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GIS AND REMOTE SENSING TECHNOLOGY IN EVALUATION OF GEOSTATISTICAL HEAVY METALS SOIL FOR ENVIRONMENTAL QUALITYIN YENAGOA METROPOLIS, BAYELSA STATE NIGERIA

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Abstract

This research concentrates on heavy metals in urban soil in Yenagoa metropolis including 3D modeling of the environment by applying GIS and remote sensing techniques to evaluate the spatial distribution of heavy metal in the soil for better visualization of contamination zone and non-contamination zone. The results revealthe spatial pattern of heavy metals is successfully interpolated based on in situ data by using Ordinary Kriging technique. It also shows the absence of contamination in the area expect dumpsites in soil 1 in Akenfa,2, 13,19 in Etegwe, and 20 in Swail. Pearson Correlation Coefficient is significant for the following heavy metals P >0.05 at Zn-Pb, Fe- Zn, Cr-Zn, Mn-Fe, and Correlation is Highly Significant at P >0.01 Fe-Pb, Cu-Pb, Cu-Zn, Cu-Fe, Cd-Pb, Cd-Zn, Cd-Fe, Cd-Cu, Cr-Pb, Cr-Fe, Cr-Cu, Cr-Cd, Ni-Pb, Ni-Zn, Ni-Fe, Ni-Cu, Ni-Cd, Ni-Cr, Mn-Zn, Mn-Cu, Mn-Cd, and two Principal Component Analysis were found. The first principal component explained 80.324 %, and the second principal component explained 18.922 % of the total variance, which indicate two sources of heavy metal in the area. Besides that, urban development in the area is about 23 % of the landmass. The impacts of pollution on soil are found close to the river, making the river in the area not suitable to be used for drinking and watching of household items due to, it serves as a dumpsite. Therefore, the area lacks environmental law and need to embark on site suitable for landfill using GIS and remote sensing.

1. Introduction

Soil polluted with a high concentration of heavy metals is one problem that directly or indirectly gives a bad influence on the general quality of life in the city. Especially in the industrialized environment in urban soil. Heavy metal contamination is a major environmental problem that is harmful to human beings and plants [13]. These toxic heavy metals in soil strongly impact the natural ecosystem and are a threat to human health through the food chain [3]. Estimating and analyzing the spatial distribution of heavy metals are particular interests to control and manage soil quality. Generally, the accumulation of heavy metals in soil influenced by different variables in nature (parent rocks, soil types, soil properties, etc.) as well as human activities (industry, traffic, agriculture, etc.). Therefore, monitoring these changes is truly necessary that allows them to identify their source and assess potential risks associated with heavy metal contamination. There are diverse criteria and methods used to access environmental soil quality based on the heavy metal content in the soil [11]. People used different indices for soil pollution monitoring such as pollution load index, the potential of ecological risk index, geo-accumulation index, and so on. Geostatistics, multivariate methods, and Geographic Information System (GIS) that allow for faster and more accurate information have been widely used in numerous studies and they are a powerful tool for the determination of spatial distribution in soil pollution study [1]. Kriging is a geo-statistical and one of the most commonly used methods for spatially interpolation in environmental studies [9]. It has been applied successfully to describe the spatial variability of certain soil parameters and predict the value for unknown points/areas [7]. Therefore, this research aims to evaluate the spatial distribution of heavy metals in the soil for environmental quality assessment, land use/landcover using geographical information systems remote sensing-based techniques.

2. Materials and Methods

2.1 Location and Geology of the study area

The study area is Yenagoa which is the capital city of Bayelsa State and is among the developed city in Nigeria. The area under instigation covers a mass land of an area of 20,4617 km^2 and the population estimated to be about 200,000 in 2020. It is located in the Southern part of Nigeria and with a good road network that links to various parts of the State such as LGA like Kolokuma/Opokuma, Sagbama, Southern Ijaw, Ogbia, etc. This area lies within longitudes 0060 17’30” and 0060 21’30” East of the prime meridian and Latitudes 040 55’0” and 040 7’30” North of the equator within the coastal area of the recent Niger Delta. (Figure.. 1). The study area falls within the Niger Delta Basin, the fresh water-bearing zone is the Eocene aged Benin Formation which is overlain in most areas by quaternary deposits. Sands and sandstones in the Benin Formation are coarse to fine-grained, commonly granular in texture with can be unconsolidated. The main composition of the Benin Formation is fresh water-bearing continental sands and gravels with some clay and shale intercalations characteristic of partly lagoonal and fluvial-lacustrine/deltaic depositional environment [10]. The clayey intercalation within the Benin Formation gave rise to a multi-aquifer system in the Niger Delta, with the shallow unconfined aquifer occurring at depths between 20m and 40m across the area [14].

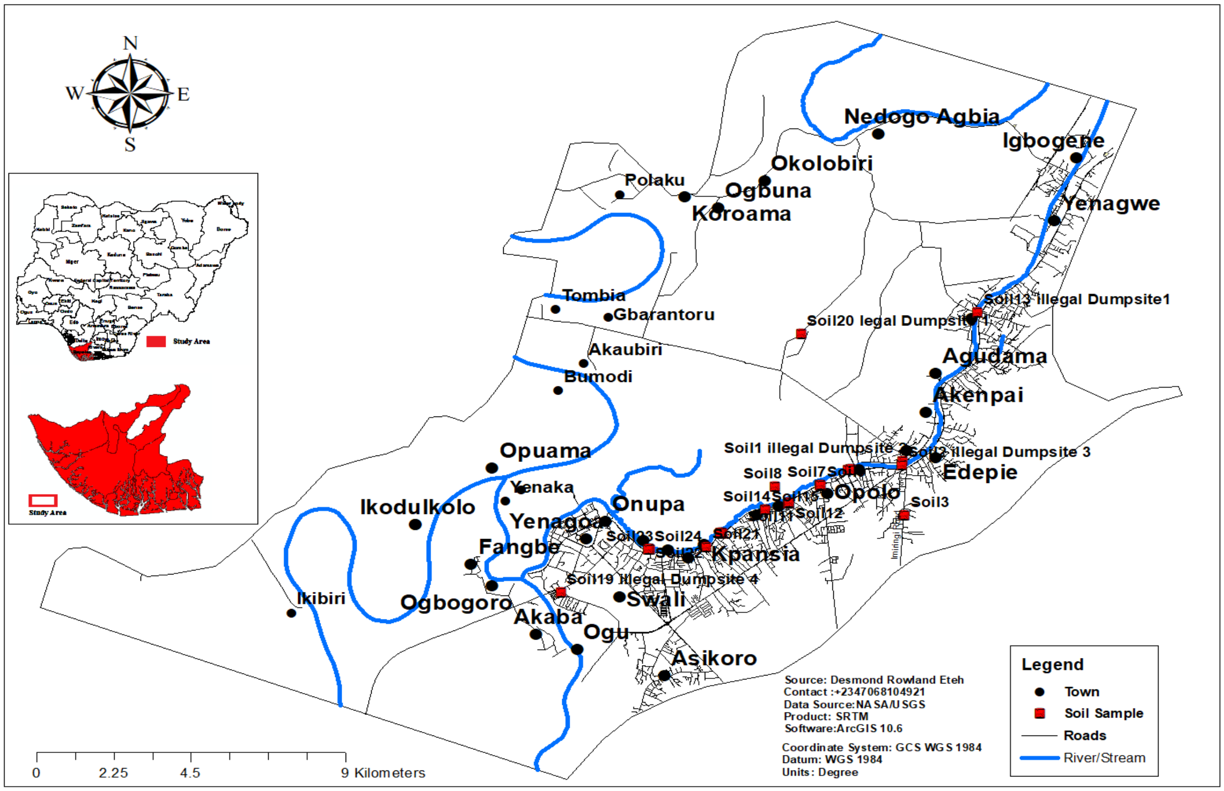

Figure.1: Topographic Map of Study area showing Soil sample Point

2.2 GIS and Remote sensing data collection

The following materials and data were collected for Digital Elevation Dataset from Shuttle Radar Topographical Mission (SRTM) and Landsat 8 downloaded from NASA/USGS explorer, prior and the spatial locations of some communities in Yenagoa were also acquired by the use of Garmin72 GPS, and extracted using TCX, DNRgps software including downloading of a satellite image from google earth in 2020 with the aid of universal map downloader. An administrative map from where political boundaries and roads were digitized. Fieldwork with GPS and notebook was also used for the acquisition of coordinates of the communities respectively.

