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Physicochemical Characteristics of Soil and Water in Electronic Waste Dump Site, Alaba Lagos, Nigeria

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Abstract

Determination of physicochemical characteristics of soil and water adjoining dumpsites is important to ascertain the fitness of drinkable water and their public health implications. Following the paucity of information on this area of study, physicochemical characteristics of water and soil in electronic waste dump site, Alaba, Lagos, Nigeria. Six samples from the dumpsite made up of three soil and water respectively were collected and extracted using USEPA methods. One soil and water sample far from the dumpsite served as control. Physicochemical parameters of water and soil samples were determined using standard methods. Results show that pH of the water samples ranged from 4.81 to 7.30. SW1 had highest pH (slightly alkaline) while SW3 had lowest pH and was acidic. The electrical conductivity of SW1, SW2 and SW3 ranged from 61 μS to 1421 μS respectively. Water temperature was between 29.53 and 29.57^{o}C. Total dissolved solid of the water ranged from 32.33 to 722 mg/L. Sulphate ranged from 238 mg/L to 314 mg/L. Phosphate ranged from 41.92 to 60 mg/L. Dissolved oxygen ranged from 0.93 to 2.4 mg/L. Similarly, soil pH ranged from 6.57 to 7.44. Soil temperature ranged from 28.43 to 30.7. Soil organic carbon ranged from 13.75% to 20.25% while the soil organic matter ranged from 17.88% to 26.32%. Soil particle distribution ranged from 58.56 – 87.52% sand, 3.22 – 13.79% clay and 8.84 – 27.65% slit. Some physicochemical characteristics of soil and water in sampled location did not follow the WHO standard. This study has informed the state of water available for consumption as well as the state of soil contamination. Proper care is required to checkmate this location to avoid future contaminations.

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1. Introduction

Electrical and electronic equipment (EEE) of all kinds and their individual components that have been dumped as waste by the owner with no intention of being reused are collectively referred to as ”e-waste” [1]. E-wastes are also known as waste electrical and electronic equipment (WEEE) or e-scrap in various locales. In the past three decades, huge amounts of electronic garbage have been discarded, and it is clear that this, along with its environmentally responsible management, is without a doubt one of the major environmental challenges of the twenty-first century. This activity of improper deposition is worldwide issue which is affecting both industrialized and developing nations [2]. E-waste is unique in that it contains both hazardous substances such as cadmium, lead, mercury, and persistent organic pollutants like polychlorinatedbiphenyls (PCBs), and precious metals such as gold, silver, and rare earth metals. The mismanagement and improper deposition of these waste could induce some irrevocable health and environmental issues. There is various route of exposure to hazardous compounds; inhalation of fumes, skin contact, and conftact through mouth and other parts. These exposure pathways can result in toxic metal accumulation in the body, which is dangerous to human health [3]. The unregulated discharge and poor recycling of e-waste has significantly increased environmental contamination. Because of the existence of this unregulated recycling industry, e-waste is frequently handled carelessly and the risks associated with it are not always understood [4]. Nigeria’s e-waste generation is by far the highest in all of West African Countries [5]. Currently, Nigeria imports sizable amounts of Used electrical and electronic equipment (UEEE) combined with E-waste each year. The majority of imported electronics are broken due to failed transporting system, thus creating significant difficulties in their management [6].

A questionnaire used in similar study by [7] in Alaba revealed that the majority of the three sources of water used in the study area are deep wells. A quarter of the participating population relied on water from a borehole, and three-quarter depended on wells. Residents in Alaba drink water from boreholes and sachets, but because the water table is so shallow (about 6 feet), it is simple to access water, making it easier for heavy metals to seep into the underground water supply. These residents equally use the water from the well for washing, cooking, bathing, and other household tasks. There are limited pipe-borne water in Alaba and this is extremely hazardous to people’s health and well-being, since they are exposed to soil contaminants through gained access. According to observations by [7], 98% of the respondents are having trouble inhaling and seeing due to burning operations of e-waste scavengers to extract different sorts of metals for money. Poor vision, asthmatic symptoms, persistent coughing, various respiratory illnesses, and heat rashes are the direct consequences of constant exposure and window closure. Due to the inadequate management and unfavorable consequences of the e-wastes dump activities, 80% of the residents of the Alaba Rago community contemplate leaving their homes in search for a better habitant. However, some people are accustomed to the activities of this environment, so leaving is not an option.

