Use Change trend (2006 – 2019)

Year	Population Growth	Built-up Area (km^2)	Farmland (km^2)	Light Vegetation (km^2)	Thick Vegetation (km^2)	Water Body (km^2)
2006	6,273	18.67	24.3	76.79	16.09	2.25
2007	6,467	20.805	24.653	75.213	15.146	2.105
2008	6,686	23.12	25.006	73.636	14.202	1.96
2009	6,914	25.435	25.359	72.059	13.258	1.815
2010	7,149	27.75	25.712	70.482	12.314	1.67
2011	7,392	30.065	26.065	68.905	11.37	1.525
2012	7,643	32.38	26.418	67.328	10.426	1.38
2013	7,903	34.695	26.771	65.751	9.482	1.235
2014	8,172	37.01	27.124	64.174	8.538	1.09
2015	8,450	39.325	27.48	62.59	7.594	0.945
2016	8,737	41.64	27.83	61.013	6.65	0.8
2017	9,034	43.955	28.183	59.436	5.706	0.655
2018	9,341	46.27	28.536	57.859	4.762	0.51
2019	9,659	48.585	28.889	56.282	3.818	0.365

Source: Obende et al. 2020

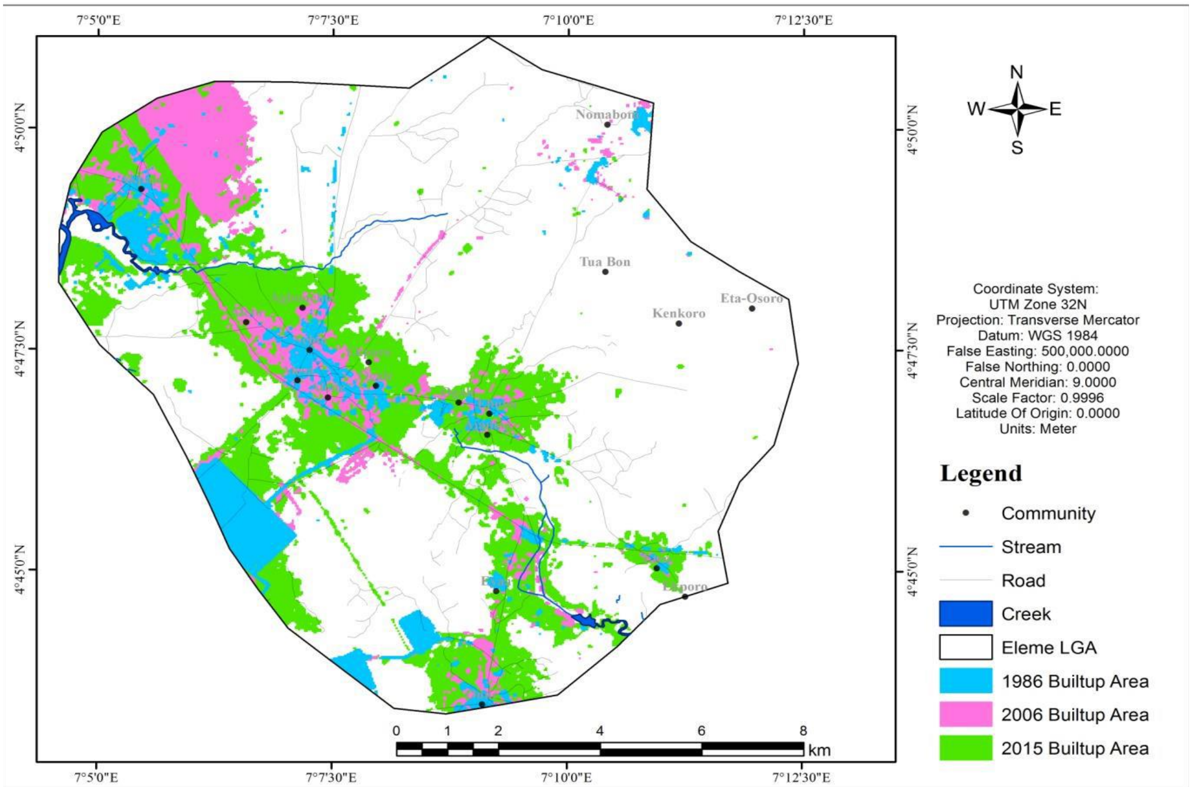


Figure 10: Distribution of the Built-up Area within the Eleme LGA (1986 – 2015)
Source: Obende et al. 2020