Table 1: List of Data collected for the study area.

Satellite Data	Date	Spatial Resolution	Source
Landsat 8	6/1/2020 Path : 189, Row : 56	30 m	[5]
SRTM	22/11/2000, 1-ARC second	30 m	[4]
Google EarthImagery	06/02/2020	3m	[4]

2.3 Soil Sampling Data collection

A total number of 24 soil sampled was collect with aid of hand auger and they are randomly taken over the entire study area (see Figure's 1 and 2). Soil samples were collected from the outer surface to 0 – 1m depth with a total of 2-3 kg of soil per sample following the Guidance on sampling techniques. They are stored in a polyethylene bag for transport and then analyzed in the laboratory.

2.4 Data analysis

Chemical properties were obtained following the standard procedures. The soil samples were air-dried at room temperature and milled to a particle size of < 2mm after dried. They will be then classified as representative samples for later analysis. The total concentrations of heavy metal were determined using Flame Atomic Absorption Spectrophotometry method. The metals ions Fe, Mn, Cr, Cu, Zn, Ni, Cd, and Pb were analyzed using the atomic absorption spectrometer. Samples were acid digested in the fume hood and filtered. The samples were then filtered and diluted to 100ml in a 100ml flask. They were then brought for the AAS spectrometer analysis.

2.5 Data processing

Arc GIS 10.6 spatial analyst extension was used to process the data collected using handheld Global Positioning System (GPS) in degree, minute, second and imported into Microsoft Excel where the data was converted to degree decimal and transferred to Geographical Information System environment in DataBase Format before point map was generated alongside Digital Elevation Model and also Open data gotten from NASA/USGS explorer for Landsat 8 2020 (Table 1) used to generate the land cover/land use map with the aid of remote sensing software known as ERDAS IMAGINE 9.2 and ArcGIS 10.6 [5] using image analysis tools, layer stake, band combination which is also called the near infrared (NIR) composite of near-infrared (5), red (4) and green (3), subset and defining of the training sites, extraction of signatures from the image and then classify using supervised classification before exporting the data and import it to SPSS software for statistical analysis.

Geo-statistical Analysis based on the GIS Geo-statistic method as employed in this study for estimating the spatial distribution of heavy metals. Ordinary Kriging is a linear spatial interpolation that estimates spatial data at the unknown location using a weight function of adjacent data points [8]. The general equation for estimating the z value as a point is: Kriging is the weights of the relevant calculated values to achieve a forecast for an unknown position. The formula of the kriging interpolators is the weighted sum of the data:

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$$\hat{Z}(s_0) = \sum_{i=1}^{N} \lambda_i Z(s_i)$$

Where: $Z(S_i)$ = measured value at the ith location,

λi = an unknown weight for the measured value at the ith location

S_o = Prediction location,

N = Number of measured values

3. Results and discussion

3.1 Digital Elevation Model

It gives general information on the topographic nature of the area is like high and low Elevation which turn gives a better view to understanding the digital terrain of the area. From Figure. 2. The DEM of the study area range from -14-37 m (Figure. 2) beside it is used to determine the area that is prone to flood during the rainy season [2] like the area with yellow colour reflect flood plain and also use for research for site suitability for flood relief center and other projects apart from that it can be used for rice farming due to the terrain.

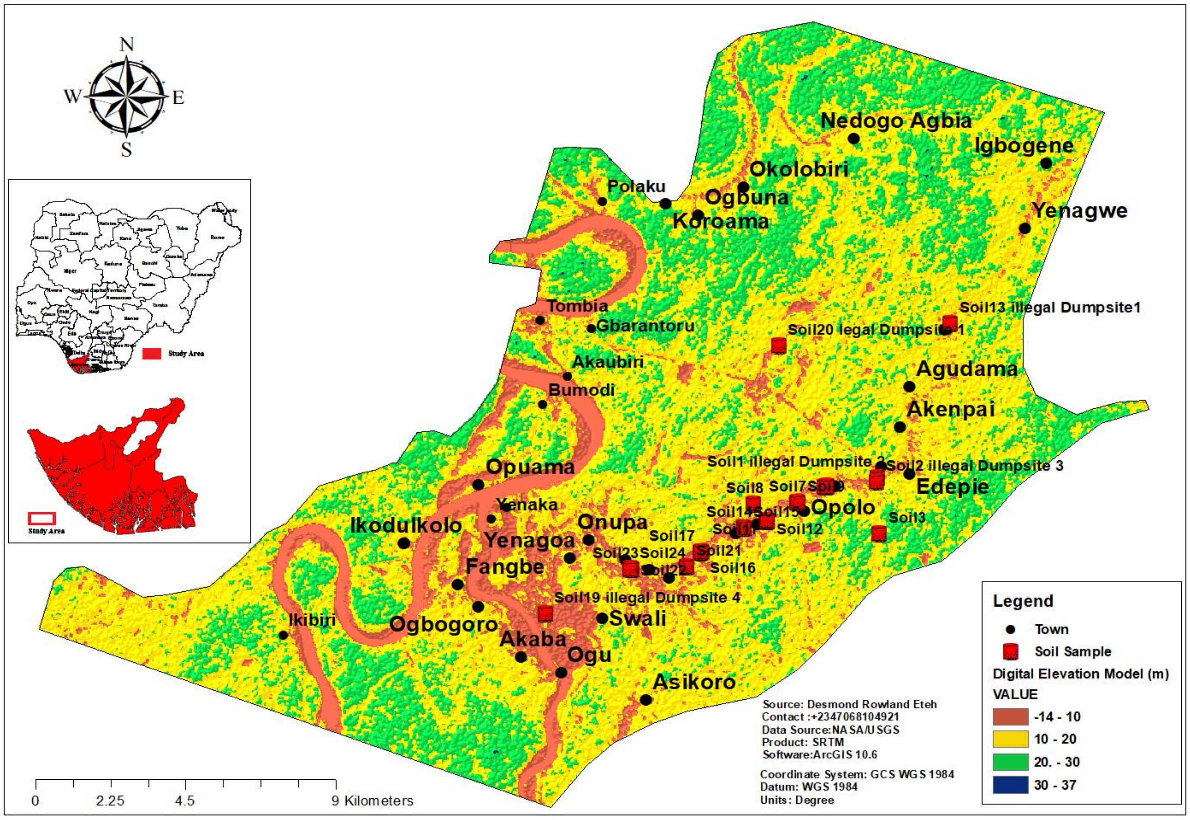


Figure 2: Digital Elevation Model showing Soil Sample Point

Heavy metal concentration the concentration of heavy metals and statistical analysis results of the soil in the study site can be seen as Table 1. heavy metals can be identified from soil samples in the study site including Cd, Cu, Co, Zn, Fe, Mn, Pb, and Ni Among these 8 metals, Zn and Fe have higher value of concentration compared to others.

Table 2: Descriptive Statistics for heavy metals in soil

Sample Code	Long	Lat	Fe	Mn	Cu	Cd	Cr	Ni	Zn	Pb
Soil1 illegalDumpsite 2	6.357223	4.95617	932.54	38.795	14.174	9.017	15.81	6.511	20.518	10.727
Soil2 illegalDumpsite 3	6.357058	4.954938	109.563	22.981	5.178	1.328	5.419	1.286	11.254	4.786
Soil3	6.357831	4.940502	2.54	0.35	0.044	0.026	0.14	0.017	2.54	0.012
Soil4	6.342981	4.953496	1.28	0.25	0.041	0.028	0.02	0.031	0.88	0.012
Soil5	6.343678	4.953784	2.63	0.35	0.072	0.042	0.04	0.032	1.48	0.021
Soil6	6.3438	4.953529	1.87	0.23	0.052	0.034	0.18	0.028	2.2	0.022
Soil7	6.335802	4.949292	1.88	0.24	0.042	0.034	0.18	0.028	2.2	0.022
Soil8	6.323853	4.948708	2.64	0.36	0.062	0.042	0.04	0.032	1.48	0.01
Soil9	6.335957	4.949193	2.86	0.54	0.056	0.038	0.082	0.03	2.4	0.013
Soil10	6.327505	4.943905	2.05	0.3	0.038	0.03	0.024	0.02	2.6	0.024
Soil11	6.327704	4.943861	2.35	0.48	0.036	0.024	0.026	0.024	2.56	0.014
Soil12	6.327738	4.94416	1.6	0.28	0.04	0.026	0.034	0.026	1.2	0.012
Soil13 illegal Dumpsite1	6.37696	4.999078	1686.35	2.121	11.007	10.313	44.182	2.897	5.121	22.873
Soil14	6.321465	4.942102	2.05	0.3	0.038	0.03	0.024	0.02	2.6	0.024
Soil15	6.321355	4.942003	2.35	0.48	0.036	0.024	0.026	0.024	2.56	0.014
Soil16	6.309784	4.935288	1.6	0.28	0.04	0.026	0.034	0.026	1.2	0.012
Soil17	6.310061	4.935399	3.45	0.68	0.035	0.03	0.065	0.033	2.48	0.01
Soil18	6.309784	4.935432	2.53	0.34	0.054	0.026	0.14	0.017	2.55	0.013
Soil19 illegalDumpsite	6.267906	4.918096	983.29	39.329	14.253	6.765	17.186	6.219	20.872	11.098

