Effect of Selected Electronic Waste Dump Sites on Quality of Surrounding Water Bodies in Abuja, Nigeria

1Olutunmilayo I. Ndububa and 2Alexander O. Oyije

1Department of Civil Engineering, Federal University, Oye-Ekiti, Nigeria
2Department of Civil Engineering, University of Abuja, Nigeria
ndububao@yahoo.com

Abstract- Due to inappropriate management of vast amount of waste produced by various human activities, urban surface and ground water resources have been under danger of pollution. It is noted that solid waste management is a universal issue and that it is a growing source of worry in developed and developing countries due to the increase in urbanization, changes in consumer pattern, and industrialization which all directly transform to an increase in solid waste generation. The sampling points used of the research are Electronic Waste (e waste) dump sites of Guzape, Karmo and Kubuwa areas of Abuja with terrains of flowing surface water bodies/ pond water. The sample sites were chosen to investigate the impact of e-waste on the water quality of surrounding water bodies in the environment. Parameters measured from collected water samples are pH, Temperature, Conductivity, Turbidity, Dissolved Oxygen, Total Dissolved Solids, Total Suspended Solids, Calcium, Magnesium, Ammonia Nitrogen, Nitrate Nitrogen, Nitrite Nitrogen, Phosphate, Biochemical Oxygen Demand, Chemical Oxygen Demand, Bicarbonate, Manganese, Copper, Zinc, Lead, Cadmium and Chromium. Results showed heavy metal values for Cadmium and Manganese in the water samples were above the maximum permitted level as compared with standards for drinking water, it is inferred that the impact of E waste in the environment contributed to the presence of heavy metals in the water samples. Copper, Zinc, and Chromium were also detected in all water samples except for a sample with the absence of Chromium in the water sample.

Keywords- Disposal sites, Electronic waste, Water quality

1 INTRODUCTION

A common problem in most third world countries is municipal solid waste disposal, with succeeding Governments applying different approaches in a bid to eliminate the menace in Nigeria. The effective waste to energy model has not been completely accepted by the Federal, State and Local Governments as a way of putting these wastes to sustainable use in all the State capitals and Local Government headquarters. Several scholars have informed on the haphazard nature of waste disposal and unsustainable waste management in Nigeria (Ogwu et al., 2010; Ohakwe, 2011). It is noted that solid waste management is a universal issue and that it is a growing source of worry in developed and developing countries due to the increase in urbanization, changes in consumer pattern, and industrialization which all directly transform to an increase in solid waste generation (Anikwe and Nwobodo, 2002).

Like most cities in the developing economies producing several tons of municipal solid waste which are left sometimes uncollected at the designated and in the undesignated waste dumping sites, Abuja metropolis suffer the same situation. These unattended heaps of waste leads to; clogging of drains and gutters, creating breeding ground for pests that spread disease, thereby producing countless similar health and infrastructural problems. The solid waste in most cases are being blown around by winds or rainstorm making the environment untidy, and increase in air pollution arising from the decay of these waste releasing poisonous gases to the environment. This could also increase the volume of greenhouse gases (GHGs) in the atmosphere and consequently increase the danger of climate change (Amoo and Fangbale 2013; Olorutande et al 2013).

In developing countries planning and management of solid waste has remained an arduous task due to the unplanned exponential growth of urban population, unplanned urbanisation, absence of training in modern solid waste management practices (Nabegu et al., 2012; Nabegu and Wudil 2013), lack of sensitization on the dangers of unsustainable waste management practices, poverty, illiteracy, and poor Government support amongst other factors (Islam et al., 2008; Uwadije, and Iyi 2014; Nwoke H.U. 2013). The process of collecting, storing, treatment and disposal of solid waste in such a manner that is harmless to humans, plants, animals, ecology and the environment in general is important in Municipal Solid Waste Management (Agwu, 2012). Municipal solid waste production can be affected by several factors such as economic development, income level, industrialization, urbanization, human attitude and local climatic conditions (Odoemene and Ofoedu 2016).

The most common practice for waste management in Nigeria is the utilization of open dumping (Agwu, 2012), while large quantity of solid waste produced in many cities in Nigeria are randomly deposited on roads or roadsides, unlawful dumpsites, in water ways (drainage system) or in open sites which negatively influence the environment and de-beautify its landscape (Ukpong et al, 2015). Some of the open dumps are haphazardly located at streams, valleys, water lands, open fields and abandoned borrow-pits (Ukpong et al, 2015). This system of waste disposal buildup huge quantity of waste yearly and is related with several problems such as contamination of groundwater and outbreak of various human diseases (Akor, 2013).

