ASSESSMENT OF HEAVY METALS ON SURFACE WATER IN SHIRORO LANDFILL SITE

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Abstract

Due to different wastes infused in landfill work, the presence of heavy metals on surface water requires urgent attention. In view of this, the study assessed heavy metal on surface water in Shiroro landfill site for ascertaining the status of the surface water. The study chose different sampling points and a control within the landfill site. The surface water samples were taken and analysed in line with the methods and procedures of WHO and Nigeria Standard for Drinking Water Quality. The results show that the physic-chemical properties of the surface water on the landfill changed drastically when compared to the values of the control sample. The study found out that the mean Iron concentration value was 0.3 mg/l (equal to WHO and Nigeria Standard for Drinking Water Quality maximum limit concentration), lead concentration (0.02 mg/l- more than Nigeria Standard for Drinking Water Quality but less than WHO maximum limit concentration), Nickel concentration (0.03mg/l- more than Nigeria Standard for Drinking Water Quality) and Manganese concentration was 1.05 mg/l (more than Nigeria Standard for Drinking Water Quality and WHO maximum limit concentration). Furthermore, the environment was vulnerable to the risk of cancer, possible carcinogenic and Neurological disorder because the distance of the landfill site was less than 200 m to Shororo River. Based on the WHO standard and Nigeria Standard for Drinking Water Quality maximum limit concentrations, it can be inferred that presence of these parameters were low on the landfill site. This implies that the surface water within and outside the landfill sites was unfit for drinking and farming purposes. It is recommended that an embankment should be constructed within the landfill to restrict the movement of heavy metals. Also, the landfill site should not be used for farming purpose so as reduce its impact on the people of the area.

Keywords: Landfill, Heavy metals, Surface Water

1.0 Introduction

Landfill refers to the engineering method of disposing waste material by burying it, especially as a method of filling in and reclaiming excavated pits. Dunnet (2004) viewed landfill as the cheapest method of filling excavated pits or erosion spot based on design and management strategy put in place (Oduro-Appiah, 2013). Inappropriate landfill and the types of waste used causes numerous issues which include soil contamination, pollution of groundwater, and contrary effect associating with the materials. There are three methods of producing sanitary landfill and these include area, trench and ramp and the most commonly used are area and trench. The inappropriate design of landfill posed serious threat on the environment, human health, and provides unaccepted risk to water, soil, atmosphere as well as the plant and animal in the area (Environmental protection Agency, 2003).

The possible pollution of soil-water environment by landfill rely on numerous element such as dumped waste type, leachates amount transmigrating beyond the landfill (Koc-Jurczyk, et al., 2011). According to Ezyske and Deng (2012), landfill site produced leachate that pollutes both water and land thereby producing leachate, which is highly comprises of dissolved organic matters, inorganic macrocomponents such as calcium, magnesium, sodium, potassium, ammonium, iron, magnesium, chloride, sulfate, and hydrogen carbonate; heavy metals like cadmium, chromium, copper, lead, nickel, and zinc and xenobiotic organic. Also, the Leachates penetrating into the soil and surface water did not only pollute the chemical and microbiological activities but also alter the engineering and geological parameters of the area such that landfill leachate harms surface water bodies by depleting dissolved oxygen (DO) and increasing ammonia levels altering the flora and fauna of the water body (Ezyske and Deng, 2012).

Numerous studies employed analytical methods and risk assessment to evaluate the presence of heavy metals in surface and groundwater. The former has to do with the laboratory analysis of the sampling location while the latter involves on spot assessment and measurement of risk variable that measures the impact of the leachate on the environment. This study employed analytical method to generate data from the landfill sites. Furthermore, most researchers used WHO and Nigeria or nations' standard drinking water quality to examine the present of heavy metals in landfill (Al Raisi et al., 2014).