4										
Soil20 legalDumpsite 1	6.330748	4.993005	1807.43	1.927	10.793	10.267	39.326	2.918	4.812	23.192
Soil21	6.306059	4.9312	3.55	0.78	0.035	0.06	0.065	0.032	2.48	0.01
Soil22	6.29098	4.930692	2.47	0.35	0.032	0.028	0.26	0.017	3.1	0.023
Soil23	6.291171	4.930628	3.86	0.62	0.031	0.03	0.028	0.021	2.58	0.024
Soil24	6.290917	4.930532	1.72	0.3	0.038	0.024	0.05	0.022	1.22	0.018
Minimum			1.28	0.23	0.031	0.024	0.02	0.017	0.88	0.01
Maximum			1807.43	39.329	14.253	10.313	44.182	6.511	20.872	23.19
Mean			283.58	5.85	2.71	1.87	6.45	1.03	4.79	3.70
Background Value			3.38	0.78	0.08	0.05	0.09	0.05	3.21	0.26

Concentration is expressed in milligrams per kilograms (mg/kg)

Table 3:Pearson correlation coefficients between heavy metals in surface soil samples.

	Pb	Zn	Fe	Cu	Cd	Cr	Ni	Mn
Pb	1							
Zn	0.486*	1						
Fe	0.992**	0.510*	1					
Cu	0.867**	0.850**	0.883**	1				
Cd	0.966**	0.641**	0.979**	0.944**	1			
Cr	0.994**	0.413*	0.985**	0.823**	0.947**	1		
Ni	0.721**	0.929**	0.758**	0.967**	0.856**	0.667**	1	
Mn	0.389	0.987**	0.408*	0.788**	0.550**	0.310	0.882**	1

*Correlationissignificant at the P> 0.05 level (2-tailed).

**CorrelationisHighlySignificant at the P> 0.01 level (2-tailed).

The Pearson correlation coefficients, Principal Component Analysis and Cluster Analysis,were considered for heavy metal concentrations in surface soil samples. As shown in Table 3. Correlation is significant at P > 0.05 which indicates that Zn-Pb, Fe- Zn, Cr-Zn, Mn-Fe, and Correlation is Highly Significant at P > 0.01, Fe-Pb, Cu-Pb, Cu-Zn, Cu-Fe, Cd-Pb, Cd-Zn, Cd-Fe, Cd-Cu, Cr-Pb, Cr-Fe, Cr-Cu, Cr-Cd, Ni-Pb, Ni-Zn, Ni-Fe, Ni-Cu, Ni-Cd, Ni-Cr, Mn-Zn, Mn-Cu, Mn-Cd, and Mn-Ni are Highly significant correlated when observed. In contrast, others, such as Mn-Pb and Mn-Cr, are non-significant Correlated.

Table 4: Factor loadings of PCA showing total Variance explained for heavy metals in surface soil samples

	Initial Eigenvalues			Extraction Sums of SquaredLoadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.426	80.324	80.324	6.426	80.324	80.324
2	1.514	18.922	99.245	1.514	18.922	99.245
3	.043	.539	99.785			
4	.007	.087	99.872			
5	.006	.079	99.952			
6	.004	.048	100.000			
7	2.254E-5	.000	100.000			
8	1.474E-6	1.843E-5	100.000			

Extraction Method : Principal Component Analysis.

Table 5: Factor loadings of PCA after Component Matrix for heavy metals in surface soil samples.

Metal	**Component 1**	**Component 2**
Pb	0.909	-0.407
Zn	0.799	0.597
Fe	0.923	-0.380
Cu	0.995	0.095
Cd	0.971	-0.219
Cr	0.873	-0.481
Ni	0.942	0.306
Mn	0.726	0.682

Extraction Method : Principal Component Analysis.

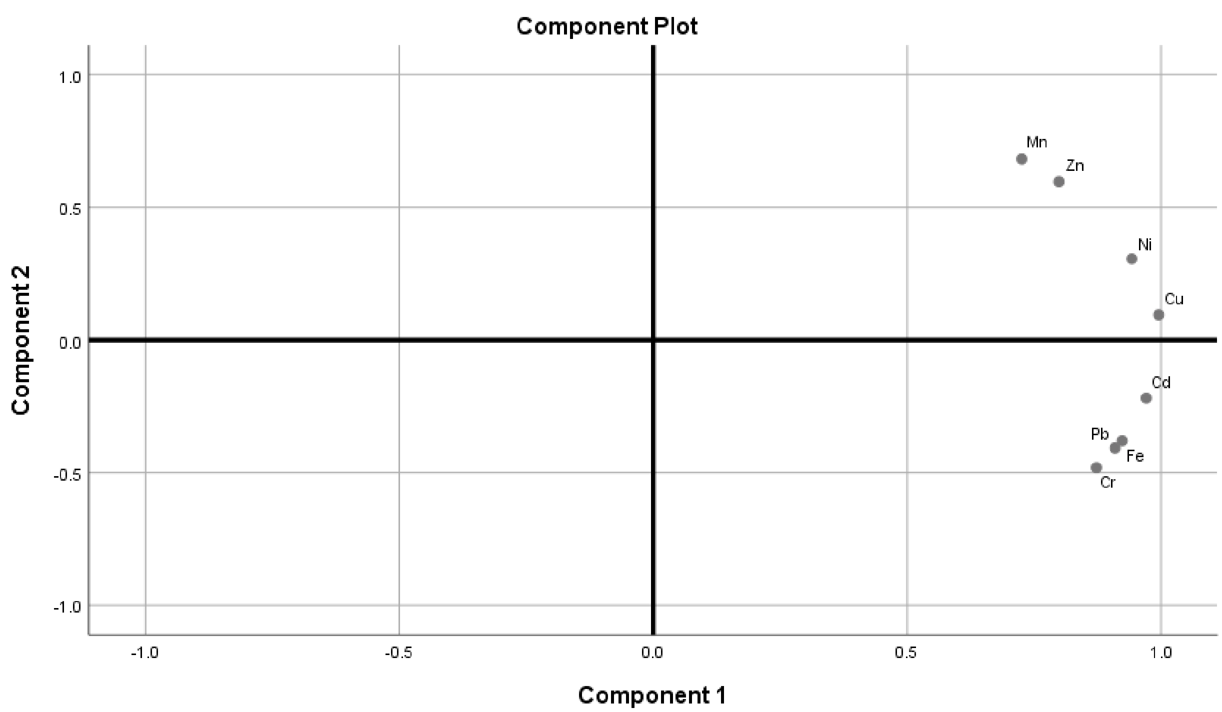


Figure 3: Loading principal components of heavy metalsin a surface soil sample in the study area

The Principal Component Analysis output in Table 4 and Figure 3. Two principal components were extracted, which explained 99.245 % of the total variance. This result indicates that there were two main sources of heavy metals in soil samples. The first principal component explained 80.324 % of the total variance. This component was significantly loaded by Mn, Zn, Ni, and Cu. The second principal component explained 18.922 % of the total variance, which was mainly loaded by Cd, Pb, Fe, and Cr is similar to Table 5.