Awareness of the negative impact of e-waste dump on their underground water is known by majority. However, only 20% of the respondents acclaimed they are unaware, and 6% are unsure because they are unsure of how the waste water leaving the dump site can affect them. Seven-four percent (74%) of the respondents confirmed that the surface and ground water are contaminated. Diarrhea, nausea, vomiting, eye discomfort, malaria, and typhoid fever were all extremely common. At such e-waste dump sites, these were the prevalent environmental and health issues. The combustion of e-waste to recover copper by scavengers, according to a sizable portion of participants, may have contributed to people developing asthmatic symptoms and other respiratory illnesses. A few respondents also mentioned that they had recently noticed an increase in the number of sudden deaths. These deaths were mostly shop owners, and the cause was mostly found to be high blood pressure, though some respondents also connected the deaths to fetish acts. However, the cause may actually be the buildup of heavy metals in their bodies.While some women were reported to have miscarriages on occasion, this might possibly be strictly associated to the buildup of heavy metals in their blood [7]. According to [8], PCBs on the other hand are a group of non-polar dangerous chemical compounds that consist of 209 congeners, only 130 (di-deca-PCBs) of which are found in commercial combinations. They are organic compounds that are water soluble and have 1 to 10 chlorine atoms connected to the biphenyl molecule, which is made up of two benzene rings and has the chemical formula $C_{12}H_{10}$-xClx, where x ranges from 1 to 10. They are also organic pollutants that are persistent, meaning that their effects linger long after use. They are frequently used and put to use in dielectric fluids for things like transformers, capacitors, coolants, and other uses in agriculture. In all parts of the world, they have been found in a variety of environmental compartments, which includes biota (fish as well as other benthic organisms), soil, water, air, sediment, plants, and animal tissue.

Seven congeners have been reported by the ICES (International Council for the Exploration of the Sea) monitors, namely CB-28, CB-52, CB-101, CB-118, CB138, CB-153 and CB-180, serve as the primary indicator PCBs [9] .The concentration of PCBs in sediments, water, leachate, and aquatic fauna (*Tilapia guineensis*, *Callinectes amnicola*, and *Cardiosoma armatum*) found in and around e-waste dumpsites in Lagos South-West, Nigeria, according to [10]were examined, using Gas Chromatography Electron Capture Detector (GC ECD) Agilent 7820A. All 28 PCB congeners under investigation were found. Lagos has the highest quantities of PCBs in sediment, fish gill, fish muscles, water, crab, and leachate. The amount of total indicator PCBs (7PCBs) in the sediment from Lagos (4.19 g/kg) was higher than both the National Oceanic Atmospheric Administration Threshold Effect Level (NOAA TEL) for marine and freshwater sediments and the Canadian Sediment Quality standard threshold effect level (CSQ TEL) (0.03 g/kg). Fish from Lagos has a computed Toxic Equivalent Quotient (TEQ) of 3.7, which points to the likelihood of negative effects on humans who ingest the fish [10]. Due to the constant deposition, increased use of electronic and electrical devices in the area, and the health and environmental risks it has created for the general public, it is crucial to further investigate the level of other PCB congeners, specifically in the dumb-sites surrounding the Alaba market. Studying the amount of PCBs in electronic waste from this region will not only help the government create regulations on the import, improper handling, and disposal of wastes, but it will also help raise public awareness of the effects of improper handling of electronic waste and encourage recycling and reuse of such wastes rather than improper disposal. Studies on the physicochemical parameters in soil and water in Alaba Lagos is lacking. In order to motivate public health intervention, this study aims to link the physicochemical properties of the dumpsite with the heavy metal composition.

also tends to display the quality of the drinking water at the dump site as well as the soils around for any potential accumulation of heavy metals in food crops.

2. Materials and Methods

2.1. Study Area

The study for the determination of physicochemical parameters of electronic waste dumpsites was carried out in Alaba, Lagos State, Nigeria. It is located in Ojo local government of the state. It is Nigeria's biggest electronics market. The market also engages in the repair of household appliances in addition to the sale of electronic goods. Electronics and electrical experts that specialize in the repair of broken home appliances have opportunities to conduct business with electronics dealers. Alaba is a known site for the deposition and burning of several electronic wastes such as television, radio and electronic plastics. This dumpsite is very close to Alaba market and drinking wells that service residents of Alaba. The dumpsite is located on longitude 3.11°E and latitude 6.28°N. Shrubs and vegetables grow along the dumpsite region. Children and adults are found roaming around and living in this sites in search of recyclables. Sometimes, children play on the soil around the study area to carry out their daily activities. Households in this dump sites live there in order to sort some recyclable deposited electronic wastes and burn undesirable wastes. Sample collection was done during the dry season. Every day, an estimated one million people transact business at the packed Alaba market. The market occupies a land area of approximately two kilometers by one kilometer on the Ojo Igbede road. The market can be accessed from Badagry on Badagry-Oshodi express way through Iyana Iba, and can also be reached from any part of Lagos via Mile 2/Festac Town. The market is also very popular because it is on the international boarder road leading to Seme and Ghana road. This informed the need to ascertain the healthiness of humans to live in close proximity to thus dump site through physicochemical parameter determination. For the purpose of this study, three wells were mapped out and selected (WS1-3) for water sample collection, soil samples point (SS1-3) were equally mapped within the dumpsite in Alaba for soil sample collection (Figure 1). Soil and water samples for control location was equally mapped.