In Abuja, experimental research has indicated that about 47.39% of the total solid waste is organic and compostable whereas recyclable waste accounts for about 4.69–9.90% (Ayuba et al., 2013). Inappropriate
disposal of these untreated wastes can be detrimental to humans and the environment. Air pollution, underground water contamination, land degradation, soil contamination and habitat deterioration can be caused by inappropriate waste disposal (Odoemene and Ofodun 2016). Environments close to dumpsites are continually exposed to danger, reduced agricultural yield, surface and groundwater contamination, decrease in benthic communities due to toxicity and exposure to hazardous compounds (Ukpong et al, 2015; Ayuba et al, 2013). Moreover, global warming, photochemical oxidant creation, acidification, ecotoxicity of water, eutrophication and abiotic resource depletion can be caused by random dumping of waste (Nkwachukwu, 2010). The complexity in providing the required level of service matching the increasing demand for good sanitation service is characteristically connected to institutional, technical and financial constraints at the various levels of governance: national and local levels, as well as the private sector (UN Habitat, 2010).

Residents in poor urban communities usually have to deal with heaps of refuse over-flowing which is left lying uncollected. In some situations, residents’ burn or dump wastes in streams and stagnant gutters, all of which generates breeding grounds for disease spreading insects and vermin. The efforts being made to handle this menace are primarily targeted at safe guarding human health, promote environmental quality, and provide support for economic productivity (Fobil, 2010; Henry et al, 2006). To attain this, successive governments in Nigeria took the needed move to manage solid waste effectively (Kaseva et al, 2005). The effort led to a systematic shift in policy from assemblies being solely in charge for waste collection and disposal to the contribution of private waste management companies.

The background that rapid urbanization in Nigeria has increased the stress on urban infrastructure and environmental services has caused the waste accumulation and unsanitary environmental conditions (Songsore et al, 2005; Owusu-Sekyere, 2013). Other common disadvantages that influence efficient solid waste management are: government’s inability to streamline the accountable institutions to attain their directive, poor urban planning with regards to entrance routes for waste removal, inadequate sanitation facilities, lack of political will with regard to the awareness and dedication among national and local government to effectively manage solid waste as well as the low technological know-how to manage the waste which is swallowing up the cities and towns (Cointreau, 2006).

Veit et al (2005) informed that around the world, waste production rates are raising. In 2012, the worlds’ cities produced 1.3 billion tonnes of solid waste per year, leading to a footprint of 1.2 kilograms per person per day. With rapid population increase and urbanization, municipal waste production is expected to rise to 2.2 billion tonnes by 2025. Studies show that Municipal solid waste generation, composition and GHG emissions in Bangalore, India comprise mainly of degradable materials (>70%), which plays an important role in GHG (Greenhouse gas) emissions in urban localities. The growing municipal solid waste production along with the high fraction of organic waste and its crude disposal is leading to emission of GHG (methane, CO2, etc.) in the atmosphere (Ching-Hwa et al, 2004).

The difficulty of e-waste has propelled environmental agencies of many nations to institute, advance and adapt environmentally healthy alternatives and plans for e-waste control, with a view to reduce and administer the ever growing problem of e-garbage to the surrounding and human health. Once electronic equipment reaches the end of their useful life, they become electronic waste (E waste) or, waste from electrical and electronic equipment (WEEE). WEEE has been described as any equipment that relies on electric currents or electromagnetic fields in order to work appropriately, comprising equipment for the production, transfer and measurement of current (Intharathirat, 2015). In addition, there is no standard or generally embraced definition of e waste in the world, E waste has become the fastest growing section in the solid waste stream. Informal E waste recycling system in Nigeria such as open burning to recover metals, dumped or stockpiled resulted due to absence of national management strategies. (Ramachandra et al, 2018).

2 MATERIALS AND METHODS

2.1 STUDY AREA

Abuja is the capital city of Nigeria. It is situated in the midpoint of Nigeria within the Federal Capital Territory. It falls within latitude 8.28 and 9.20 North of the Equator and longitude 6.45 and 7.39 East of the Greenwich Meridian. It dwells in an area of about 250 km2 with the Gwagwa plains in the northeast quadrant of the FCT. The city of Abuja had a population of 776,298 as at 2006, making it one of the top ten most densely inhabited cities in Nigeria (NBS 2007). The FCT is bordered in the north by Kaduna state, on the west by Niger state, on the east and south east by Nassara state, and on the southwest by Kogi state.