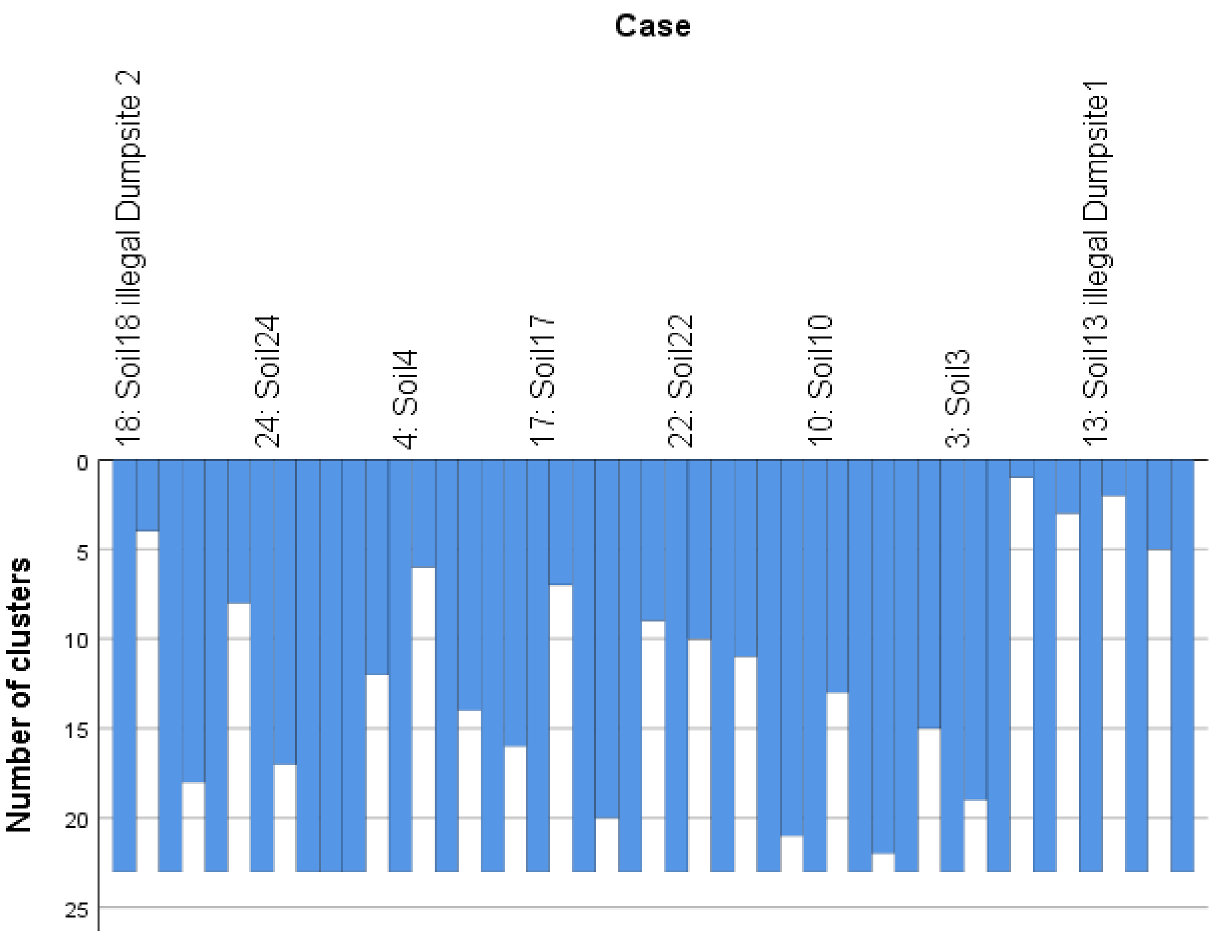


Figure 4: Icicle diagram for heavy metals in Soil Sample in the study area

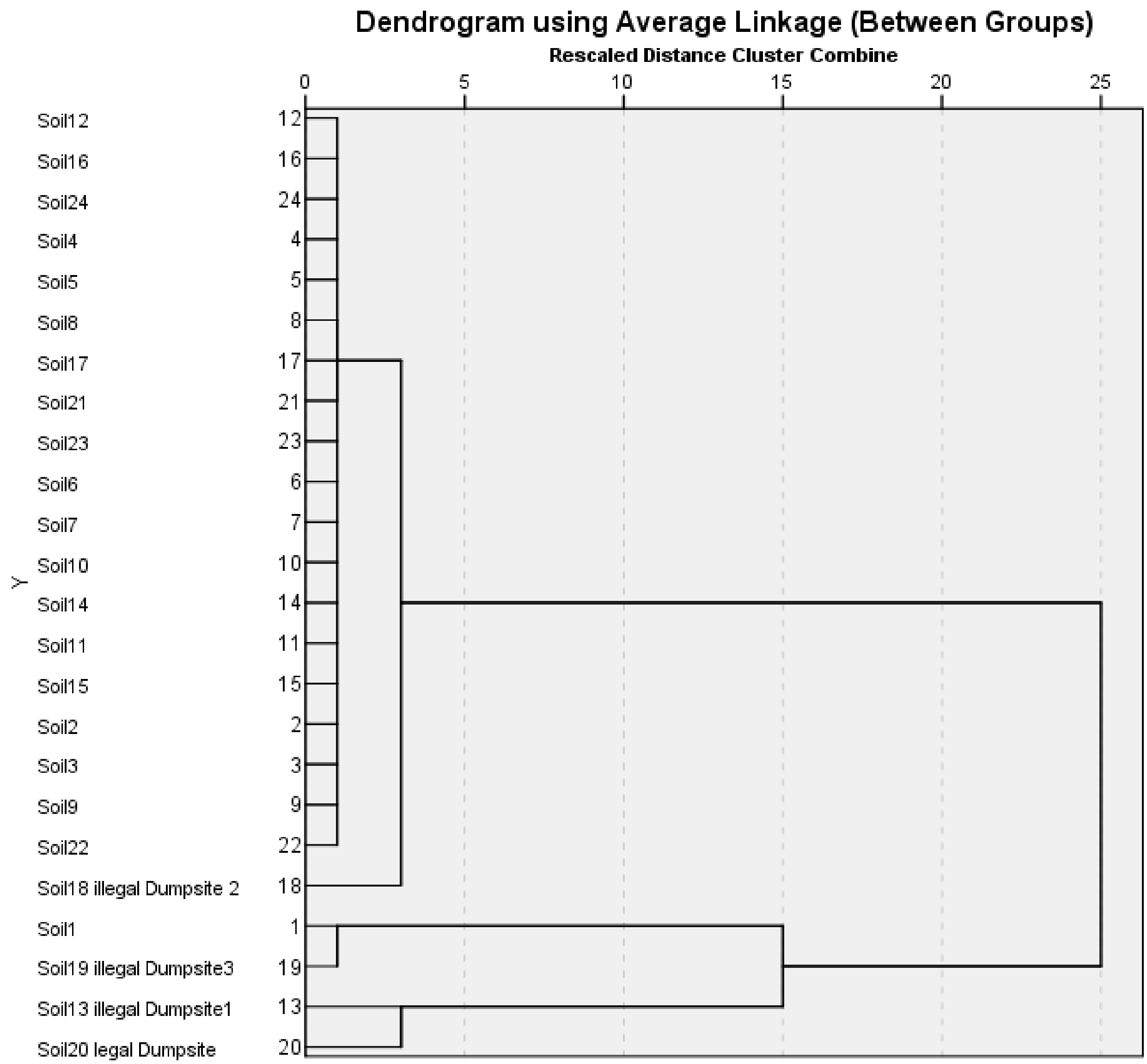


Figure 5: Dendrogram of sampling locations in terms of heavy metals in soil.

