Determination of Physicochemical and Some Heavy Metal of Soil around Dana Steel Industry Limited Katsina, Katsina State, Nigeria

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Abstract
The aim of this study was to investigate the physicochemical parameters and level of some Heavy metal concentrations in dumpsites soil around Dana steel limited dumpsite located in latitude 12º 57¹ 43¹¹N to 12º 58¹ 7¹¹N, Longitude 7º 37¹11¹¹E to 7º 37¹ 16¹¹E and altitude 522.5m to 616.6m in Katsina state of Nigeria were investigated in this research. Soil samples were collected from the dumpsite and control site at depths ranges 0-<10cm, 10-<20cm, 20-<30cm and 30-<40cm. The result of physicochemical parameters within the samples A, B, C,D and the control shows that there is a significant difference between contaminated and control soil. This is a clear indication of low moisture and organic matter content observed in the entire sampling site. For the heavy metals contents, Atomic Absorption spectroscopy (AAS) was used to obtain the composition and concentration of the six studied heavy metals (Zn, Cu, Cr, Co, Ni, and Pb). The Result obtained in this research showed that Pb had the highest concentration with the ranged average of 16.46-11.741mg/kg and Fe which has the lowest concentration with 0.219-0.379mg/kg. Statistical significant difference was observed between the mean of toxic metal concentration in the dumpsite and control area which suggested the effect of anthropogenic inputs, Therefore, the results indicated that the area under investigation was polluted with Cr, Fe and Cu withrespect to heavy metals content in contaminated soil and low Fe content with respect to the control soil. Some metals content investigated were above the US EPAstandard of heavy metals in soils that requires cleanup.

Keywords: Soil; heavy metals; Dana steel; environment; physicochemical.

INTRODUCTION
Increase industrialization, population growth, and complete disregard for environmental health have led to global environmental pollution (Avwin et al., 2014). Pollution is one of the most serious problems facing humanity and other form of life on earth now is environmental pollution (Inbome et al., 2014). The release of pollutants into the environment may occur accidentally or due to anthropogenic activities which ultimately results in soil, water, and air pollution, leading to many health hazards. Pollution of the natural environment by the heavy metals is a universal problem because these metals are indestructible and most of them have toxic effects on living organisms when permissible concentration levels are exceeded (Audu et al., 2016). Major environmental concern in the iron and steel industry in Nigeria is associated with the management of the industrial wastes generated in their different processes since it is becoming increasingly difficult for safe disposal of these volumes (Avwin et al., 2014). Human activity create wastes and it is the way this wastes are collected, handled, stored and disposed off that constitute risk to the public health and environment. the dumping of large amount of waste materials in sites without adequate soil protection measures results in soil surface and ground water pollution as well as degradation of abiotic and biotic components of the ecological systems (Inbome et al., 2014; Rahib et al., 2015 and Audu et al., 2016). The process of industrialization and continuous exploitation of earth resources for sustainable growth has depleted the non-renewable resources of the earth there by adversely affecting the environment. An integrated steel plant unit exhausts several harmful dusts, Fumes and substances that are quite injurious to human health, vegetation, crops, animals etc. such discharges contaminate and damage inland waters, environment, soil, food, human settlements and even plants and animals. Therefore, these wastes cannot be left uncared for and that is why threshold limits for such harmful substances have been fixed and industries are required to adhere to these norms.
Heavy metals through anthropogenic activities have been reported by various researchers (Rahib et al., 2015; Audu et al., 2016; Bello et al., 2015; and Zauro et al., 2017). The concentration of heavy metals in this dumpsite may be enhanced by bioaccumulation due to the presence of painted metals scraps and large volume of slags that were ubiquitous in the site. The main objective was to: Determine the physicochemical parameters of the contaminated and control soil and to determine the concentration of Chromium (Cr), Zinc (Zn), Lead (Pb), Iron (Fe), Nickel (Ni) and Copper (Cu) of the contaminated and control soil.

