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Effect of Landfill Leachates on Some Water Quality Indicators of Selected Surface Water and Groundwater at Ilokun, Ado-Ekiti, Nigeria

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Abstract

This study was conducted to examine the impact of dumpsites on the quality of groundwater and surface water. The water samples and leachates were collected from dumpsites in respective zones. The physicochemical properties of the samples were examined and determined in accordance with the standards of the American Public Health Association. Results indicated that the groundwater and surface water that are close to the dumpsites have an electrical conductivity of 385 and 245 Sd/cm, total dissolved solids of 168 and 128 mg/L, a turbidity of 4.6 and 22 NTU, a total alkalinity of 103 and 50 mg/L, a total hardness of 120 and 80 mg/L, Ca concentration of 44 and 14 mg/L, Mg concentration of 0.2 and 15 mg/L, SO_4 concentration of 4 and 42 mg/L, Cl concentration of 38 and 16 mg/L, and NO_3 concentration of 6 and 8 mg/L, respectively. Moreover, the water near the dumpsites had higher elevated physicochemical properties compared with those far from the dumpsites; in addition, they were significantly different ($p \geq 0.05$). Hence, the closer the groundwater and surface water to the dumpsite, the greater the negative impact on the physicochemical properties of water. The pH concentration in leachate serves as an indicator for the age and mineralization status of dumpsites, and it influences the other chemical properties of the leachate. Furthermore, the pH concentration in leachate is inversely proportional to the concentration of Ca, Mg, and SO_4 in the study area.

Abstrak

Efek dari Lindi Tumpukan Sampah terhadap sebagian Indikator Kualitas Air dari Air Tanah dan Air Permukaan yang dipilih di Ilokun, Ado-Ekiti, Nigeria. Kajian ini dilaksanakan untuk menguji dampak dari tempat pembuangan sampah terhadap kualitas air tanah dan air permukaan. Sampel-sampel air dan lindi dikumpulkan dari tempat pembuangan sampah di dalam masing-masing zona. Sifat-sifat kimiafisik sampel diuji dan ditentukan sesuai dengan standar Asosiasi Kesehatan Publik Amerika. Hasil-hasilnya menunjukkan bahwa air tanah dan air permukaan yang dekat dengan tempat pembuangan sampah masing-masing memiliki suatu konduktivitas listrik sebesar 385 dan 245 Sd/cm, keseluruhan padatan terlarut sebesar 168 dan 128 mg/L, kekeruhan sebesar 4,6 dan 22 NTU, alkalinitas total sebesar 103 dan 50 mg/L, kesadahan total sebesar 120 dan 80 mg/L, konsentrasi Ca sebesar 44 dan 14 mg/L, konsentrasi Mg sebesar 0,2 dan 15 mg/L, konsentrasi SO_4 sebesar 4 dan 42 mg/L, konsentrasi Cl sebesar 38 dan 16 mg/L, dan konsentrasi NO_3 sebesar 6 dan 8 mg/L. Lebih jauh lagi, air di dekat tempat pembuangan sampah memiliki kenaikan sifat-sifat kimiafisik yang lebih tinggi dibandingkan dengan air yang jauh dari tempat pembuangan sampah; selain itu, air-air tersebut jauh berbeda ($p \geq 0{,}05$). Oleh karenanya, semakin dekat air tanah dan air permukaan ke tempat pembuangan sampah, semakin besar dampak negatifnya terhadap sifat-sifat kimiafisik air. Konsentrasi pH di dalam lindi berfungsi sebagai suatu indikator untuk status usia dan mineralisasi tempat pembuangan sampah, dan hal ini mempengaruhi sifat-sifat kimia lindi lainnya. Selanjutnya lagi, konsentrasi pH di dalam lindi berbanding terbalik dengan konsentrasi Ca, Mg, dan SO_4 di dalam wilayah kajian.

Keywords: groundwater, leachate, open dumpsite, surface water, water quality

1. Introduction

Groundwater is a major source of drinking water in urban and rural areas. The importance of groundwater for human survival cannot be overstressed until it had been recently considered a reliable source of uncontaminated water. In view of the fact that groundwater accounts for a major portion of water supply for domestic and industrial purposes, its quality should match domestic water standards. Groundwater pollution has been attributed to the process of industrialization and urbanization, which have progressively developed over time without any regard for environmental consequences [1]. These processes have eventually resulted in the deterioration of the physical, chemical, and biological properties of water [2].