The result of HCA is in a dendrogram, as shown in Figure 5. The distance cluster represents the degree of association between sampling sites. The lower the distance value of the cluster, the more significant association. The total cluster distance in this study was restricted between the values of 0 and 25. When compared the HCA results (Figure 4) and sampling locations (Figure 5), it shows that there is a relation between geographical locations and total heavy metal concentrations and cluster 1 contain almost all soil sample expect soil 18, soil 13 and 20 with Euclidean distance of 1, cluster2 contain soil 17,21,23,6,7,10,1,11,15,2,3,9,22,18,13 and 20 with Euclidean distance of 4, cluster 3 contains soil 1,19 and 13 with Euclidean distance 15 and cluster 4 contain cluster 2 and 3 with Euclidean distance of 25

3.2 Land cover/land use map

The satellite imageryisgottenfrom NASA/USGS and wasclassifiedusingSupervised classification with the aid of Erdas Imagine 9.2 and ArcGIS 10.6 software

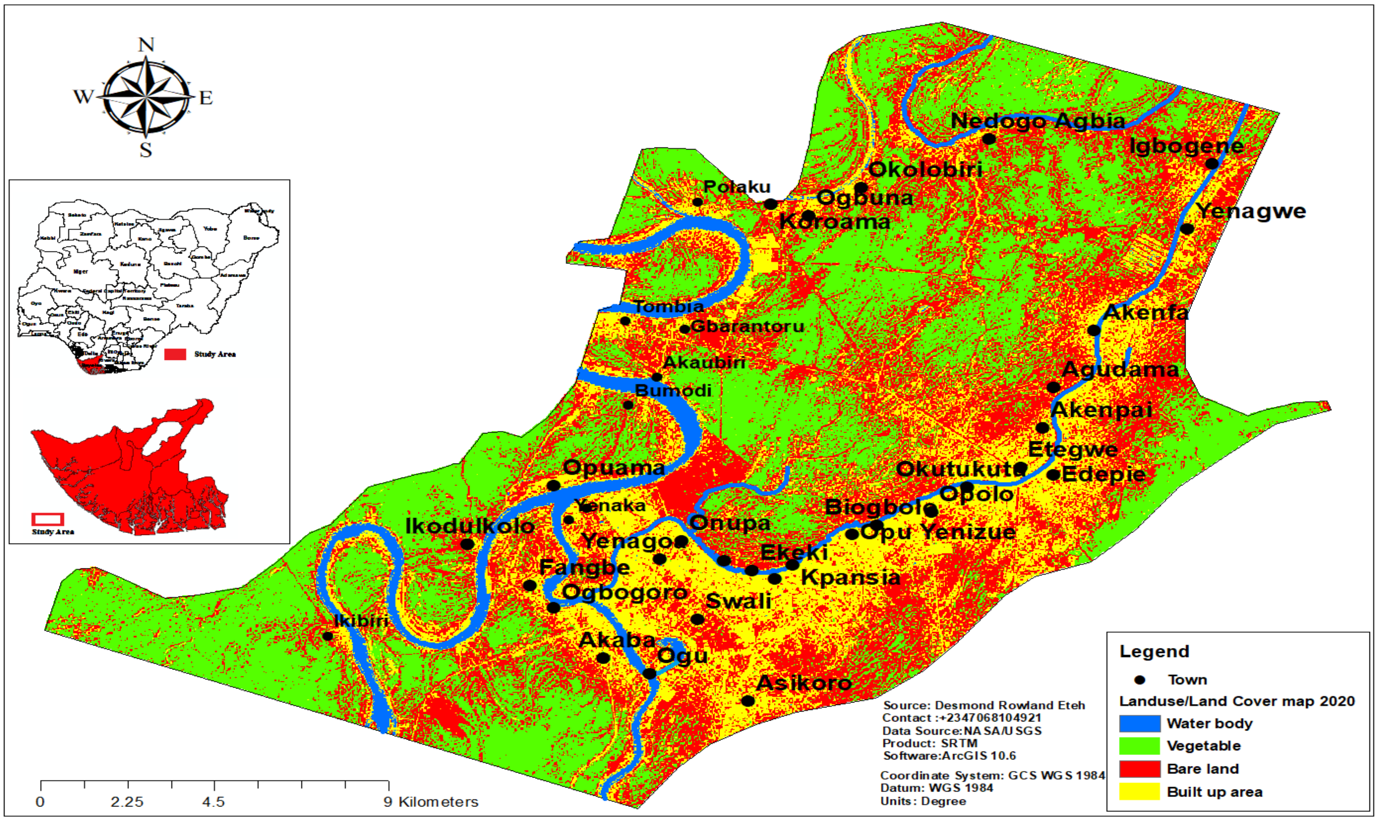


Figure 6: Landuse/landcover map (2020)

Results from Table 6 below, classification reveals that the total of landuse/landcover is 410.61 km^2 and water body is 16.07 km^2 reflecting blue colour, vegetation is 156.80 km^2 with the percentage of 38 % which is reflected in Figure 6 with a Green notation and is highest among all in Figure 7, built-up area is 93.30 km^2 which is yellow colour with 23% (see Figure. 8) and finally, bare land is made up of 144.44 km^2 with 35% showing red colour.

Table 6. Statistics of Landuse/Landcover

S/N	Classification	Land use / Land Cover (Km^2)	Land use / Land Cover %
1	Waterbody	16.07	4
2	Vegetation	93.30	38
3	Bare land	144.44	35
4	Built-Up Area	156.80	23
Total Area		410.61	

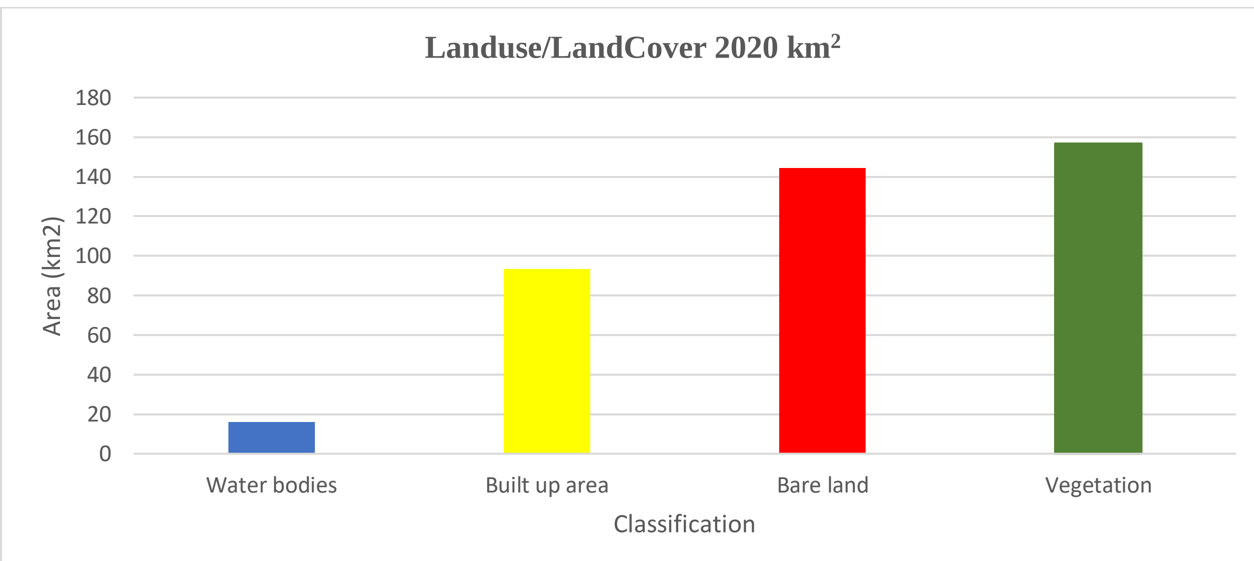


Figure 7: Land Cover/Land use Bar chart (2020)

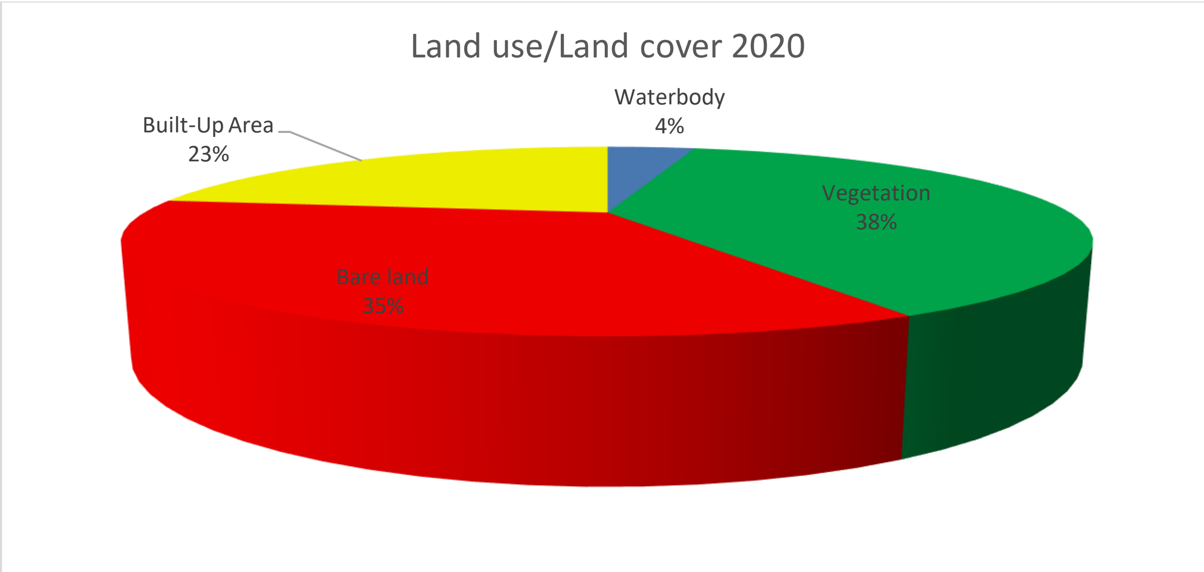


Figure 8: Pie chat for Landuse/landcover in term of development (2020)