MATERIALS AND METHODS
Description of the Study Area
The study was conducted in Katsina, Northwestern region of Nigeria in April, 2015. Katsina town is bordered to the north-east by Kaita, Jibia and Batsari to the North-west, Batagarawa to south and Mani local Government Areas to the east (Kankia et al., 2014). It is located at 12.59° N and 7.36° E at an elevation of 464 meters above sea level. The mean annual maximum and minimum temperatures are 33.2°C and 18.7°C respectively and the average relative humidity is 60% with mean annual rainfall of 600 mm (Tomlinson et al., 2016).

Sample Collection
Soil sampling
Stratified random sampling method was used as follows; each sampling area (the four cardinal points) representative samples were collected randomly at a depth 0- <10cm, 10- <20cm, 20-<30cm and 30-<40cm from different dumping sites in the company, mixed and homogenized. The representative samples were obtained using cone and quartered method. The samples were transported to the laboratory for analysis in clean polythene bags (Adu et al., 2012). The sampling areas were labeled as A = North, B = West, C = South and D = East.

Sample Pre-Treatment
Soil was air dried for one week (7days). Foreign and non soil materials were removed and the soil was crushed using pestle and mortar, sieved via 1.5 mm mesh sieve.

Soil Digestion
One gram of each soil sieved soil was put in a digestion tube. 5 cm3 of conc. H2SO4, 1 cm3 of 60% HClO4 and 0.5 cm3 HNO3 were added to the sample. The digestion tube were placed in a block digester, heated to 105°C until a clear fumes was obtained. The digest was then flashed with distilled water and allowed to cool. After cooling it was filtered into a 50cm3 volumetric flask and diluted to the mark with distilled water (Zauro et al., 2017).

Soil Analysis
The filtrate was used for metals analysis using flame Atomic Absorption Spectrophotometer (AAS) Ahmad et al., (2014) and physicochemical parameters (pH, Organic matter, moisture and cation exchange capacity, Electric conductivity, exchangeable acids and mineral elements (nitrogen, potassium and phosphorus) etc were determined in Soil Lab. of Faculty of Agriculture, Bayero University, Kano.

Statistical Analysis
In this research, physicochemical parameters and heavy metals concentrations in the samples were computed using Analysis of Variance (ANOVA) with SPSS version 10.0 statistical packages. Also, test of significance difference of their means were determine by the Duncan’s Multiple Range Test DMRT (α=0.05) method (Ahmad, 2014). The statistical variations was considered significant at p<0.05. Comparison using t-test would also be carried out to detect any significant differences in metal concentrations between polluted and Control Site (Adu et al., 2016).

RESULTS
The results of the Physical parameters of soil obtained from the contaminated and control soils were presented in Table 1 while chemical properties of then soil samples were presented in Table 2, expressed as Mean ± Standard deviation of mean of triplicate analysis.In order to understand the level of difference between the parameters in contaminated and control area to ascertain the cause of the variation, the values obtained of A, B, C and in the target and control area were analyzed using Microsoft excel 2007 T-test (Pair two samples for means) at P<0.05 significance (one-tail). Result of the heavy metals analysis was displayed in figure 1 which showed that there is a significant difference in the means of Zn, Cu, Cr, Co, Ni, and Pb. The mean values from the four different sampling sites including the control soil showed that Pb had the highest concentration with the ranged average of 16.464-11.741mg/kg and Fe which has the lowest concentration with 0.219-0.379mg/kg. Using Duncan multiple statistical analysis of variance (ANOVA) there is significant difference between heavy metals in contaminated and control soils. The E.C value ranged from 1.648-1.071% mean and found to be very significant among all the samples treated samples). Therefore, this suggested that all the significant toxic metals concentrations can be attributed to the industrial activity.
Table 1: Physical Properties of the Soil samples used.