2.2. Soil Sample Collection

The soil of the dumpsite was taken using an auger. The top soil (0 – 15cm) and the sub soil (15 – 30cm) was collected in four different locations of the sampling site. Soil samples were collected from six (6) reference points including three (3) top soil samples and three (3) sub-soil samples. Materials like plants roots, leaves, gravels and other irrelevant materials was manually removed. A total of 8 sub samples of the electronic wastes dumpsite soil was taken. One sample of soil was taken far off from the dumpsite and served as control for the assessment. The distance between each sample points were considerably far apart so as to gather samples that are fully representative of the whole.

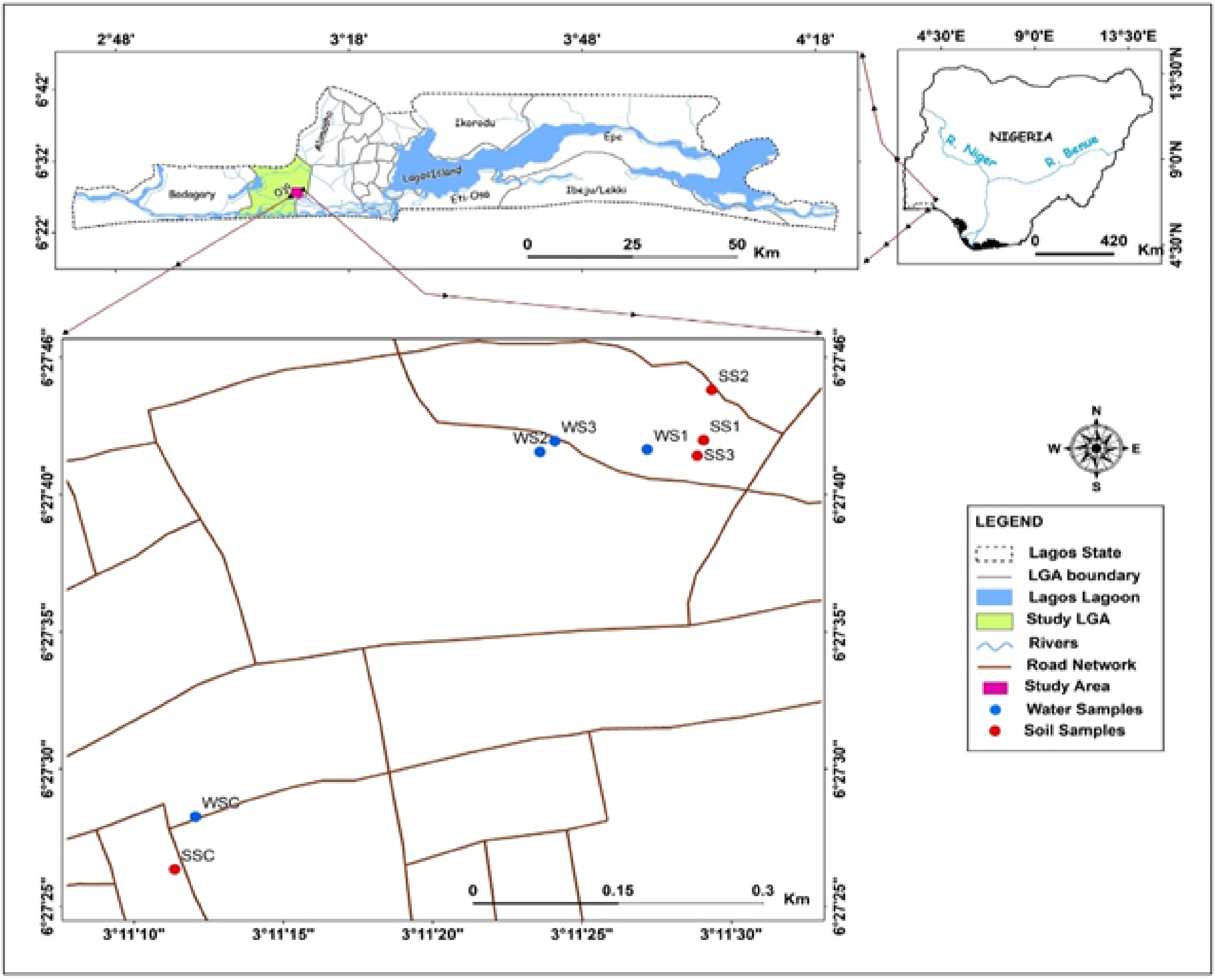

Figure 1. Map of the study area showing sampling sites. **Legend:** points with WS signify water samples

2.3. *Water Sample Collection*

Similarly, three (3) wells close to the dumpsite were selected. Samples were obtained using prewashed amber bottle that were rinsed with the water sample before collected through the tap or drawing from the well. Control samples were taken from neighbouring wells that is a farther away from the sampling sites.