3.3 Spatial distribution of heavy metals content in the soil

Kriging is based on the idea that the value at an unknown point should be the average of the known values at its neighbours; weighted by the neighbours' distance to the unknown point. Kriging interpolation method and GIS mapping technique were applied to produce the spatial distribution maps of total metal concentration for Cd, Cu, Cr, Zn, Fe, Mn, Pb, Zn, and Ni in the study area.

This result reveals that the minimum value of Cadmium is 0.02 mg/kg and a maximum 10.31 mg/kg with a mean value of 1.87 mg/kg of concentration is far less than the background of 3.85 mg/kg, (Table 2) for the non-dumpsite site while for dumpsite, the concentration of cadmium is high such as soil 1, 2 and 20 in Etegwe, soil 13 in Akenfa and soil 19 in Swail Figure 9e

The concentration of Copper in soil samples demonstrated that the maximum value of Cu is 14.25 mg/kg with a mean value of 2.71 mg/kg which is far less than the standard limit with the allowable threshold of 0.08 mg/kg (Table 2) for non- dumpsite in Figure 1. In contrast, the concentration of copper is high such as soil 1, 2 and 20 in Etegwe, soil 13 in Akenfa and soil 19 in Swail Figure 9d of the spatial distribution map

The concentration of Zinc on soil samples were found to be in the range from of 0.88 to 20.87 mg/kg with a mean 4.79 (Table 2) and Zinc concentration in the study area is below for non-dumpsite. In contrast, the concentration of zinc is high in soil 1, 2 and 20 in Etegwe, soil 13 in Akenfa and soil 19 in Swail Figure 9g. of spatial distribution map.

The lead (Pb) concentrations for the analyzed soil sample vary from 0.01 – 23.19 mg/kg. Its spatial distribution of Pb across the study area shown in Figure 9h. It is observed that the highest level of Pb was recorded in Etegwe, Akena and Swail, which is due to the dumpsite from the spatial distribution map in Figure 9h.

The concentrations Iron (Fe) for the analyzed soil sample range from 1.28 – 1807.43 mg/kg (Table 2) and it is the highest value among others. Its spatial distribution of Fe across the study area shown in Figure 9a. It is observed that the highest level of Fe was recorded soil 1, 2, and 20 in Etegwe, soil 13 in Akenfa, and soil 19 in Swail (Figure 9a). Iron concentration analyzed from soil samples is below for non-dumpsite and above for dumpsite.

The Manganese was found to be in the range of 0.23 to 0.39 mg/kg and the Mn concentration in the study area is far below the acceptable threshold limit standard of 0.78mg/kg in Table 2 for non- dumpsite in Figure 1 and its spatial distribution map in Figure 9 g. show that soil 1, 2 and 20 in Etegwe, soil 13 in Akenfa and soil 19 in Swail, record-high level of Manganese reflecting on the map in Figure 9b.

The Chromium (Cr) concentrations for the analyzed soil sample vary from 0.02 – 44.18 mg/kg (Table 2). Its spatial distribution of Cr across the study area shown in Figure 9 c. It is observed that the highest level of Cr was recorded in soil 1, 2, and 20 in Etegwe, soil 13 in Akenfa, and soil 19 in Swail which is due to the dumpsite in Figure 9c.

The Nickel (Ni) concentrations for the analyzed soil sample vary from 0.02 – 6.51 mg/kg (Table 2). Its spatial distribution of Ni across the study area shown in Figure. 9 f. It is shown that the highest level of Ni was recorded in Etegwe, Akenfa, and Swail Town in a dumpsite in Figure. 9f.

Therefore, the presence of High-level heavy metals in the soil sample is appreciable contamination of the soil by leachate migration from the open dumping site [7]. Which is confirmed to be true because the only high level of heavy metals is found to be in the dumpsite such as soil 1,2,13,19 and 20 and soil 1,2,13 are close to Epie creek [2] which serves as a significant source of water for both individuals and soil 19 is also close to River Nur which serve as a major source of water in the area. Results shows that the river and creek are polluted, and Soil 20 is within vegetation which can also be affected, making the vegetation unhealthy further study call carry out investigate on the assessment of vegetation using vegetation indices.