Open dumping is one of the unfriendly waste disposal methods used worldwide. Waste decomposition in landfills is enhanced by moisture from precipitation and physical, chemical, and biological processes. Present in the landfill are solid, liquid, and gas phases. The gas phase consists of CO_2 and CH_4. By contrast, the liquid phase is chemically complex, and its composition is characterized by the presence of different types of dissolved organic and inorganic compounds and heavy metals. This liquid is called leachate, which accumulates at the bottom of the landfill and subsequently percolates slowly into the soil to contaminate the aquifers beneath it and in the adjacent surface water bodies. The rate of production and characteristics of leachates are determined by solid waste composition, particle size, degree of compaction, hydrology, age of the landfill, moisture, temperature, and available oxygen [3]. The age of the land fill controls the quality of leachates produced [1], [3], [4]. Slomwcznska and Slomcyznski (2004) reported that old landfills produce leachates that are alkaline in nature, i.e., leachates with a pH ranging from 8.0 to 8.5 [3]. Landfills whose leachate pH ranges from 3.5 to 6.5 indicate leachates that are generated during the initial period of waste decomposition. Longe and Balogun (2010) showed that leachate outflow and percolation are sources of pollution for groundwater and surface water adjacent to landfill sites [1]. Consequently, landfills constitute potential health hazards and environmental problems. Despite these deleterious effects, landfills have remained to be the cheapest and most widely accepted method of disposing municipal solid waste in most parts of the world [5], [6]. Open dumpsites or landfills pose serious threats to the quality of groundwater and surface water resources, especially when boreholes/shallow wells are closed with a low water table [1,7]. The degree of such threat is strongly influenced by the composition of the waste in the landfill and the volume of leachates generated, as well as the location of the dumpsite in relation to water bodies, such as groundwater and surface water [3]. Marshal (2005) and Wrench (2000) reported that dumpsites emit obnoxious odors and smoke [8,9], thereby causing illnesses and airborne chemical contamination via off-site migration of gases and dust particles, especially during the period of active site operation. If not controlled, landfill leachates may cause serious environmental problems due to the continuous discharge of heavy metals [10], [11]. As far as groundwater and surface water pollution are concerned, leachate quality deserves to be analyzed for the further prevention of environmental damage [12], [13]. Several researchers have reported that some of the water quality parameters of runoff-contaminated groundwater and surface water often increase during rainfall; high values of turbidity (TD), solids, and anionic species have often been recorded, especially in areas located near dumpsites [14]-[20].

Majority of the people in cities depend on shallow groundwater wells and boreholes for their potable water needs; this situation was promoted by the lack of public water supply infrastructure. Groundwater in the study area is often provided by quacks, and the potential of groundwater contamination by refuse dumpsites is often not considered when water wells are being drilled. These conditions, coupled with the high infiltration rates and high hydraulic conductivity of aquifers prevailing in the area, tend to make shallow wells prone to contamination by landfills and other non-sources. Marc (2006) reported that the location of dumpsites should be properly planned and managed to avoid risks to human health [21]; corrective and management measures are likely to be expensive and complex and pose serious threats to the environment and its habitants. In Nigerian cities, large populations are concentrated in some areas with poor sanitation conditions [22]. This situation has invariably led to an increased generation of waste. During rainfall, some of these wastes are washed into poor drainage systems and subsequently into nearby rivers [17]. The lack of town planning principles and strategies in Nigeria's cities and towns has aggravated the risks of urban runoff with a resultant effect on surface water.

Rainfall runoff carries pollutants from dumpsites to other locations. Moreover, such landfills could be dangerous and have a significant negative impact on the future risk assessment of landfills. However, information about the characteristics of landfill leachates under Nigerian conditions is lacking. Therefore, the objective of the current research is to examine the impact of dumpsites on surface and subsurface water and evaluate the characteristics of landfill leachates. The obtained data can help in the strategic management of landfills, thereby reducing the risk of these landfills in the environment of Ado-Ekiti, Nigeria.

2. Material and Methods

Site description. The study area is Ilokun (7° 30′ N, 05° 24′ E), which is located in the Ado local government area of Ekiti States in the southwestern part of Nigeria. Its human population is approximately 414,216. The area is characterized by tropical rainforests. The temperature ranges from 19 °C to 34 °C, with an annual mean temperature of approximately 24 °C. The average rainfall is approximately 350 mm. Hydro-geologically; the drainage pattern is dendritic due to a clayey weathered overburden overlying the basement complex rock. The study area was divided into three zones, namely, Z_1, Z_2, and Z_3. Each zone consists of three groundwater (boreholes), three surface water (rivers), and three compost (leachates) areas. Zone 1 groundwater, surface water, and leachate areas are denoted as GW_1, SW_1, and L_1, respectively. Correspondingly, those of Zones 2 and 3 are denoted as follows: GW_2 and GW_3 for groundwater, SW_2 and SW_3 for surface water, and L_2 and L_3 for leachate. When the dumpsite was visited, a handheld (mobile) global positioning system was used to geo-reference the location. The zone sampling locations are presented in Table 1.