The physical development of Abuja is planned to evolve in four operational phases. Phase 1 comprise of seven districts: The central Area, Garki 1, Garki 2, Wuse 1, Wuse 2, Asokoro and Maitama. Phase 2 consists of 14 residential districts and four sector centre. Phase 3 comprise of eleven district. The spiraling economic and socio-political activities, with the following strains on housing and living conditions, contributed chiefly to the rise of squatter settlements in the territory. These settlements (with the exception of Garki village within Garki 2 District of the city) are principally located in the city suburbs, otherwise known as satellite towns. These suburban areas in general are densely populated and do not have good infrastructure, basic social services and amenities, poor unemployed persons which are low-income workers live in shanty, poor accommodation structures which makes up the suburbs.
Abuja has a moderate climatic condition, with a savannah type of vegetation. Abuja under koppen climate classification attributes a tropical wet and dry climate. The rainy season starts from April and ends in October, when the day time temperature reaches 28°C(82.4 F) to 30°C (86 F) and nighttime lows hangs around 22°C (71.6 F) to 23°C (73.4 F). Daytime temperatures can be as high as 40°C (104.0 F) and nighttime temperatures can dip to 12°C (53.6 F), in the dry season. Even the chilliest nights can be followed by day-time temperatures well over 30°C (86.0 F). The highest altitude and undulating terrain of the FCT operate as a moderate influence on the weather of the territory.

3 Sampling Points

The sampling points used for the research are Electronic Waste (e waste) dump sites of Guzape, Karmo and Kubuwa areas of Abuja with terrains of flowing surface water bodies/pond water. Activities of scavengers collecting E-waste from these various dump sites are rampant, the scavengers gather the e-waste at junk spots and are piled up to a particular quantity that can fill transport truck and sold off to companies for recycling into new products. It was realised that in these waste locations, e-waste are kept in the open, exposed to the rain, where the pollutants are leached into the soil and the surrounding water sources.

The sample sites were chosen to investigate the impact of e-waste on the water quality of surrounding water bodies in the environment. The three sampling sites were chosen based on their proximity to e-waste pollution sources of the surrounding environment.

Site 1: The Jabi Motor Park Pantaker is located at the Guzape district characterized by busy streets and different commercial activities with a stream located at the selected site. Water samples collected were given sample codes (SW for Surface Water). Samples with code SW1 were collected from this site.

Site 2: Karmo Pantaker is a big market for iron materials and wastes of different kinds. E-waste sites located in the environment were surrounded by surface water ponds. Samples with code SW2 were collected from this site.

Site 3: Kubwa Pantaker is located in one of the satellite settlement, with the Kubwa stream flowing from the upstream Deidei to the site. Samples with code SW3 were collected from this site.

Global positioning system navigator (GPS. Map 625) Garmin was used to determine the location of the sampling points.

| Sample Code | Sample Location | GPS Location |
|-------------|-----------------|--------------|
| SW 1        | Jabi Motor Park | 03208074     |
|             | Pantaker        | 1002285      |
| SW 2        | Kubwa Wasteyard | 0315676      |
|             |                 | 1012493      |
| SW3         | Karmo Wasteyard | 0320588      |
|             |                 | 1001936      |

The following water parameters were determined from the water samples collected from the sites: pH, Temperature, Conductivity, Turbidity, Dissolved Oxygen, Total Dissolved Solids, Total Suspended Solids, Calcium, Magnesium, Ammonia Nitrogen, Nitrate Nitrogen, Nitrite Nitrogen, Phosphate, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Bicarbonate, Manganese, Copper, Zinc, Lead, Cadmium and Chromium.

Results obtained from the water quality parameters were compared with the WHO Guidelines for Drinking Water Quality and Nigerian Standards for Drinking Water Quality.

4 Sample Collection

The samples were collected from the mid and edge of the streams, by using 1 liter sampling bottles for each of the sampling site, for water parameter test and 250ml bottle with stopper for each of the three sites for e-waste parameters as presented in table 2. The three 250ml bottles were preserved with nitric acid to prevent each of pH change on the water samples. The samples were stored in cooler packed with ice block and transported to Wupa treatment plant laboratory for the analysis.

| Location | Distance from pollution | Type of Water Source | Condition of Water Source |
|----------|-------------------------|----------------------|--------------------------|
| SW1      | 500m                    | A stream             | Flowing                  |
| SW2      | 2m                      | A stream             | Flowing                  |
| SW3      | 450m                    | A pond               | Stagnant                 |

All the methodologies for the laboratory analysis were carried according to the Standard methods for the examination of water and wastewater (APHA, 1999).