2.4. *Physicochemical analysis of the Soil*

The soil samples collected from the field was used to determine some physicochemical parameters such as hydrogen ion concentration (pH), electrical conductivity (EC), soil organic carbon (SOC), and soil moisture content (SMC).

2.4.1. *Hydrogen ion concentration (pH)*

This was done according to the procedures of [11]. 20 mL of distilled water was added to 20 g of soil in a 50-mL beaker, covered, and set aside. The suspension was stirred for 5 minutes. The soil suspension was allowed to sit for approximately 1 hour to allow much of the suspended clay to settle out, or filter or centrifuge the aqueous phase for pH testing. Afterward the pH meter is inserted to obtain the pH readings.

2.4.2. Electrical Conductivity (EC)

Electrical conductivity was done according to the procedure of [11]. Soil samples (10g) was dried and sieved with a 2mm sieve. The soil samples collected in each area were weighed into different labeled containers using a weighing balance, 20ml of distilled water was added to the labeled plastics, and the sample solutions was placed on a mechanical shaker. The sample was shaken for 30 minutes to achieve complete dissolution and thorough mixing in order to aid the release of acidity from the soil micelle into the partially settled suet. The resulting solutions was poured into a clean, dry beaker, and an EC meter was used to determine electronic conductivity.

2.4.3. Soil Organic Carbon and organic Matter

The procedure of Walkey-Black was adopted [11]. 1g of 0.5mm sieved sample soil was weighed into a conical flask using a weighing balance, and 10ml of potassium dichromate ($K_2Cr_2O_7$) was applied using a measuring cylinder. 20ml of concentrated sulphuric acid (H_2SO_4) was added to the samples which resulted in an exothermic reaction. The solutions were allowed to cool in a ventilated environment. Each solution received 100mL of distilled water, resulting in heat generation. The solution was allowed to cool before being used. With three drops of ferroin indicator as the indicator, these samples were titrated against Ferrous Sulphate solutions (0.5N) until a maroon color end point was observed. The blank titration was carried out at the beginning without soil. The percentage organic carbon and organic matter was calculated using the formula below;

$$\%\ Organic\ Carbon\ =\ B\ --T\ \ Weight\ of\ the\ soil\ X\ 0.1995 \tag{1}$$

Where B = Titre Value of Blank

T = Titre Value of Sample

$$\%Organic\ Matter\ =\ \%Organic\ Carbon\ X\ 1.729 \tag{2}$$

2.4.4. Soil moisture content

The gravimetric method (1959) was used to determine the weight of wet soil sample in the jar. The sample and container were dried in an oven for 24 hours, and the weight of the dry soil sample was determined.

The water content of the soil (ω, in percentage) is obtained from the relation

$$\omega = \frac{W_2 - W_3}{W_3 - W_1} \tag{3}$$

W_1 = weight of container

W_2 =weight of container + weight of moist soil

W_3 =weight of container + weight of dry soil

2.4.5. Particle Size Analysis

The Bouyoucous Hydrometer method of [11] was used to determine particle size distribution. The soil samples was air dried and sieved with a 2mm diameter mesh sieve before being weighed into a beaker with a weighing balance. Each sample received a calgon solution (Sodium hexametaphosphate) that was left to spread for 24 hours. The dispersed calgon oiled sample was moved into a 1000ml measuring cylinder and rendered up to 950ml with distilled water after this time span. The soil hydrometer and thermometer were used to take the first reading after 40 seconds to obtain H_1 and T_1. The measuring cylinder containing the soil mixture was allowed to stand for 2 hours to determine H_2 and T_2. The particle size distribution was calculated using the equation below;

$$\%\ Sand = 100 - (H_1 + 0.2(T_1 - 68) - 2.0)2 \tag{4}$$

$$\%\ Clay = (H_2 + 0.2(T_2 - 68) - 2.0)2 \tag{5}$$

$$\%\ Silt = 100 - (\%Clay + \%Sand) \tag{6}$$

2.5. Physicochemical Analysis of the Water

Some physicochemical analysis such as hydrogen ion concentration (pH), electrical conductivity, sulphate, phosphate, total suspended solids, total dissolved solids, dissolved oxygen and biochemical oxygen demand was done after collection of the water sample from the field. Multiple analysis pen device was used.

2.5.1. Hydrogen ion concentration (pH)

The pH of water samples was measured in situ with the aid of pocket sized pH meter (Hanna Combo). The pH meter was kept in moderate motion in the water sample during which the values were collected when the meter has stabilized after a few minutes, according to [12].

2.5.2. Electrical Conductivity (EC)

Multiple analysis pen device that reads for conductivity was kept in moderate motion in the water sample during which the values are collected when the meter has stabilized after a few minutes, according to [12]. The measurement is made 10cm below the surface of the water. The multiple analysis pen device was used to determine pH, temperature, EC and TDS in situ.HH

2.5.3. Sulphate

Titration method was used. A pipette was used to measure 10ml of water into a 25ml standard volumetric flask. 5ml of the conditioning reagent was added to the water sample on its own. A vortex mixer was used to completely mix 1g of Barium chloride into the liquid. According to [13], the study was performed using a UV-VIS Spectrophotometer at a wavelength of 425nm.