Collection of water samples. Water samples were collected at a depth of 25 cm. The samples were stored in ten (20) sterilized 1 L plastic bottles for physiochemical parameter analysis. The required quality parametric analyses were performed in the next 24 hours. All the water sources, including the surface and groundwater around, near, or far from the dumpsite, were located. A total of 27 samples were collected from water sources, that is, nine samples each were collected from the surface water (flowing stream), groundwater (borehole), and compost (leachates) of the dumpsite.

Table 2 shows that the average distances of groundwater (GW_1, GW_2, and GW_3) source to the dumpsite are 120 ± 23, 129.5 ± 31, and 155 ± 45 m, respectively. The distances of surface water (SW_1, SW_2, and SW_3) source to the dumpsite are 38 ± 12, 120 ± 15, and 130 ± 55m, respectively.

Collection of leachates. Each sampling location was taken in triplicate (three different 250 mL bottles were filled at a sampling point) for physicochemical parameter analysis.

Table 1. Sampling Locations in IIokun

Zone/Location	SAMPLING
1: 7° 21′ N, 05° 19′ E	GW_1 SW_1 L_1
2: 7° 23′ N, 05° 20′ E	GW_2 SW_2 L_2
3: 7° 25′ N, 05° 21′ E	GW_3 SW_3 L_3

Table 2. Distance of the Water Sources from the Dumpsite and their Depth to the Water Table

Source	Distance from Dumpsite (m)	Depth to Water Table (m)
GW_1	120.0 ± 23	20.0 ± 2.5
GW_2	139.5 ± 31	27.8 ± 2.8
GW_3	155.0 ± 45	28.0 ± 2.7
SW_1	38.0 ± 12	
SW_2	120.0 ± 15	
SW_3	130.0 ± 55	

Sample measurements. Analysis of samples. The experiment was conducted from February 12th to 19th, 2017.

The collected samples were filtered through a 0.2 lm membrane and stored for chemical analysis. The following physicochemical properties of water were determined: pH, electrical conductivity (EC), total dissolved solids (TDS), TD, total alkalinity (TA), total hardness (TH), and Ca, Mg, SO_4, Cl, and NO_3 concentrations. The pH and EC were taken in situ with the aid of multiparameter EC-D 1152/215 model pH meters. Cation analysis was conducted using a flame atomic absorption spectrophotometer, whereas anions analysis was performed using the iron chromatographic method; the titrimetric method was used for SO_4. All the analyses were performed in accordance with the American Public Health Association [23]. Similarly, nine representative landfill leachate samples were collected and analyzed. All measurements were replicated four times.

Data analysis. Data were analyzed using descriptive statistics.

3. Results and Discussion

The results of the physicochemical parameters of groundwater, surface water, and leachate are presented in Tables 3, 4, and 5, respectively. The physicochemical parameters of the groundwater and surface water were compared with those of the World Health Organization [24] and National Agency for Food and Drug Administration and Control [25]. Meanwhile, those of leachate were compared with those of the Federal Environmental Protection Agency [26].

Composition of groundwater in the study area. The results of the physicochemical properties of groundwater in the study zones are presented in Table 3The results of the analyzed physicochemical properties, shown that the composition of groundwater in the zones (Z_1GW_1; Z_2GW_2; Z_3GW_3) ranged between pH, EC, TDS, TD, TA, TH, Ca, Mg, SO_4, Cl and NO_3 were pH (5.9–7.2; 6.2–7.3; 6.1–7.3); (312–458; 305–432; 299–413) mg/L; (148–198; 137–189; 131–172) mg/L; (4.5–5.7; 3.3–3.4; 3.3–3.5) NTU; (88–121; 70–107; 52–97) mg/L; (112–130; 89–127; 88–128) mg/L; 42–49; 41–44; 38–45) mg/L; (0.19–0.26; 0.18–0.25; 0.18–0.24) mg/L; (2–6.5; 2–5; 2–4.5) mg/L; (30–48; 29–39; 27-35) mg/L, and (5–7.3; 3–6; 2–6) mg/L respectively. The composition of the groundwater in the zones were within the recommended levels by WHO (2008) and NAFDAC (2004) [23], [24], except for TD for domestic use. The results indicated that the compositions in Z_1 were highest among the zones, except for pH, which was almost the same (Table 3). The compositions of the groundwater in Z_1 were significantly different ($p \geq 0.05$) from the other zones but were fairly constant in composition from location to location within the zone. The trend in the composition among the zones is presented in Figure 1. The highest values in Z_1 can be linked to the distance to the dumpsite and the depth of water table (Table 2) in relation to other zones. Other factors that may be attributed to soil properties are the texture and infiltration rate in the zone., Hence, the EC (385 Sd/cm), TDS (168 mg/L), TD (4.6 NTU), TA (103 mg/L), TH (120 mg/L), and Ca (44 mg/L), Mg (0.2 mg/L), SO_4 (4 mg/L), Cl (38 mg/L), and NO_3 (6 mg/L) concentration values were contaminated groundwater in Z_1. This finding agrees with Fatta *et al*. (2009) and Longe and Balogun (2010) [1], [7], who stated that open dumpsites or landfills pose contaminated groundwater resource quality, especially when the boreholes/shallow wells are closed with a low water table.