5 Results

Physical, chemical parameters and heavy metals were measured to determine the extent of water pollution in the different sample sites. Table 3 shows the results obtained from the different sample sites compared to drinking water quality standards.
The laboratory investigation of the presence of Nitrite nitrogen, while standards as these parameters do not have Phosphate values were within standards as compared to drinking water quality standards, shows recent organic pollution with the adverse effect on health, while the presence of Total Suspended Solids (TSS) is not allowed in drinking water quality, this water sample must be treated to remove TSS. The parameter, Magnesium had values higher than recommended in standards for drinking water quality, all three samples recorded high values for turbidity, the presence of Ammonia Nitrogen in the water samples shows recent organic pollution, the water therefore requires treatment before use for drinking. Nitrate values were within standards as compared with the Nigerian Standard for Drinking Water Quality. Nitrite

### Table 3. Physical, Chemical and Heavy Metal Results from Sampling Sites

| SN | Parameters                  | Sample SW 1 - Jabi Motor Park | Sample SW 2 - Kubwa Pantaker | Sample SW 3 - Karmo Pantaker | Nigerian Drinking Water Quality Standard - 2007 | Who Drinking Water Quality Standard - 2011 |
|----|-----------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------------------------------|-----------------------------------------------|
| 1  | pH                          | 7.28                          | 6.76                          | 6.35                          | 6.5-8.5                                       | 6.5-8.5                                       |
| 2  | TEMPERATURE (°C)            | 23.8                          | 24.1                          | 23.7                          | AMBIENT                                      | -                                             |
| 3  | CONDUCTIVITY (µS/cm)        | 303                           | 244                           | 181.5                         | 1000                                         | -                                             |
| 4  | TURBIDITY (NTU)             | 23.4                          | 178                           | 249                           | 5                                            | 5                                             |
| 5  | DISSOLVED OXYGEN (mg/l)     | 8.87                          | 5.71                          | 4.46                          | -                                            | -                                             |
| 6  | TOTAL DISSOLVED SOLIDS (mg/l) | 160.9                        | 90.8                          | 130                           | 500                                           | 1000                                         |
| 7  | TOTAL SUSPENDED SOLIDS (mg/l)| 17.9                         | 150.9                         | 208.8                         | -                                            | -                                             |
| 8  | CALCIUM (mg/l)              | 30.7                          | 35.4                          | 24.8                          | -                                            | -                                             |
| 9  | MAGNESIUM (mg/l)            | 7                             | 8                             | 6                             | 0.2                                          | -                                             |
| 10 | AMMONIA NITROGEN (mg/l)     | 1.3                           | 0.7                           | 0.8                           | -                                            | -                                             |
| 11 | NITRATE NITROGEN (mg/l)     | 12.7                          | 11.1                          | 6                             | 0.2                                          | 50                                            |
| 12 | NITRITE NITROGEN (mg/l)     | 0.04                          | 1.76                          | 0.3                           | 0.2                                          | 3                                             |
| 13 | PHOSPHATE (mg/l)            | 1.4                           | 0.5                           | 0.8                           | -                                            | -                                             |
| 14 | BOD (mg/l)                  | 20                            | 21                            | 19                            | -                                            | -                                             |
| 15 | COD (mg/l)                  | 38                            | 46                            | 41                            | -                                            | -                                             |
| 16 | BICARBONATE HCO3 (mg/l)     | 54.7                          | 58.9                          | 30.1                          | 150                                          | -                                             |
| 17 | MANGANESE (mg/l)            | 0.26                          | 1.01                          | 0.91                          | 0.2                                          | 0.1                                          |
| 18 | COPPER (mg/l)               | 0.1                           | 0.16                          | 0.33                          | 1                                            | 2                                             |
| 19 | ZINC (mg/l)                 | 0.05                          | 0.01                          | 0.04                          | 3                                            | 4                                             |
| 20 | LEAD (mg/l)                 | 0.003                         | 0.01                          | 0.001                         | 0.01                                         | 0.01                                         |
| 21 | CADMIUM (mg/l)              | 0.053                         | 0.111                         | 0.161                         | 0.003                                        | 0.003                                        |
| 22 | CHROMIUM (mg/l)             | 0.001                         | ND                            | 0.001                         | 0.05                                         | 0.05                                         |