Vaverkova (2014) reported that the presence of heavy metals on surface water in landfill was insignificant. In the work of Hossain et al., (2014), the heavy metals on surface and ground water in landfill using analytical method (Iron and others) have higher concentration which above WHO limits. According to Al Raisi *et al.*, (2014), the presences of heavy metals in Leachate of an Unlined Landfill exceed Oman drinking water standards. Blumberga (2001) reported that the Skede landfill has serious impact on the surface water, soil and groundwater of the area via risk assessment. Based on these, it can be deduced that few landfill works was designed and constructed based on engineering specifications while majority of landfill sites pose serious risk to surface, groundwater and the environment. It is against this backdrop that the study is evaluating the holistic surface water status of Shiroro Landfill site.

2.0 Materials and Methods

2.1 Study area

Shiroro Dam is located on the Latitude 9^0 58’ N and Longitide 6^0 51’ E as shown in Figure I. The tributaries flow in the North-South direction and then meander in the Northwest to Southeast direction. The coordinate of these sampling points were $09^0$58. 981’N, 006^0 49. 301’E; 09^0 58. 981’N, 006^0 49. 307’E; 09^0 59.058’N, 006^0 49.137’E; 09^0 58. 590’N and 006^0 49.199’E respectively.

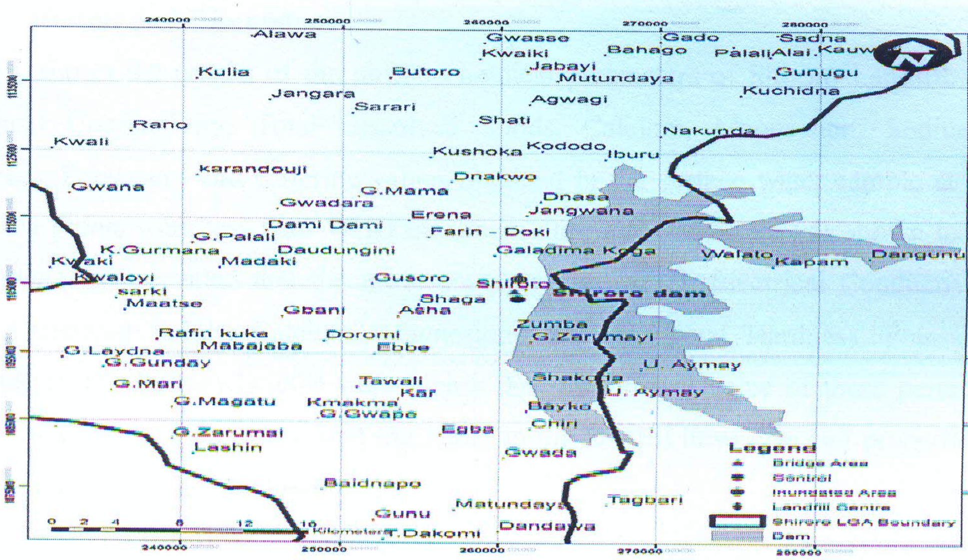

Figure I: Location of Shiroro Landfill Site with Sampling Points

2.2 Landfill sampling points

The study used purposive sampling techniques within the landfill site to choose three points such as sample location 1(landfill centre i.e. Centre of the circular metallic pipe), sample location 2 (outside submerged circular metallic pipe) and sample location 3 (bridge area). A control point (sample location 4) was taken at approximately 200m before the landfill.

2.3 Research tools

The study used pH metre, conductivity metre and thermometer to measure physical parameter such as pH, electrical conductivity and temperature on the fields. Also, Atomic Absorption Spectrometer was used to determine cations, anions and trace metals in the Laboratory.