A breakdown of the primary land uses in the Eleme LGA is presented in table 4 It is evident from the field observations made that in 2019, residential made up the largest percentage (50%) of the land use, followed by industry covering approximately 35% of the area.

Table 4 Observed Land Use Pattern within the Eleme LGA

Land use	**Percentage**
Residential	50%
Industry	35%
Agriculture	10%
Undistributed forest	5%
Habitat protected area	0%

Possible Project Impacts on Soil

Possibilities of Soil contamination

This may arise as a result of indiscriminate dumping of waste, oil/chemical/product spillage from equipment and machinery both during construction and operation. Furthermore, this may also lead to groundwater contamination due to seepage of spill material through the soil horizon to the groundwater.

Possibilities of soil compaction

Movement of equipment and machinery on site may lead to soil compaction, this may hamper the rate of water infiltration into soil and as such may lead to water accumulation.

Possibilities of soil erosion

Excavation of topsoil and soil compaction which may increase surface run-off, may lead to soil erosion especially within the banks. This will occur due to reduced rate of water infiltration into the soil due removal of topsoil and soil compaction from construction activities.

Mitigation

Dedicated equipment maintenance area fortified from seepage of any material into the soil.

Handling of hazardous chemicals by a trained personnel to reduce the possibilities of spillage.

Limited vegetation clearing/removal.

Shoreline protection within quay area to prevent bank collapse.

Reference

Bohn, H., McNeal, B. and O'Connor, G., 1979. Soil Chemistry. Wiley, New York, 329 pp.

Isirimah NO, Igwe C, Iwegbue CMA (2003). Important Ions in Soils Environment; In: Introductory Soil Chemistry and Biology for Agric and Biotech. Osia In'l Pub. Lt. Port Harcourt. pp. 34-97.

Obenade Moses, Ugochi E. Ekwugha, Ogungbemi A. Akinleye, Kanu C. Collins and Henry U. Okeke (2020); An Assessment of the Socio-economic Effects of Land Use Trends and Population Growth in Eleme, Rivers State, Nigeria, *International Journal of Scientific & Engineering Research Volume 11, Issue 9, September-2020 1737 ISSN 2229-5518*

Appendix 1: Soil Quality Results

Topsoil (0-15cm)