### Table 4. Control Water Samples in FCT from protected water sources away from Electronic Waste Sites

| SN | Parameter | Unit    | Protected Source1 | Protected Source2 | Protected Source3 |
|----|-----------|---------|-------------------|-------------------|-------------------|
| 1  | Zinc (Zn) | mg/L    | 0.02              | 0.055             | 0.04              |
| 2  | Copper (Cu)| mg/L    | 0                 | 0                 | 0                 |
| 3  | Iron (Fe2+) | mg/L    | 0.005             | 0.055             | 0.005             |
| 4  | Manganese (Mn2+) | mg/L | 0 | 0 | 0 |
| 5  | Calcium (Ca) | mg/L | 3.1 | 3.2 | 3.9 |
| 6  | Cadmium (Cd) | mg/L | 0 | 0 | 0 |
| 7  | pH         |         | 7.1               | 7                 | 6.8               |
| 8  | Turbidity  | NTU     | 0                 | 0                 | 0                 |
| 9  | Temperature| °C      | 27.5              | 27.5              | 27.5              |
| 10 | Colour     | TCU     | 0                 | 0                 | 0                 |

Source: Ndububa (2016).

### 6 DISCUSSION

The effect of e waste on surrounding water bodies at dump sites were analyzed by the quality of the surface waters obtained from the laboratory investigation of the collected water samples. The pH of the water samples SW1 and SW2 were within the acceptable range as compared with drinking water quality standards, conductivity of the water sample values were below the maximum permitted for drinking water standard. Results obtained for Dissolved Oxygen, Calcium and Phosphate were not compared to drinking water standards as these parameters do not have direct adverse effect on health, while the presence of Total Suspended Solids (TSS) is not allowed in drinking water quality, this water sample must be treated to remove TSS. The parameter, Magnesium had values higher than recommended in standards for drinking water quality, all three samples recorded high values for turbidity, the presence of Ammonia Nitrogen in the water samples shows recent organic pollution, the water therefore requires treatment before use for drinking. Nitrate values were within standards as compared with the Nigerian Standard for Drinking Water Quality. Nitrite
values for samples SW2 and SW3 were higher than recommended values as compared with standards.

For heavy metals, values for Cadmium and Manganese in the water samples had values above the maximum permitted level as compared with standards, while the three control samples presented in table 4 recorded zero values for the heavy metal Manganese, it is inferred that the impact of e waste in the environment contributes to the presence of heavy metals in the water samples. Copper, Zinc, and Chromium were detected in all water samples except for sample SW2 with the absence of Chromium in the water sample; the values for these heavy metals were all below the maximum permitted levels. Control samples also recorded values below the maximum permitted levels.

It can be seen from Table 5 that 95% confidence interval was achieved for the mean values of results obtained from water parameters from sample SW1 at Jabi. The Descriptive analysis for the collected water samples achieved the same output from other sampling points.

The statistical regression analysis has shown a positive correlation relationship between measured parameters, results obtained to ascertain the relationship between measured water quality parameters is supported by the work of Gashi, (2017). From the investigation on the relationship between the heavy metals and water parameters, the dendogram using the ward linkage showed that pH, Magnesium, Dissolved Oxygen, Nitrogen Nitrate, Chemical Oxygen Demand, Biochemical Oxygen Demand and Calcium are in a common cluster, designated as cluster 1.

8 CONCLUSION
The effect of e waste on surrounding water bodies at dump sites were analyzed by the quality of the surface waters, the following conclusions are made:
1. The pH values of all the water samples were between 6.35 and 7.28, water sample SW3 had acidic values below recommended values for drinking water, conductivity of the water sample values were below the maximum permitted for drinking water standard therefore pH adjustment is required for sample SW3 to meet standards for domestic use.
2. Results obtained for Dissolved Oxygen, Calcium and Phosphate do not have a direct negative impact on health, these parameters are not listed on the Nigerian Standard for Drinking Water Quality, the parameters at levels obtained are not critical.
3. The presence of Total Suspended Solids (TSS) is not allowed in water samples for drinking water, these water samples must be treated to remove TSS to meet required quality for domestic use.
4. The parameter, Magnesium had values higher than recommended in standards for drinking water quality and all three samples recorded values for turbidity higher than recommended for drinking water quality, turbidity removal by use of coagulants is required to treat samples to acceptable values.
5. The presence of Ammonia Nitrogen in the water samples shows recent organic pollution, all the collected water samples had values of Ammonia Nitrogen which should not be present in water samples to be used for drinking, the samples therefore requires treatment before use for drinking.