2.5.4. Phosphate

Titration method was used. The method developed by [14], was used to determine phosphorus. In a 50ml standard flask, 25ml of water sample was measured, followed by 10ml of vanadomolybdate. The mark was then filled with distilled water and measured using a UV-VIS spectrophotometer.

2.5.5. Total Suspended Solids (TSS)

TSS were calculated using the APHA's recommended procedures. To eliminate interaction with the ambient air and moisture, wet filter paper was oven dried for 30 minutes before being removed and placed in the dessicator. After weighing and recording the dried filter paper, it was transferred to the oven for another 20 minutes and weighed again. Using the already dried and weighted filter paper, about 50ml of the water sample was carefully filtered into a conical flask. The complete suspended solid, which was suspended on the filter paper, was dried in the oven for additional 30 minutes and weighed.

$$TSS\left(\frac{mg}{L}\right) = \frac{Final\ Weight - Initial\ Weight}{Sample\ volume} \times 1,000,000 \tag{7}$$

2.5.6. Dissolved oxygen (DO)

The Azide-Winkler method was used to determine dissolved oxygen. Manganese sulphate ($MnSO_4$) solution (2ml) and 2ml of alkali-iodide-azide reagent were added to the water samples collected in amber bottles, according to the procedure provided by [13]. The reagents were added well below the liquid's surface, and the stopper was carefully put to avoid air bubbles. The combination was stirred by repeatedly tilting the bottle until clear supernatant water was obtained, then allowed to settle for 2 minutes. When the bottle arrived at the laboratory, 2ml of concentrated H_2SO_4 was added and the oxygen was liberated by allowing the acid to flow down the neck of the bottle. Covered, the bottle was inverted gently until the dissolving was complete. A 50ml sample of water was taken and poured into a conical flask. The solution turned blue-black after 2ml of starch solution indicator was added to it. It was then titrated with 0.025M sodium thiosulphate drop-by-drop until the blue color faded and the endpoint was colorless.

2.5.7. Biochemical oxygen demand (BOD_5)

According to [13], 10ml of the water sample was measured into each BOD container and diluted with distilled water before placing the glass stopper over the BOD bottles. After five days in a dark cabinet, 2ml of manganese sulphate solution and alkali-iodide-azide reagent were pipette to the samples in each BOD vial, and bubbles were avoided. It was set down to allow for complete reaction time. The contents were extensively agitated by turning upside down after a floc settled at the bottom. A pipette was used to add 2ml of concentrated sulphuric acid above the sample. To dissolve the floc, the stopper was put and inverted multiple times. 50 mL of the solution from the bottle

Table 1. Physicochemical analysis of water samples

Parameters	SW1	SW2	SW3	WC	WHO (2011)
Ph	7.30 ± 0.04	6.14 ± 0.04	4.81 ± 0.05	7.11 ± 0.01	6.5–8.5
EC (μs)	1141.33 ± 4.10	61 ± 1.53	1421.33 ± 7.62	118.33 ± 5.81	< 400
Temp (^{0}C)	29.57 ± 0.44	29.53 ± 0.52	29.17 ± 0.44	26.87 ± 0.12	25 – 50
TDS (mg/L)	573 ± 4.04	32.33 ± 1.45	722.33 ± 4.91	28.67 ± 0.88	60 - 900
TSS (mg/L)	750 ± 144.34	148.33 ± 7.26	141.67 ± 4.41	1150 ± 57.74	< 500
Sulphate (mg/L)	238.99 ± 0.38	314.84 ± 0.52	241.77 ± 0.19	345.43 ± 5.86	250
Phosphate (mg/L)	41.92 ± 0.49	42.28 ± 1.58	60 ± 1.83	47.26 ± 0.47	0.1
Dissolved Oxygen (mg/L)	0.93 ± 0.07	1.13 ± 0.07	2.4 ± 0.00	2.23 ± 0.03	5 – 6

was transferred to a conical flask, 5 drops of starch solution indicator was added, and the solution was titrated against standard sodium thio sulphate until it reached a colorless endpoint.

BOD_5 (mg/L) = DO – DO_5

DO is the initial DO of the sample

DO_5 is the DO of the sample after the fifth day.