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>Texture class</th>
<th>Colour</th>
<th>%Carbon</th>
<th>Moisture content (%)</th>
<th>pH(H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>78.77²</td>
<td>15.82²</td>
<td>5.41²</td>
<td>S-L</td>
<td>BLK</td>
<td>2.05²</td>
<td>3.80²</td>
<td>7.18±0.03²</td>
</tr>
<tr>
<td>B</td>
<td>76.97²</td>
<td>13.77²</td>
<td>9.26²</td>
<td>S-L</td>
<td>BLK</td>
<td>2.01³</td>
<td>2.00²</td>
<td>7.10±0.20³</td>
</tr>
<tr>
<td>C</td>
<td>80.42²</td>
<td>11.11²</td>
<td>8.47²</td>
<td>S-L</td>
<td>BLK</td>
<td>2.14³</td>
<td>1.50³</td>
<td>7.11 ±0.30³</td>
</tr>
<tr>
<td>D</td>
<td>74.26²</td>
<td>15.77²</td>
<td>9.97²</td>
<td>S-L</td>
<td>BLK</td>
<td>1.45³</td>
<td>2.00³</td>
<td>7.10±0.09³</td>
</tr>
<tr>
<td>CTRS</td>
<td>65.40²</td>
<td>19.90²</td>
<td>14.70²</td>
<td>S-L</td>
<td>L-B</td>
<td>0.18³</td>
<td>1.00³</td>
<td>5.98±5.94³</td>
</tr>
</tbody>
</table>

*Values are expressed in percentage and Mean ±S.D in pH. Values having different superscript in the same column are significantly (p<0.05) different.

Key: A, B, C&D: Contaminated Soil, CTRS: Control Soil, S-L (Sandy-loamy); BLK (Blackish); L-B (Light brown).

Table 2: Chemical Properties of the Soil samples used.

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>N (%)</th>
<th>Organic Matter (%)</th>
<th>P (Cmol/mg/kg)</th>
<th>K (Cmol/kg)</th>
<th>Ca (Cmol/kg)</th>
<th>Mg (Cmol/kg)</th>
<th>Na (Cmol/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.20⁰</td>
<td>3.73±0.42⁰</td>
<td>31.55±1.35⁰</td>
<td>2.35±0.78⁰</td>
<td>4.46±0.50⁰</td>
<td>2.41±0.52⁰</td>
<td>0.94±0.79⁰</td>
</tr>
<tr>
<td>B</td>
<td>0.22⁰</td>
<td>2.75±1.07⁰</td>
<td>27.37±5.77⁰</td>
<td>3.00±1.31⁰</td>
<td>5.14±0.46⁰</td>
<td>1.51±0.72⁰</td>
<td>0.92±0.07⁰</td>
</tr>
<tr>
<td>C</td>
<td>0.28²</td>
<td>5.82±0.28⁴</td>
<td>22.62±1.97⁰</td>
<td>2.48±0.58⁰</td>
<td>1.97±1.19⁰</td>
<td>1.88±0.95⁰</td>
<td>0.27±0.25⁰</td>
</tr>
<tr>
<td>D</td>
<td>0.18⁰</td>
<td>4.22±0.85⁵</td>
<td>23.59±10.20⁰</td>
<td>2.10±0.55⁰</td>
<td>3.22±1.26⁰</td>
<td>1.13±0.12⁰</td>
<td>0.19±0.06⁰</td>
</tr>
<tr>
<td>CTRS</td>
<td>0.03⁵</td>
<td>0.29±0.05⁵</td>
<td>14.76±0.96⁵</td>
<td>0.04±0.01⁵</td>
<td>1.12±0.11⁵</td>
<td>0.72±0.25⁵</td>
<td>0.01±0.01⁵</td>
</tr>
</tbody>
</table>

Mean ±S.D. Mean values having different superscript in the same column are significantly (p<0.05) different. A, B, C&D: Contaminated Soil, CTRS: Control Soil.

Table 3: Cation Exchange Capacity of the soil and Exchangeable ions in the Soil Samples.