7 STATISTICAL ANALYSIS USING CLUSTER ANALYSIS
Multivariate statistical analysis methods have been put to use in various water quality and hydro geochemical studies, IBM Statistical Package for the Social Sciences (SPSS) Statistics 23 software has been used to run the Hierarchical cluster analysis function to group the water quality parameters in clusters and generate a dendrogram. Table 4 presents the results of Normality test conducted on results of the water quality parameters achieving 100% valid cases for presented results.

| Table 4. Case Processing Summary for Normality Test |
|---------------------------------------------------|
| Valid | Missing | Total |
|-------|---------|-------|
| log_Jabi | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |
| log_Kubwa_pantaker | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |
| log_Karim_o_pantaker | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |

Fig. 1: Presence of Heavy Metals in Water Samples SW1, SW2 and SW3

It can be seen from Table 5 that 95% confidence interval was achieved for the mean values of results obtained from water parameters from sample SW1 at Jabi. The Descriptive analysis for the collected water samples achieved the same output from other sampling points.

The statistical regression analysis has shown a positive correlation relationship between measured parameters, results obtained to ascertain the relationship between measured water quality parameters is supported by the work of Gashi, (2017). From the investigation on the relationship between the heavy metals and water parameters, the dendogram using the ward linkage showed that pH, Magnesium, Dissolved Oxygen, Nitrogen Nitrate, Chemical Oxygen Demand, Biochemical Oxygen Demand and Calcium are in a common cluster, designated as cluster 1.

8 CONCLUSION
The effect of e waste on surrounding water bodies at dump sites were analyzed by the quality of the surface waters, the following conclusions are made:
1. The pH values of all the water samples were between 6.35 and 7.28, water sample SW3 had acidic values below recommended values for drinking water, conductivity of the water sample values were below the maximum permitted for drinking water standard therefore pH adjustment is required for sample SW3 to meet standards for domestic use.
2. Results obtained for Dissolved Oxygen, Calcium and Phosphate do not have a direct negative impact on health, these parameters are not listed on the Nigerian Standard for Drinking Water Quality, the parameters at levels obtained are not critical.
3. The presence of Total Suspended Solids (TSS) is not allowed in water samples for drinking water, these water samples must be treated to remove TSS to meet required quality for domestic use.
4. The parameter, Magnesium had values higher than recommended in standards for drinking water quality and all three samples recorded values for turbidity higher than recommended for drinking water quality, turbidity removal by use of coagulants is required to treat samples to acceptable values.
5. The presence of Ammonia Nitrogen in the water samples shows recent organic pollution, all the collected water samples had values of Ammonia Nitrogen which should not be present in water samples to be used for drinking, the samples therefore requires treatment before use for drinking.

| Table 4. Case Processing Summary for Normality Test |
|---------------------------------------------------|
| Valid | Missing | Total |
|-------|---------|-------|
| log_Jabi | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |
| log_Kubwa_pantaker | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |
| log_Karim_o_pantaker | 22 | 100.0% | 0 | 0.0% | 22 | 100.0% |

Fig. 1: Presence of Heavy Metals in Water Samples SW1, SW2 and SW3

It can be seen from Table 5 that 95% confidence interval was achieved for the mean values of results obtained from water parameters from sample SW1 at Jabi. The Descriptive analysis for the collected water samples achieved the same output from other sampling points.

The statistical regression analysis has shown a positive correlation relationship between measured parameters, results obtained to ascertain the relationship between measured water quality parameters is supported by the work of Gashi, (2017). From the investigation on the relationship between the heavy metals and water parameters, the dendogram using the ward linkage showed that pH, Magnesium, Dissolved Oxygen, Nitrogen Nitrate, Chemical Oxygen Demand, Biochemical Oxygen Demand and Calcium are in a common cluster, designated as cluster 1.