3. Results and Discussion

3.1. Physicochemical Analysis of Water Samples

Physicochemical characteristics of water samples had several ranges as shown in Table 1. Hydrogen ion concentration (pH) of water samples was between 4.81 and 7.30. The pH in the water sample from sample point 1 (WS1 as shown on the map) was slightly alkaline and recorded the highest pH. The water samples from point 3 (WS3 as shown on the map) had lowest pH and was acidic. Electrical conductivity of SW1, SW2 and SW3 was between 61 μS/cm and 1421 μS/cm. This study was aimed to determine the contamination status of soil and water in the various sample loci in order to ascertain if it follows World Health Organization (WHO) agreeable standard. It was observed that some parameters of water violated the standard by WHO. [14] ascribed electrical conductivity (EC herein) to the measures of ionic process of a solution that enables it to transmit current. With reference to WHO standards, EC value of any sample is not expected to exceeded 400 µS/cm. The finding of this study show that electrical conductivity recorded in SW1 and SW3 exceeded recommended WHO standard. However, the conductivity recorded in SW2 was within WHO standard. The ECs recorded in this present study were higher than that of [14], which averaged 192.14 µS/cm. The EC values of water samples collected from SW1 and SW2 were highly ionized and had significantly higher level of ionic concentration activity.

Temperature of the water was between 29.53 and 29.57^{o}C. According to WHO standard, water temperatures ranged from 25–50 °C, in order to prevent the growth of organisms. The water temperature in this study were found to be safe because they were within WHO acceptable range.

The values of total dissolved solid of water was between 32.33 and 722 mg/L. SW3 had the highest dissolved solid compare to the other water samples analyzed. The palatability of drinking- water had been rated excellent when TDS is <300 mg/L; good when TDS is between 300 and 600 mg/L; fair when between 600 and 900 mg/L; poor when between 900 and 1200 mg/L, and unacceptable when > 1200 mg/L. Sulphate recorded in this study was between 238 mg/L and 314 mg/L. Sulphate recorded in SW2 was higher than WHO limit of 250mg/L, but those recorded in SW1 and SW3 were within the limit. Sulphate is generally non-toxic. However, drinking water containing high amounts of magnesium sulphate or sodium sulphate may lead to intestinal discomfort, diarrhea and consequent dehydration, especially drinking water containing above 500 mg/L of sulphate [15]. Phosphate recorded in this study was between 41.92 and 60 mg/L. The water samples in this study were higher than WHO permissible limit of 0.1 mg/L for fresh water and this shows that the waters in this study were very rich in phosphate. Dissolved oxygen recorded in this study was between 0.93 and 2.4 mg/L. The dissolved oxygen of water in this study was below the concentration of 5 – 6 mg/L with reference to WHO standard.

Table 2. Physicochemical Parameters of Soil Samples

Parameters	**TS1**	**SS1**	**TS2**	**SS2**	**TS3**	**SS3**	**TSC**	**SSC**	**WHO (2014)**
pH	7.33 ± 0.06	7.39 ± 0.05	6.88 ± 0.07	6.57 ± 0.03	7.33 ± 0.06	7.44 ± 0.04	6.59 ± 0.062	6.75 ± 0.02	6.0 – 7.0
EC (μs)	>3999 ± 0.00	>3999 ± 0.00	>3999 ± 0.00	>3999 ± 0.00	>3999 ± 0.00	>3999 ± 0.00	80 ± 1.15	65.33 ± 0.88	110 – 570
Temp (^{0}C)	29.3 ± 0.55	30.7 ± 0.42	28.43 ± 0.64	30.43 ± 0.55	29.3 ± 0.55	28.87 ± 0.69	27.57 ± 0.03	27.23 ± 0.03	18 – 24
TDS (ppm)	>2000 ± 0.00	>2000 ± 0.00	>2000 ± 0.00	>2000 ± 0.00	>2000 ± 0.00	>2000 ± 0.00	42.33 ± 0.88	32.33 ± 1.45	-

3.2. Physicochemical Analysis of Soil Samples

The soil pH recorded in this study was between 6.57 and 7.44 [16] referred alkalinity to the measure of saline or saltiness of soil. Soil pH less than 6.0 is considered acidic; soil pH between 6 and 8.5 is normal; and pH greater than 8.5 is alkaline. The soil samples from all locations were found to be normal and was between the ranges of 6 to 8.5 [16]. The pH of water was in line with those reported in the study of [17], when mosquitoes were exposed to grounded powders of some potential plants. According to WHO standard, soil pH below 5.6 is considered low for most crops. Generally, the ideal pH range is between 6.0 and 7.0. TS2 and SS2 were within the recommended pH standard while the remaining samples (TS1, SS1, TS3 and SS3) were slightly alkaline in nature. Liming is a common method to increase pH.

The electrical conductivity recorded in TS1, SS1, TS2, SS2, TS3, and SS3 were greater than 3999 μS/cm. This indicates that the soil samples have electrical conductivity that exceeds the instrument's limit and shows higher electrical conductivity. The conductivity value represents the number of ions present in the soil sample. Optimal EC levels in the soil therefore is from 110-570 μS/cm. The finding of this study shows that EC of the soil samples exceed WHO standard. This shows that the soil samples were highly saline in nature. The cations of the clay/colloidal matter were exchanged in equal amounts with the cations of the soil and salt solutions during this process. Cation exchange is the process of cation exchange between soil and salt solution. Anions such as CO_3, HCO_3, PO_4^{3-} and cations such as Ca^{2+}, Mg^{2+}, Na^+, K^+. The conductivity levels of soil might vary depending on its chemical composition. EC less than 4 show that the soil type is normal.