<table>
<thead>
<tr>
<th>Soil Sample</th>
<th>CEC (%)</th>
<th>E.A(Cmol/kg)</th>
<th>EC (dS/m)</th>
<th>pH (CaCl2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.76±2.66⁵</td>
<td>0.61±0.24⁴</td>
<td>1.65±0.51⁴</td>
<td>6.77±0.15⁵</td>
</tr>
<tr>
<td>B</td>
<td>12.25±3.55⁵</td>
<td>0.74±0.45⁵</td>
<td>1.52±0.4⁴</td>
<td>6.33±0.74⁵</td>
</tr>
<tr>
<td>C</td>
<td>6.98±2.66⁶</td>
<td>0.37±0.06⁵</td>
<td>1.07±0.18⁴</td>
<td>6.43±0.47⁵</td>
</tr>
<tr>
<td>D</td>
<td>6.99±3.36⁸</td>
<td>0.36±0.14⁵</td>
<td>1.58±0.36⁴</td>
<td>6.30±0.17⁵</td>
</tr>
<tr>
<td>CTRS</td>
<td>2.94±0.32⁶</td>
<td>0.71±0.06⁵</td>
<td>0.08±0.01⁴</td>
<td>5.69±0.15⁵</td>
</tr>
</tbody>
</table>

*Values are expressed as Mean ±S.D. mean values having different superscript in the same column are significantly different (p<0.05). A, B, C&D: Contaminated Soils, CTRS: Control Soil.

Figure 1. Showing Heavy metals concentration in soil samples.

DISCUSSION

Observation from this study shows that there were little variations in physicochemical parameters. The physicochemical properties of the treated soils in this study indicated that contaminated dumpsite soil has poor nutrient content due to the highly industrial waste composed by soil which differs with the control soil in all the parameters of the findings. The pH value of the soil in water and pH value in acid are varied with the value in sample A, B, C and D which indicated that the soil in the entire samples site and in control soil were mildly basic and slightly acidic soil in nature. pH is one of the most important parameter that serve as an indication for nature. pH is one of the most important parameter that serve as an indication for

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The level of Zn in such samples is however within the range recommended by EPA. Fe though high above WHO safety standard, it is still safe because it has benefits to organisms though in very high concentration leads to conjunctivitis, chroiditis and retinitis if it is in contact and remains in the (Rahib et al., 2015). Its presence in any compartment of the terrestrial ecosystem indicates contamination. Concentrations of metals were low in contrast to higher when compared to other polluted. (Kankia and Abdulhamid, 2014) According to the WHO, the maximum allowable limits for metals in soil should not exceed their unit depending on the metals, for, Zn (10), Cr (1.3), Fe (0.02), Ni (10) and Cu 0.1 and Pb (10) mg/kg, excess of essential metals are highly toxic. The high level of these metals in the soil are as a result of the dumping of industrial, domestic wastes and other reasonable factors in the environment at different points are known to contain heavy metals such as As, Cd, Co, Cu, Fe, Hg, Mn, Pb, Ni, and Zn which will eventually end up in this aquatic ecosystem.

CONCLUSION
This research presented data on the Physicochemical and levels of heavy metals contents from dumpsites soil around Dana Steel Company Katsina. The results obtained showed that the soil of the study area is basic/alkaline and of low fertility. Other parameters such as CEC, E.A, E.C, pH (H2O and CaCl2), Na, K, Ca and Mg ions etc. were low in the soil. Likewise, the results of heavy metals showed that all the metals analyzed were present in samples A, B and C, D and the control. The Pb was found high. The amount of metals obtained in this work showed that the area was polluted with heavy metals. These heavy metals can cause environmental problems in ecosystem of the area due to the release of toxic metals from the contaminated soil to the ground water system and also in the plants grown in the soil. This alarming situation should be regularly monitored for health related problems in the inhabitants of the area. It is therefore strongly recommended that Phyto and bio-remedial measures be considered by appropriate authorities in order to minimize the extent of accumulated pollutant.

Recommendations
1. Public enlighten campaign on danger imposed by heavy metal pollution in to the environment for safety alternate disposal especially people residing and farming around the industry
2. Secondly, Phyto and bio-remedial measures to be considered by appropriate authorities in order to minimize the extent of accumulated pollutant.

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United Environmental Protection Agency (USEPA) on Guidelines and Standards for heavy metals.