Physicochemical parameters of the groundwater in the study area: Composition of Surface Water in the Study Area. The results of the physicochemical properties of surface water in the study zones are presented in Table 4.

The results of the analyzed physicochemical properties, shown that the composition of surface water in the zones (Z_1GW_1; Z_2GW_2; Z_3GW_3) ranged between pH, EC, TDS, TD, TA, TH, Ca, Mg, SO_4, Cl and NO_3 were (6.6–8.2; 6.1–7.8; 6.4–7.4); (135–368; 115–148; 99–126) mg/L; (95–222; 80–104; 66–84) mg/L; (18-27; 9–14; 8–14) NTU; (34–70; 20–25; 11–19) mg/L; (58–105; 30–41; 23–36) mg/L; 8–23; 8–15; 5–7) mg/L; (11–20; 6–11; 4–6) mg/L; (36–55; 11–29; 13–19) mg/L; (56–82; 15–22; 10-14) mg/L, and (5–11; 4–8; 2–7) mg/L respectively. The composition of the surface water in the zones were within the recommended values by WHO (2008) and

Table 3. Mean and Standard Deviation of the Physicochemical Parameters of Groundwater

Parameters	Z_1GW_1	Z_2GW_2	Z_3GW_3	WHO	NAFDAC
pH	6.7 ± 0.5a (5.9–7.2)	6.7 ± 0.5a (6.2–7.3)	6.7 ± 0.6a (6.1–7.3)	6.5–8.5	6.5–8.5
EC (Sd/cm)	385 ± 71a (312–458)	365 ± 65b (305–432)	361 ± 62b (299–413)	1000	1000
TDS (mg/L)	168 ± 27a (148–198)	163 ± 25b (137–189)	151 ± 23b (131–172)	500	500
TD (NTU)	4.6 ± 0.1a (4.5–5.7)	3.4 ± 0.05b (3.3–3.4)	3.35 ± 0.09b (3.3–3.5)	0.0	5.0
TA (mg/L)	103 ± 18a (88–121)	86 ± 18b (70–107)	78 ± 16b (52–97)	150	150
TH (mg/L)	120 ± 18a (112–130)	112 ± 15b (89–127)	112 ± 14b (88–128)	150	150
Ca (mg/L)	44 ± 4a (42–49)	42 ± 2a (41–44)	42 ± 2a (38–45)	100	100
Mg (mg/L)	0.2 ± 0.05a (0.19–0.26)	0.2 ± 0.05a (0.18–0.25)	0.2 ± 0.04a (0.18–0.24)	0.2	0.2
SO_4 (mg/L)	4 ± 2a (2–6.5)	3 ± 1.5a (2–5)	3 ± 1a (2±4.5)	100	100
Cl (mg/L)	38 ± 8a (30–48)	35 ± 5b (29–39)	32 ± 3b (27–35)	250	250
$N0_3$ (mg/L)	6 ± 1.4a (5–7.3)	4 ± 1b (3–6)	4 ± 1b (2–6)	10	10

The above values are means of the four replicates (n = 4) in all treatments. The results presented are the mean values of each determination ± standard error mean (SEM). The means indicated by the same letter do not differ ($P \geq 0.05$), as assessed by Duncan's multiple range test (horizontal comparisons only).