Temperature of the soil was between 28.43 and 30.7. Ideal soil temperatures for planting most crops falls between 18 and 24^{o}C. The water temperature recorded in this study corroborated those reported in the study of [18]. This shows that the soil in the location of this study were not ideal for planting. The total dissolved solid for all the soil samples were greater than 2000ppm. This shows that the readings exceeded the limits of the instrument used to determine the total dissolved solid. Not all parameters of the soil samples followed WHO standard as observed in the study of [19].

3.3. Soil Organic Carbon and Soil Organic Matter Analysis

The soil organic carbon ranged from 13.75 to 20.25% while the soil organic matter ranged from 17.88 to 26.32% (Figure 2). The analyzed soil organic carbon in this present study was lower than that recorded in the study of [20] where mean percentage of soil organic carbon was 66 and 70% for surface and deep layers of soil. The soil organic matter was equally greater than that recorded in the study of [21] where soil organic matter ranged from 3.2 to 5.3%. [22], showed that organic matter is an important factor of the soil that contributes to soil fertility. Even the study of [23], confirmed the contribution of phosphate to soil due to biologic activities related to the soil chemistry. Soil organic carbon is the basis of soil fertility. It releases nutrient for plant growth, and increases soil organic carbon that improves soil health and fertility. The organic carbon content for dry land agricultural soils is between 0.7 and 4%, although soil organic carbon can be as low as 0.3% for desert soils and as high as 14% for intensive dairy soils. The analyzed soil samples could be classified as an intensive diary soil. [23] opined that the organic compounds of the soil are paradigm for soil fertility and maximum agricultural food production. This view was supported by the study of [24].

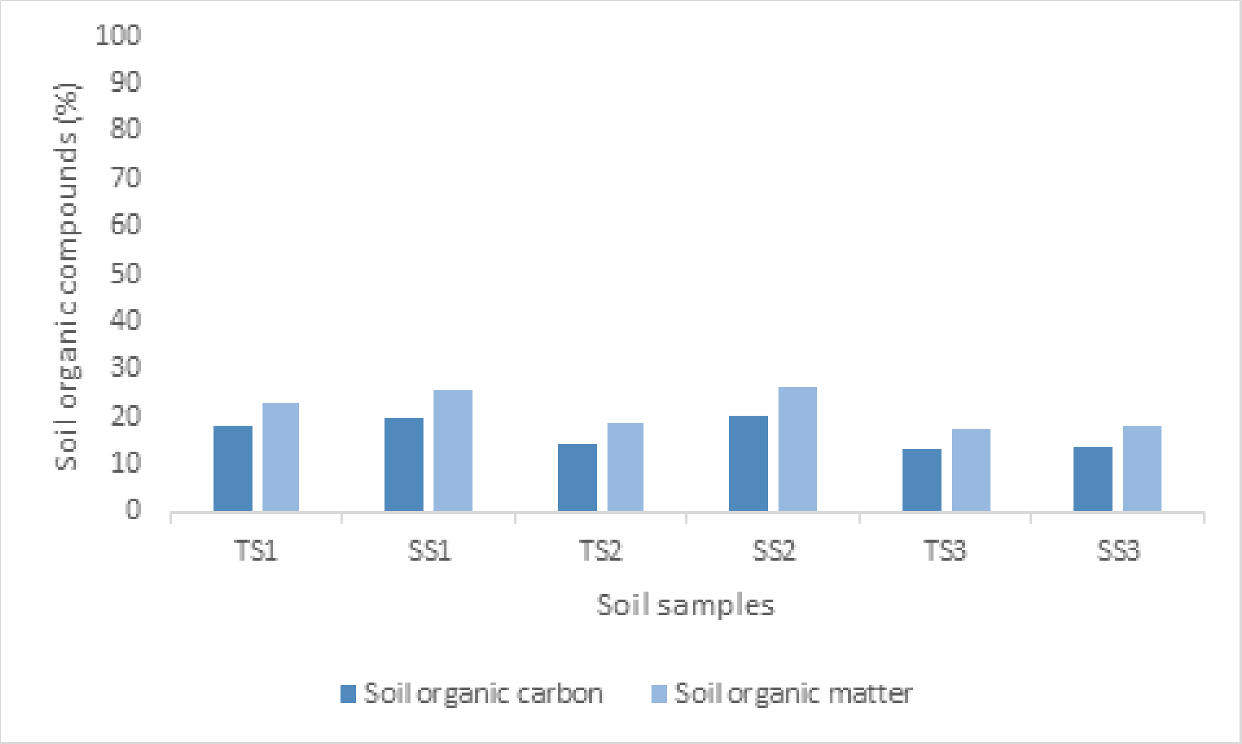

Figure 2. Soil organic carbon and soil organic matter analysis. **Legend:** TS means top soil and SS means subsoil