8 CONCLUSION
The effect of e waste on surrounding water bodies at dump sites were analyzed by the quality of the surface waters, the following conclusions are made:
1. The pH values of all the water samples were between 6.35 and 7.28, water sample SW3 had acidic values below recommended values for drinking water, conductivity of the water sample values were below the maximum permitted for drinking water standard therefore pH adjustment is required for sample SW3 to meet standards for domestic use.
2. Results obtained for Dissolved Oxygen, Calcium and Phosphate do not have a direct negative impact on health, these parameters are not listed on the Nigerian Standard for Drinking Water Quality, the parameters at levels obtained are not critical.
3. The presence of Total Suspended Solids (TSS) is not allowed in water samples for drinking water, these water samples must be treated to remove TSS to meet required quality for domestic use.
4. The parameter, Magnesium had values higher than recommended in standards for drinking water quality and all three samples recorded values for turbidity higher than recommended for drinking water quality, turbidity removal by use of coagulants is required to treat samples to acceptable values.
5. The presence of Ammonia Nitrogen in the water samples shows recent organic pollution, all the collected water samples had values of Ammonia Nitrogen which should not be present in water samples to be used for drinking, the samples therefore requires treatment before use for drinking.
Nitrate values were within standards as compared with the Nigerian Standard for Drinking Water Quality.

6. Results obtained for heavy metals showed values for Cadmium and Manganese in the water samples above the maximum permitted level as compared with standards, it is inferred that the impact of waste in the environment contributed to the presence of heavy metals in the water samples.

7. Copper, Zinc, and Chromium were detected in all water samples except for sample SW2 with the absence of Chromium in the water sample; the values for these heavy metals were all below the maximum permitted levels.

Table 5. Descriptive Analysis

| Statistic                  | log_Jabi | log_Kubwa_pantaker | log_Karimo_pantaker |
|----------------------------|----------|---------------------|---------------------|
| Mean                       | 0.35132  | 0.48809             | 0.44574             |
| Std. Error                 | 0.324542 | 0.328467            | 0.32865             |
| 95% Confidence Interval for Mean | Lower Bound | -0.32360 | -0.19499 | -0.23818 |
|                            | Upper Bound | 1.02624 | 1.17118  | 1.12965  |
| 5% Trimmed Mean            | 0.41814  | 0.58720             | 0.52919             |
| Median                     | 0.90503  | 0.86652             | 0.77815             |
| Variance                   | 2.317    | 2.374               | 2.379               |
| Std. Deviation             | 1.52227  | 1.540644            | 1.542513            |
| Minimum                    | 2.000    | -3.301              | -3.000              |
| Maximum                    | 2.481    | 5.481               | 5.396               |
| Range                      | 2.473    | 5.688               | 2.004               |
| Interquartile Range        | -0.775   | -0.922              | -0.892              |
| Skewness                   | -0.333   | 0.491               | 0.491               |
| Kurtosis                   | -0.775   | 0.491               | 0.491               |

REFERENCES

Agwu M.O. (2012). Issues and Challenges of Solid Waste Management Practices In Port-Harcourt City, Nigeria –A Behavioural Perspective. American Journal of Social and Management Science, 3(2):83–92.

Akor A.J., Ayotamuno M.J., Aman L.I. and Enokela S.O. (2013). Assessment of Domestic Solid Waste Generation in Port-Harcourt by separator – Receptacle technology. International Journal of Science and Engineering; 4:1–7.

Amoo O.M, Fangbale R.L. (2013). Renewable Municipal Solid Waste Pathways for Energy Generation and Sustainable Development in the Nigerian Context. International Journal of Energy and Environmental Engineering, 4(1): 42

Anikwe M.A.N. and Nwobodo K.C.A. (2002). Long Term Effect of Municipal Waste Disposal on Soil Properties and Productivity of Sites used for Urban Agriculture in Abakaliki, Nigeria. Bioresource Technology, 83 (3): 241-250.

APHA. (1999). Standard Methods for the Examination of Water and Wastewater. AMWA, WWPCF 20th Edition. APHA (American Public Health Association).

Ayuba K.A., Manaf L.A., Sabrina A.H. and Azmin S.W.N. (2013). Current Status of Municipal Solid Waste Management Practise in
FCT Abuja. Research Journal of Environmental Earth Science.; 5:295–304.

Ching-Hwa, L. Chang-Tang, C. Kuo-Shuh, F. and Tien-Chin, C. (2004). “An overview of recycling and treatment of scrap computers.” Journal of Hazardous Materials, B vol. 114, pp. 93–99

Cointreau S. (2006). Occupational and Environmental Health Issues of Solid waste Management: Special emphasis on middle and low-income countries. World Bank, Washington, DC. www.worldbank.org

Fobil, J., Kolawole O., and Hogarth J. (2010). Waste Management Financing in Ghana and Nigeria - How can the concept of polluter-pay-principles work in both countries? International Journal of Academic Research, Vol.2.No.3.