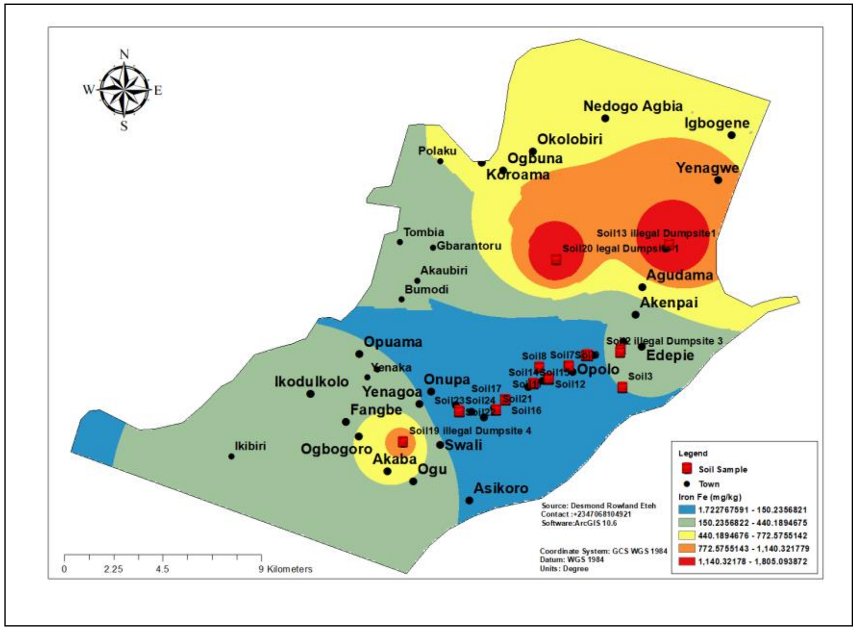


Figure 9 a: Concentration of Iron

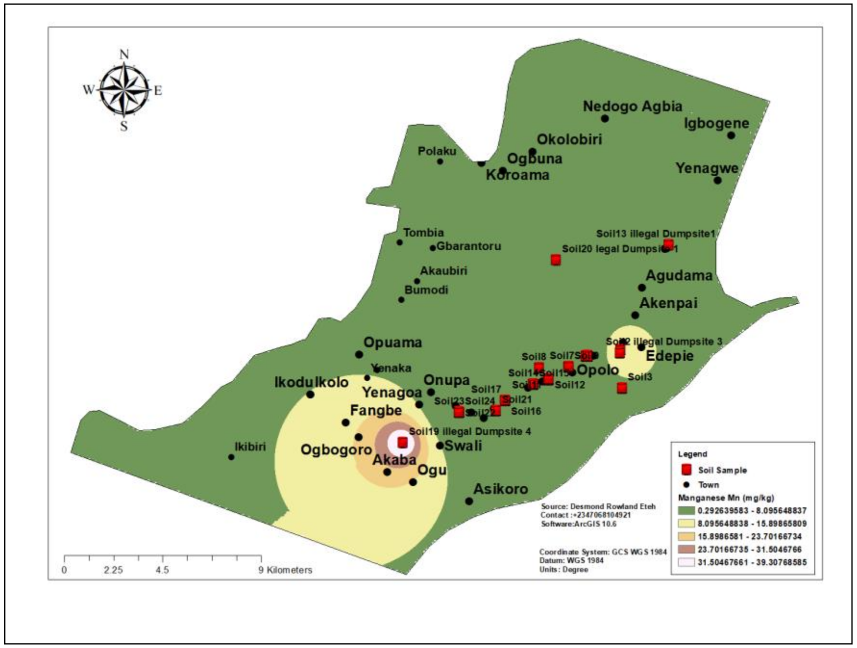


Figure 9 b: Concentration of Manganese

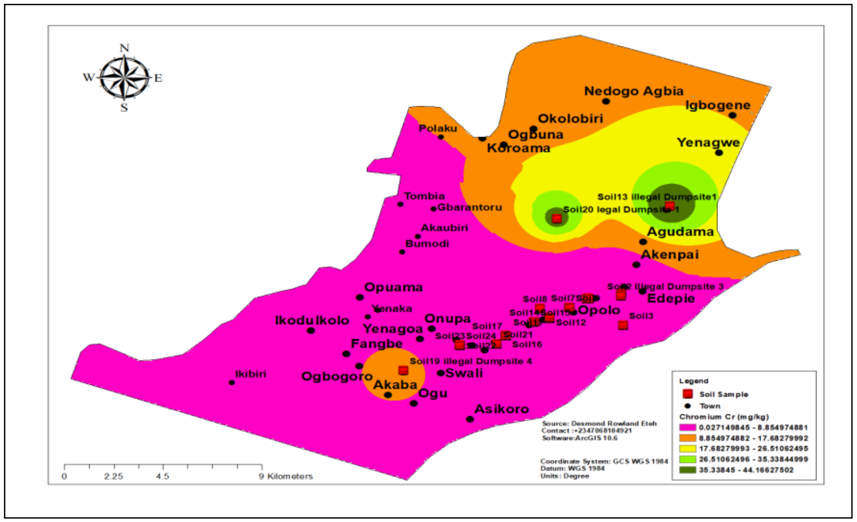


Figure 9 c: Concentration of Chromium

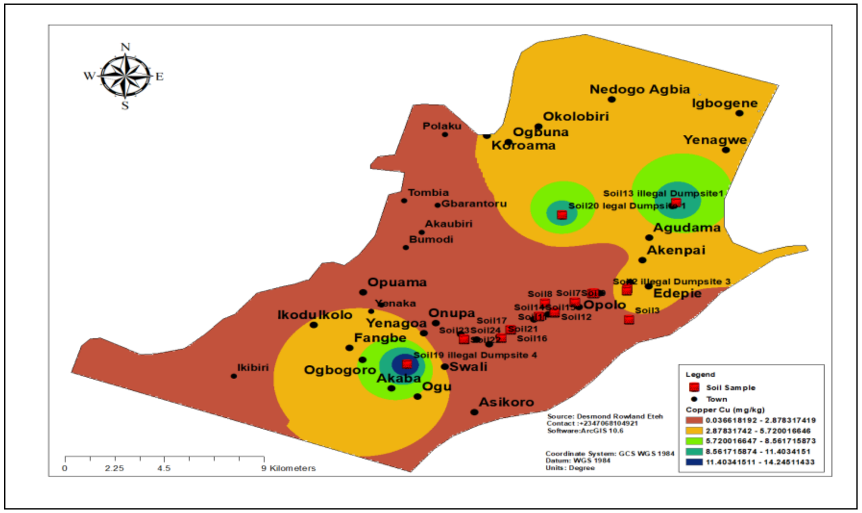


Figure 9 d: Concentration of Copper

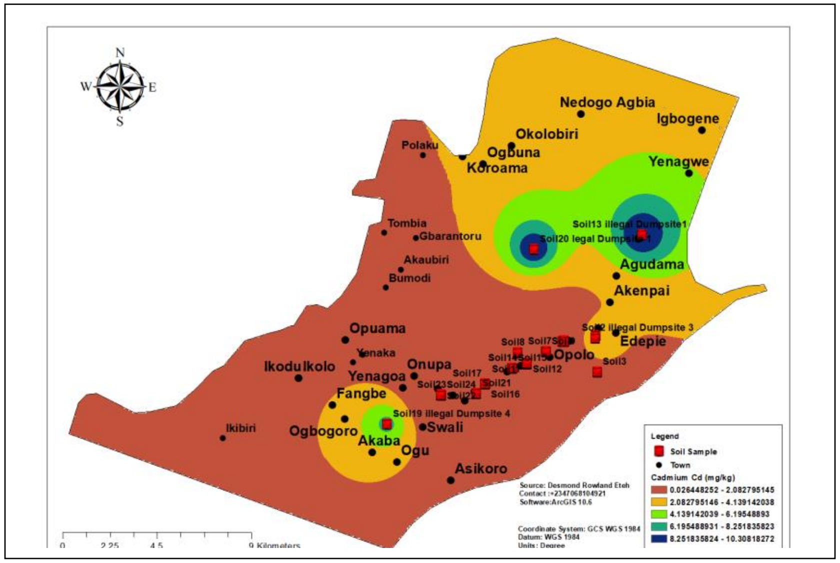


Figure 9 e: Concentration of Cadmium

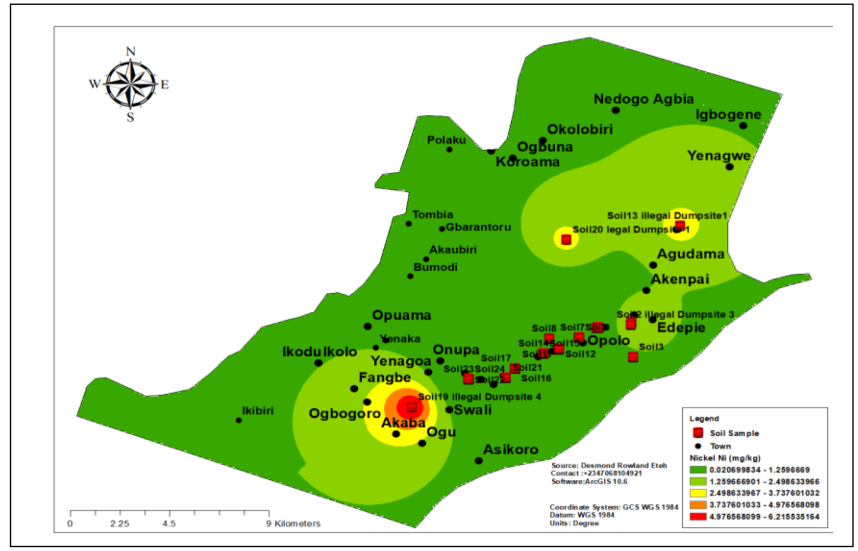
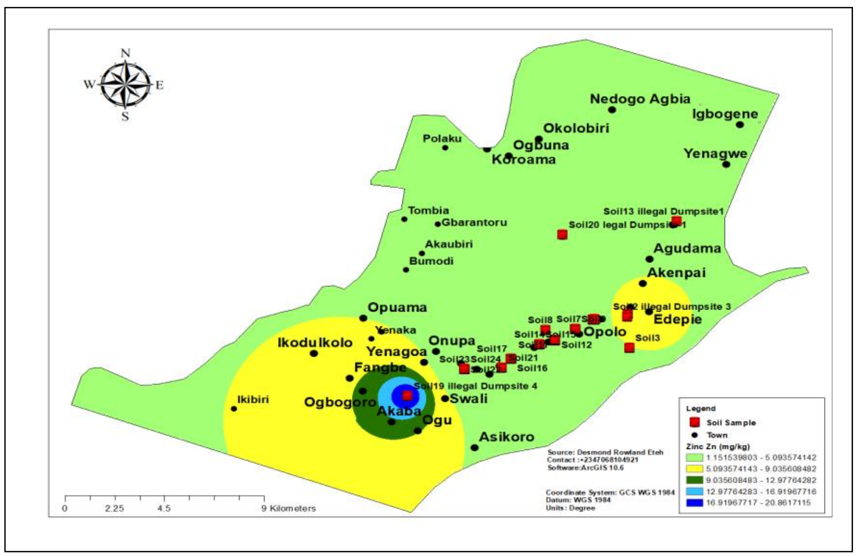