3.4. Particle Size Distribution

The distribution of soil particles in this study was between 58.56 and 87.52% (sand), 3.22 and 13.79 (clay), and 8.84 and 27.65% (slit) (Figure 3). The percentage of slit was greater than that reported in the study of [25], where soil particle distribution ranged from 2 to 8% silt. TS1, SS1, SS2 and SS3 recorded in the present study were within the results obtained by [25] that recorded 8% – 17% clay. SS3 and SS2 had high percentage of clay, indicating soil with adequate water holding capacity and water logging capability. All samples except SS3 were within the results obtained by [25] that recorded soil particle size distribution ranged from 76 to 86% sand. This demonstrates that the soil in Alaba region is coarse, with a poor supply of nutrients and moisture, a high erosive capacity, low infiltration, and a high degree of run-off, and hence is particularly prone to gully erosion. This fraction of sandy soil shows that in contrast to fine texture soil, sandy soil has considerable water holding capacity, good aeration, and a strong nutrient supply. The soil has a high sorption capacity for ions and heavy metals because of its sandy texture.

4. Conclusion

This study has shown that physicochemical characteristics of water associated with these dumpsites were high and exceeded WHO limits for water suitability for consumption. The electrical conductivities were considerably high in all the soil samples compare to the electrical conductivities for water samples. The pH of some water samples were slightly alkaline in nature with SW2 been slightly acidic while SW3 been more acidic. The findings suggest that by using this study as a template for future research, food poisoning and the associated bioaccumulation in food can be avoided. This study's potential implications include the need for additional research to ascertain whether local residents may have heavy metal accumulations. In an effort to ensure that metallic toxins are never tolerated,

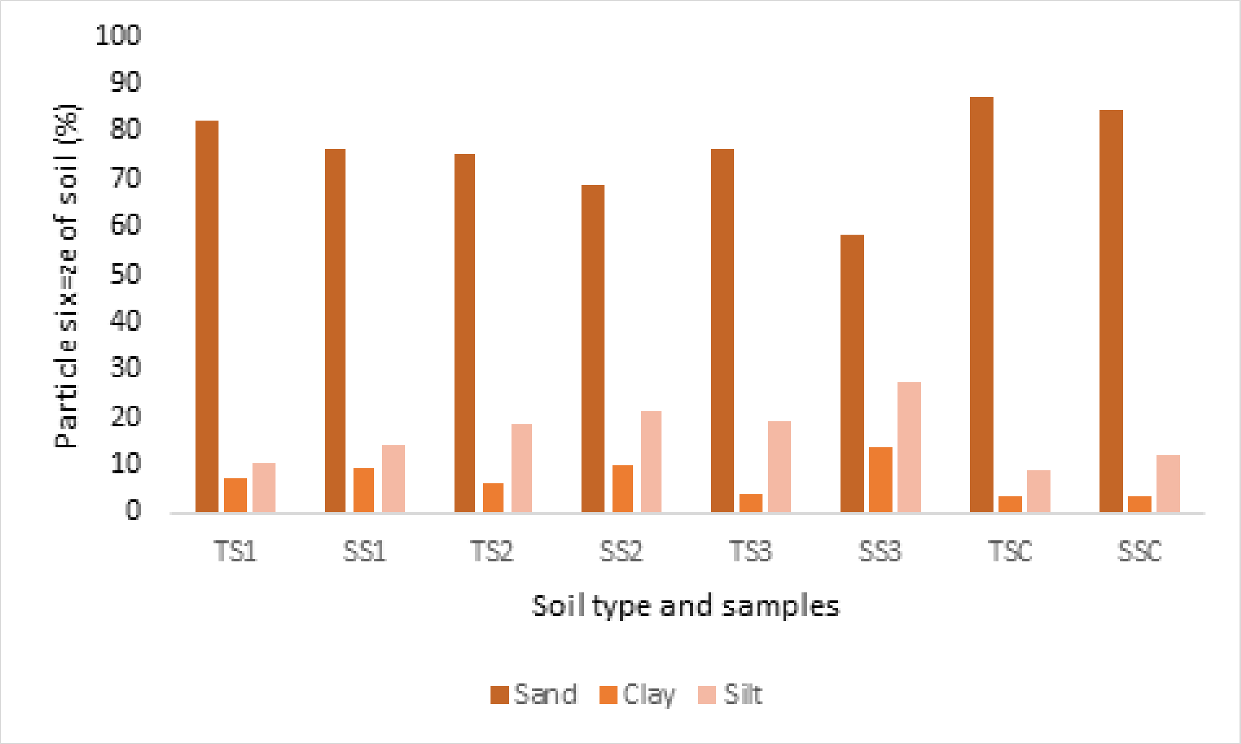

Figure 3. Particle size determination of the soil samples. **Legend:** TS means top soil and SS means subsoil, TSC means top soil control and SSC means subsoil control

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