2.4 Water collection, laboratory and data analysis

The surface water samples were collected within the landfill at different points in the month of October (wet season). The samples were analysed in line with 2010 World Health Organization and 2007 Nigeria Standard for Drinking Water Quality recommended methods and procedures. The parameters analyzed on the surface water consist of pH, Electrical Conductivity, Total Dissolved Solids, Calcium, Magnesium, Sodium, Total Hardness, Potassium, Chloride, Chromium, Copper, Iron, Zinc, Lead, Cadmium, Mercury, Vanadium, Nickel, Manganese and Boron. The data obtained from the laboratory were subjected to descriptive analysis and the results were presented in Tables.

3.0 Results and Discussions

Table 1 shows the results of the physicochemical parameters of Shiroro Landfill. The pH, Electrical Conductivity, Total Dissolved Solids, Calcium, Magnesium, Sodium, Total Hardness, Potassium and Chloride values obtained in the surface water sample at different sampling points were less than WHO maximum allowed (wet season) as shown in Table 2. Also, the study revealed that the mean concentration of pH, Electrical Conductivity (Ec), Total Dissolved Solids, Calcium, Magnesium, Sodium, Total Hardness, Potassium and Chloride in the Shiroro landfill were higher than the control value of these parameters as shown in Table 2. This means that the waste in the landfill have changed properties of the surface water sample of the Area.

Table 1: Physicochemical Properties of Shiroro River (water) Sample

Sampling Points	Ph	Electrical Conductivity (µS/cm)	Total Dissolved Solids (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Total Hardness (mg/l)	Potassium (mg/l)	Chloride (mg/l)
SL1	6.81	303	152	26.2	6.3	8.96	91.75	4.18	12.51
SL2	8.08	52	26	1.12	1.26	1.38	8.05	1.7	6.45
SL3	6.79	45	23	0.55	1.25	1.31	6.58	1.63	8.47
SL4	7.08	45	22	0.5	1.4	1.38	7.5	1.7	5.24

Sources: Futminna WAFT Laboratory, 2015

Table 2: Physico-chemical Parameters of Shiroro River (water) Sample

Parameters	Mean Values	Control Values	WHO 2010
pH	7.23	7.08	8.50
Electrical Conductivity (µS/cm)	133.33	45	1000.00
Total Dissolved Solids (mg/l)	67.00	22	500.00
Calcium (mg/l)	9.29	0.5	200.00
Magnesium (mg/l)	2.94	1.4	0.20
Sodium (mg/l)	3.88	1.38	200.00
Total Hardness (mg/l)	35.46	7.5	500.00
Potassium (mg/l)	2.50	1.7	200.00
Chloride (mg/l)	9.14	5.24	250.00

Table 4 shows the heavy metal concentration of shiroro landfill site. The mean concentration value (mg/l) for Iron, Zinc, Lead, Cadmium, Nickel, Manganese and Boron were 0.28, 0.04, 0.02, 0.04, 0.03, 1.05 and 0.08 respectively. These values were less than the control values. But, the concentration of Zinc and Cadmium were less than the maximum permitted limit used by WHO and Nigeria Standard for Drinking Water Quality. Furthermore, the heavy metals presence in the surface water were Iron, lead, Nickel and Manganese. These metals are present as follow:

(i) Iron: The SL1 was higher than that of SL2 and SL3 which indicates that the waste disposed have element of steel scrap. The control value (SL4) was greater than that of SL1, SL2 and SL3 respectively as shown in Table 3. The mean value of iron concentration was approximately equal to the limit set out by WHO and Nigeria Standard for Drinking Water Quality. This implies that the centre landfill contains metallic waste that contaminates the surface water and this was in line with the work conducted by Al Raisi et *al*., 2014.

(ii) Lead: It came due to the activities of gold miners, presence of metals and coal miners (Reddy *et al.*, 2012). Also, it shows that disposal of batteries, paints, plastics, and pipes (Al Raisi et al., 2014). The concentration of Lead at the SL1 was greater than that of SL2, SL3 and SL4 while that of SL1 was greater than the control value. The mean value of Lead was greater than Nigeria Standard for Drinking Water Quality but also less than maximum permitted WHO Standard. This means that the circular submerged pipe (metal) contaminated surface water at the landfill.