Figure 9 f: Concentration of Nickel



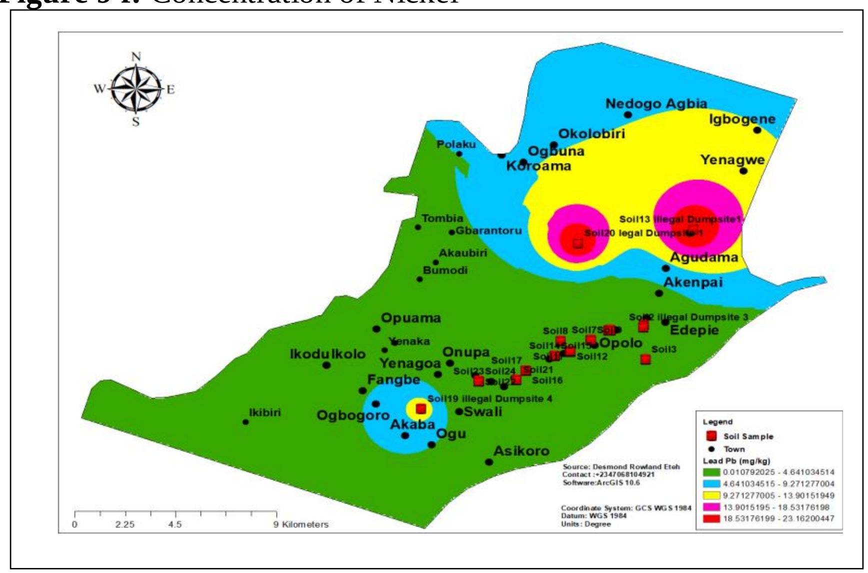


Figure 9 g: Concentration of Zinc **Figure 9 h:** Concentration of Lead

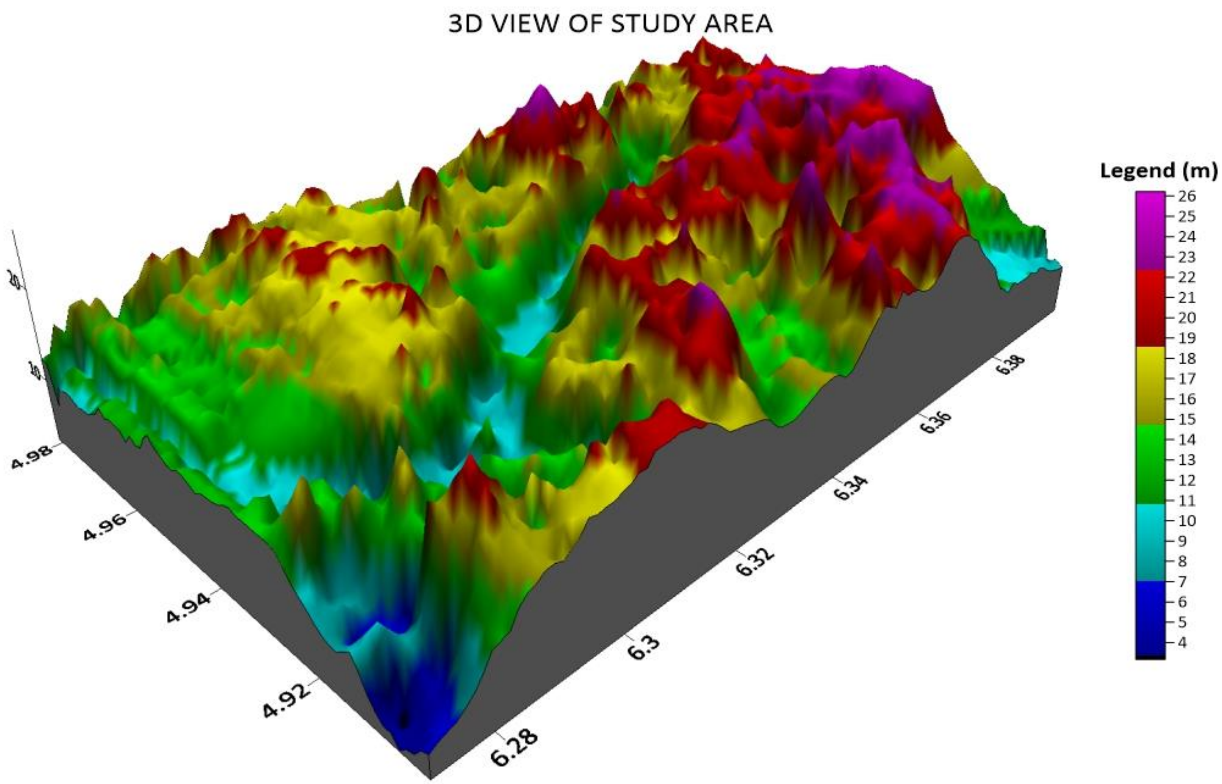


Figure 10: 3D View of Study area

The 3D view of the study area in Figure 10, reflect the real view on how the area is generally [2]. Area with low and high altitude is recorded on the legend from 4m to 11m. Low altitude contain colour ranging from dark blue to light blue and when compared with Figure 1. it shows that those area reflecting dark blue is referred to the drainage system of the area ,which serves as a water channel like the Epie Creek which serves as a source of water for most household usage living in that area [2] and also in the market area, in Etegwe most marketers use the water from the creek to watch their meat, vegetable leaf, plate, knife and others which is harmful to human health besides, the creek serves as dumpsite due to lack of site suitable for dumpsite in the city and individual use the creek for stooling which is a significant threat to life. The area from red to pink has a value of high altitude, showing that it can be used for flood relief centers and also suitable for government projects such as schools, hospitals, and others.

4. Conclusion

The study showed that all the soil samples contained various heavy metals such as Cd, Cu, Cr, Zn, Fe, Mn, Pb, Zn, and Ni. When analysis and compared with the background value it shows that soil 1,2,13,19, and 20 are polluted, and the presence of High-level heavy metals in the soil sample is appreciable contamination of the soil by leachate migration from the open dumping site. Which is confirmed to be accurate due to the only high level of heavy metals are found to be in the dumpsite. Soil 1,2,13 are close to Epie creek which serves as a major source of water for both individuals, and soil 19 is also close to River Nur which serve as of source water results from it show the Epie creek is polluted. Soil 20 is sounded by vegetation which could lead to unhealthy vegetation.

The estimated land use/land cover map is 410.61 Km^2, with a Built-up area of 156.80 km^2 with 23%, which is Urban Development in 2020, and the bare land is 35%.

The Terrain Modelling of the area is observed and found in the area has altitude from -14 to 37 m (Figure 2) which is relatively very low and the 3D modelling in Figure 10 also shows majority of the area are prone to flood including poor drainage network, and most of the drainage are all blocked including the water, i.e. stream in the area should not be used for drinking and watching household items due it serves as a dumpsite and individual stool on the creek. The area showed lack of environmental law for drainage channel protection [2] and lack of ecological law makes people build on drainage channels.

The Pearson correlation coefficients in Table 3 shows that 75% are Highly significant correlated, 14% are significantly correlated, and 10.71 % are non-correlated in soil samples. While Principal Component Analysis in Table 4 indicates two main sources of heavy metals in soil samples of 99.245 % of the total variance. The first principal component explained 80.324 %

of the total variance. The second principal component explained 18.922 % of the total variance, which are mainly loaded in Table 5. and Cluster Analysis was considered for heavy metal concentrations in surface soil samples in Figure. 4 and 5. shows the distance cluster represents the degree of association between sampling sites. Almost all the soil samples are more significant association.

Geostatistical and Geographical Information Systems (GIS)-based mapping technique applied in this study to predict the spatial distribution of metals across the study site. The GIS-based spatial distribution maps showed that the concentration of as Cd, Cu, Cr, Zn, Fe, Mn, Pb, Zn, and Ni are less in most of the soil samples, apart from soil samples 1,2,13,19 and 20 which are dominant in Akenfa, Etegwe and Swali areas are closer to the market with a larger number of migrations which serve as hot spot zone [10]. As a result, these metals can pose a risk to soil quality, human health, and the environment. This study provides useful information, on Urban environmental soil quality monitoring for Hydrology properties of the area, including heavy metal content in soil [14] for better strategies protection environment and life quality in urban areas.

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