S/No	Parameter(s)	SS 1T	SS 2T	SS 3T	SS 4T	SS 5T	SS 6T	SSC T
1	Sand (%)	84.69	86.15	86.54	84.68	83.28	84.26	85.10
2	Silt (%)	6.05	5.39	5.81	7.20	7.26	8.28	6.50
3	Clay (%)	9.26	8.46	7.65	8.12	9.46	7.46	8.40
4	Texture	SS	SS	SS	SS	SS	SS	SS
5	Porosity	37.30	40.60	41.00	39.30	38.30	38.60	37.60
6	Colour	Light Brown	Grey	Grey	Grey	Grey	Grey	Dark Brown
7	Permeability (cm/sec)×10	0.16	0.17	0.15	0.13	0.14	0.15	0.15
8	Bulk Density (g/cm3)	1.23	1.16	1.35	1.4	1.42	1.42	1.56
9	pH	7.40	6.80	6.00	6.10	6.40	6.80	6.50
10	Moisture Content (%)	10.51	10.25	7.55	9.54	12.45	7.82	7.64
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Sulphate, SO42- (mg/kg)	5.00	4.00	8.00	4.00	12.00	4.00	11.00
14	Nitrate, NO3- (mg/kg)	2.00	1.80	2.30	2.00	1.50	2.30	3.40
15	Total Nitrogen (%)	0.024	0.030	0.015	0.027	0.024	0.034	0.024
16	Phosphate, PO43- (mg/kg)	1.80	0.65	0.85	0.78	1.80	2.50	1.81
18	TOC (%)	0.27	0.35	0.59	0.31	0.27	0.39	0.27
19	THC (mg/kg)	0.86	1.75	2.16	2.45	2.4	0.75	2.46
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	12.18	3.31	3.18	1.66	5.72	3.51	32.57
24	Iron, Fe (mg/kg)	978.6	695.3	1,613.8	1,467.7	758.3	907.5	3,068.8
25	Zinc, Zn (mg/kg)	2.78	3.38	3.47	2.60	3.59	7.71	17.06
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	<0.001	0.41	<0.001	<0.001	<0.001	0.08	<0.001
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.61
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 103	0.8	0.5	0.8	0.3	0.6	0.4	0.6
34	HUF (CFU/g) x 103	0.5	0.3	0.4	0.2	0.4	0.2	0.3
35	THB (CFU/g) x 105	2.8	1.5	2.8	2.3	1.1	2.1	3.5
36	THF (CFU/g) x 105	0.8	0.3	0.6	1.1	0.5	0.7	1.2

Subsoil (15-30cm)

S/No	Parameter(s)	SS 1B	SS 2B	SS 3B	SS 4B	SS 5B	SS 6B	SSC B
1	Sand (%)	86.72	85.10	84.95	85.15	82.64	83.17	84.38
2	Silt (%)	5.14	6.37	7.63	6.37	9.09	8.08	9.31
3	Clay (%)	8.14	8.53	7.42	8.48	8.27	8.75	9.31
4	Texture	SS	SS	SS	SS	SS	SS	SS
5	Porosity	36.80	40.00	39.60	40.20	38.00	38.40	37.00
6	Colour	Brownish	Grey	Grey	Grey	Grey	Grey	Dark Brown
7	Permeability (cm/sec)×10	0.10	0.14	0.16	0.15	0.14	0.16	0.14
8	Bulk Density (g/cm3)	1.33	1.25	1.26	1.53	1.33	1.58	1.45
9	pH	7.50	6.30	5.80	6.30	6.90	7.20	6.60
10	Moisture Content (%)	12.31	11.40	8.16	8.12	11.84	10.51	8.50
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Sulphate, SO42- (mg/kg)	8.00	2.00	16.00	10.00	8.00	2.00	10.00
14	Nitrate, NO3- (mg/kg)	2.20	1.80	2.80	1.80	2.00	1.40	1.90
15	Total Nitrogen (%)	0.022	0.025	0.041	0.023	0.016	0.024	0.014
16	Phosphate, PO43- (mg/kg)	1.40	0.75	1.25	1.25	1.69	1.85	1.65
18	TOC (%)	0.25	0.28	0.47	0.28	0.19	0.28	0.17
19	THC (mg/kg)	0.65	1.25	1.75	1.65	0.96	1.16	1.40
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	4.82	3.24	2.22	2.80	5.77	2.03	17.38
24	Iron, Fe (mg/kg)	688.3	962.2	2,109.2	1,081.3	729.5	358.1	2,713.0
25	Zinc, Zn (mg/kg)	2.47	2.35	1.97	2.75	3.02	3.05	8.32
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.46
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	<0.001	<0.001	<0.001	<0.001	0.14	<0.001	0.19
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 103	0.4	0.1	0.2	0.2	0.2	0.1	0.3
34	HUF (CFU/g) x 103	0.2	NIL	NIL	0.2	0.1	NIL	0.1
35	THB (CFU/g) x 105	1.9	1.1	1.6	1.3	0.7	1.6	2
36	THF (CFU/g) x 105	0.6	NIL	NIL	0.6	0.3	0.2	0.8