(iii) Nickel: it came to landfills due to rampant disposal of electronic wastes, circuit boards, computer chips and LCD displays, industrial activities, electroplating and household batteries (Abu-Daabes *et al.*, 2013). The Nickel values at SL1 and SL2 were greater than the WHO maximum limit concentration while that of SL3 and SL4 were less than the recommended value as shown in Table 3. The mean value (0.03mg/l) of Nickel was greater than the recommended value of Nigeria Standard for Drinking Water Quality as shown in Table 4. This means that the surface water at the centre and outside the circular submerged pipe was lowly contaminated due to the composition of the circular metallic pipe and the wastes inculcated in the landfill.

(iv) Manganese: This product came due to steel wastes from industrial activities, electroplating, spent rechargeable and household batteries (Abu-Daabes *et al.*, 2013). The values of manganese concentration at the landfill at SL1, SL2 and SL3 were greater than control sampling point (SL4) as shown in Table 3. The mean value of Manganese concentration within landfill was greater than the recommended value set by WHO and

Nigeria Standard for Drinking Water Quality. It can be inferred that the concentration of Manganese was low within the landfill site.

The study revealed that the presence of Iron, lead, Nickel and Manganese within the landfill poses serious health implication such as Cancer, interference with vitamin D metabolisms, affect mental development in infants, possible carcinogenic and Neurological disorder (Standard Organization of Nigeria, 2007). Also, the landfill area should not use for farming activities. During the raining season these heavy metals move from the landfill site to the Shiroro River which poses serious threat to the people living at the downstream of the river and the environment. This was in agreement with work conducted by Al Raisi et al., in 2014.

Table 3: Heavy Metal Properties of Surface Water

Sampling Point	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Zinc (mg/l)	Lead (mg/l)	Cadmium (mg/l)	Mercury (mg/l)	Vanadium (mg/l)	Nickel (mg/l)	Manganese (mg/l)	Boron (mg/l)
SL1	<0.001	<0.001	0.63	0.06	0.02	0.03	<0.001	<0.001	0.02	3.1	0.2
SL 2	<0.001	<0.001	0.09	0.02	<0.001	0.05	<0.001	<0.001	0.03	0.04	0.03
SL 3	<0.001	<0.001	0.13	<0.001	<0.001	0.05	<0.001	<0.001	<0.001	0.01	0.01
SL 4	<0.001	<0.001	1.4	<0.001	<0.001	0.005	<0.001	<0.001	0.01	<0.001	<0.001

Sources: Futminna WAFT Laboratory, 2015

Table 4: Heavy Metals Concentration in Shiroro Landfill Surface Water

Parameters	Mean Values	Control Values	NSWDQ 2007	WHO 2007
Chromium	-	<0.001	-	0.05
Copper	-	<0.001	1	0.05
Iron	0.28	1.4	0.3	0.3
Zinc	0.04	<0.001	3	5
Lead	0.02	<0.001	0.01	0.05
Cadmium	0.04	0.005	0.003	0.005
Mercury	-	<0.001	0.001	-
Vanadium	-	<0.001	-	-
Nickel	0.03	0.01	0.02	-
Manganese	1.05	<0.001	0.2	0.1
Boron	0.08	<0.001	-	-

4.0 Conclusions

The presence of heavy metals in Landfill site was assessed with the objective of ascertaining the status of the surface water. The study found out that different wastes in the landfill have changed both the physical and chemical properties of the surface water. The study indicates that Iron, lead, Nickel and Manganese were found within the landfill and these heavy parameters pose health risk such as Cancer, possible carcinogenic and Neurological disorder to people living downstream of the River. Also, the distance of the landfill was found to be less than 200m to Shororo River which makes the environment vulnerable to risk. The presence of heavy metals on surface water was low. It is therefore concluded that the surface water was unfit for drinking and farming purposes.

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