Henry, K.R., Yongsheng Z., and Jun D. (2006). Municipal Solid Waste Management Challenges in Developing Countries – Kenyan Case Study. Waste Management, 26(2): 92-100.

Imam, A., Mohammed, B., Wilson, D.C., Cheeseman, C.R. (2008). Solid waste management in Abuja, Nigeria. Waste Management, 28(2): 468-472.

Kaseva, M.E., and Mbuligwe S.E. (2005). Appraisal of Solid Waste Collection following Private Sector involvement in Dar es Salaam City, Tanzania. Habitat International 29, 352-366.

Nabegu A.B and Wudil. P. (2008). An Assessment of Refuse Management and Sanitation Board (REMASAB) Solid Waste Management in Kano metropolis. Techno-Science Africana Journal, 1: 101-108.

National Bureau of Statistics (NBS). (2007). Federal Republic of Nigeria 2006 Population Census Figures. http://www.nigerianstat.gov.ng

Ndububa, Olufunmilayo and Umar Shuaibu (2016). Assessment of Community Awareness/Participation in Domestic Water Supply Activities for Anguwan Dodo Community, Gwagwalada Abuja Nigeria. Research Journal of Applied Sciences, Engineering and Technology. Vol. 12(8): 841-846. Maxwell Scientific Publication Corp. United Kingdom. www.maxwellsclsi.com

Nigerian Industrial Standards (NIS 554). (2007). Nigerian Standard for Drinking Water Quality (NSDWQ). Standards Organisation of Nigeria, Abuja.

Nkwachukwu O.J., Chidi N.I., and Charles K.O. (2010). Issues of Roadside Disposal Habit Of Municipal Solid Waste, Environmental Impacts and Implementation of Sound Management Practices in Developing Country “Nigeria”. International Journal of Environmental Science Dev., 5:409–418.

Nwoke H.U. (2013). Generation Rate of Solid Waste in Owerri Metropolis, Imo State, Nigeria. Continental Journal of Environmental Sciences, 7(1):1-3.

Odoemene U.D. and Ofodu J. (2016). Solid wastes management in Aba Metropolis. International Journal of Advanced Academic Research, 2:1–7.

Ogwueleka T. C. (2009). Municipal Solid Waste Characteristics and Management in Nigeria. Iran Journal of Environmental Health Science and Engineering, 6(3): 173-180

Olahkwe J. (2011). A statistical analysis of medical waste generation, management and the health implications: A case study of Enugu metropolis. Enugu State Nigeria. Continental Journal of Applied Sciences, 6: 25.

Oloruntade A.J, Adeoye P.A, Alao F. (2013). Municipal solid wastes collection and management strategies in Akure, South-Western Nigeria. Capsian Journal of Environmental Sciences, 11(1): 1.

Owusu-Sekeyere, E.; Osunamu, I.K and Yaro, J. A. Dompoase. (2013). Landfill in the Kumasi Metropolitan Area of Ghana, International Journal Current Research 2 (1): 87-96

Songsoore, J. ; Nabila, J.S. ; Yangyuoru, Y. ; Amuah, E. ; Bosque-Hamilton, E. K. ; Etisiah, K. K. ; Jan-Eric, G and Jacks, G. (2005). State of the Environmental Health Report of the Greater Accra Metropolitan Area (GAMA). Ghana University Press, Accra.

Ukpong E.C.U., Udo E.A. and Umoh I.C. (2015). Characterization of Materials from Aba Waste Dumpsites. International Journal of Engineering and Applied Sciences, 2015;6:1–10.

UN-habitat. (2010). Solid Waste Management in the World’s Cities. Nairobi. Water and Sanitation in the World Cities. Un-habitat. www.unhabitat.org

Uwadiegu, B.O. and Iyi, EA (2014). An Evaluation of the Operational Efficiency of a Public Agency: A Case Study of Enugu State Waste Management Authority (Eswama) in Enugu City. Nigeria. British Journal of Environmental Sciences, 2(2): 27-34.

Veit, H. M., Diehl, T. R., Salami, A. P., Rodríguez, J. S., and Bernardes, A. M. (2005). “Utilization of magnetic and electrostatic separation in the recycling of printed circuit boards scrap.” Journal of waste management, vol. 25, pp. 67-68.

World Health Organization. (WHO) (2011). Guidelines for Drinking Water Quality. Third Edition. World Health Organization. Geneva, Switzerland. www.who.org