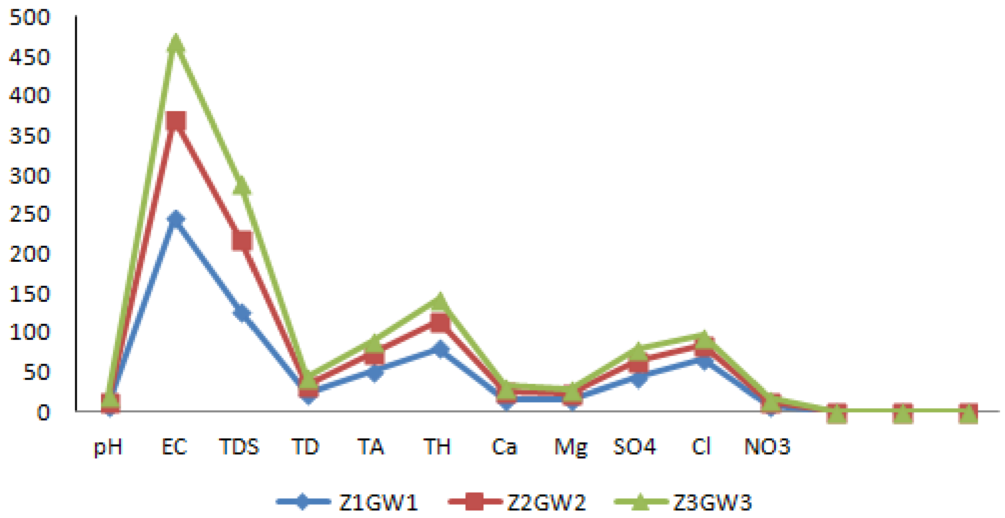

Figure 1. Variation between the Physicochemical Analyses of Groundwater in the Study Area

NAFDAC (2004), except for TD, Mg, and NO_3 in Z_1 that are suitable for domestic uses only. The findings indicated that the compositions in Z_1 were highest among the zones, except for pH, which was almost the same (Table 4). The compositions of surface water in Z_1 was significantly different ($P \geq 0.05$) from the other zones. The trend in the composition among the zones is presented in Figure 2. The characteristics of the surface water differ from the groundwater in terms of composition from location to location within the zone. The highest values in Z_1 can be linked to the distance to dumpsite and rainfall pattern (Table 2) in relation to other zones.
The findings are consistent with those of Jaji *et al*. (2007) [14], Mustapha (2008) [15], Taiwo (2011) [16], Taiwo *et al*. (2011) [17], Wakawa *et al*. (2008) [18], Osibanjo *et al*. (2011) [19], and Ajibade (2004) [20], who stated that the water quality parameters of ground and surface water were contaminated due to runoff and often increased during rainfall; high values of TD, solids, and anionic species have often been recorded, especially if the water is close to dumpsites.

Physicochemical Parameters of Leachate in the Study Area. The results of the physicochemical properties of leachate in the study zones are presented in Table 5. The results of the physicochemical properties analyzed, shown that the composition of leachate in the zones (Z_1GW_1; Z_2GW_2; Z_3GW_3) ranged between pH, EC, TDS,

Table 4. Mean and Standard Deviation of the Physicochemical Parameters of Surface Water

Parameters	Z_1SW_1	Z_2SW_2	Z_3SW_3	WHO	NAFDAC
pH	7.1 ± 0.6a (6.6–8.2)	6.4 ± 0.3a (6.1–7.8)	6.6 ± 0.5a (6.4–7.4)	6.5–8.5	6.5–8.5
EC (Sd/cm)	245 ± 110a (135–368)	125 ± 13b (115–148)	110 ± 15b (99–126)	1000	1000
TDS (mg/L)	128 ± 88a (95–222)	91 ± 12b (80–104)	72 ± 8b (66–84)	500	500
TD (NTU)	22 ± 5a (18–27)	12 ± 3b (9–14)	10 ± 3b (8–14)	0.0	5.0
TA (mg/L)	50 ± 17a (34–70)	24 ± 3b (20–25)	15 ± 4b (11–19)	150	150
TH (mg/L)	80 ± 20a (58–105)	35 ± 6b (30–41)	28 ± 5b (23–36)	150	150
Ca (mg/L)	14 ± 6a (8–23)	12 ± 4b (8–15)	6 ± 1c (5–7)	100	100
Mg (mg/L)	15 ± 4a (11–20)	8 ± 2b (6–11)	5 ± 1b (4–6)	0.2	0.2
SO_4 (mg/L)	42 ± 8a (36–55)	22 ± 4b (18–29)	16 ± 2b (13–19)	100	100
Cl	66 ± 5a (56–82)	18 ± 3b (15–22)	12 ± 3b (10–14)	250	250
NO_3	8 ± 2a (5–11)	5 ± 2b (4–8)	4 ± 2b (2–7)	10	10

The above values are the means of the four replicates (n = 4) in all treatments. The Results presented are the mean values of each determination ± SEM. The means indicated by the same letter do not differ ($P \geq 0.05$), as assessed by Duncan's multiple range test (horizontal comparisons only).

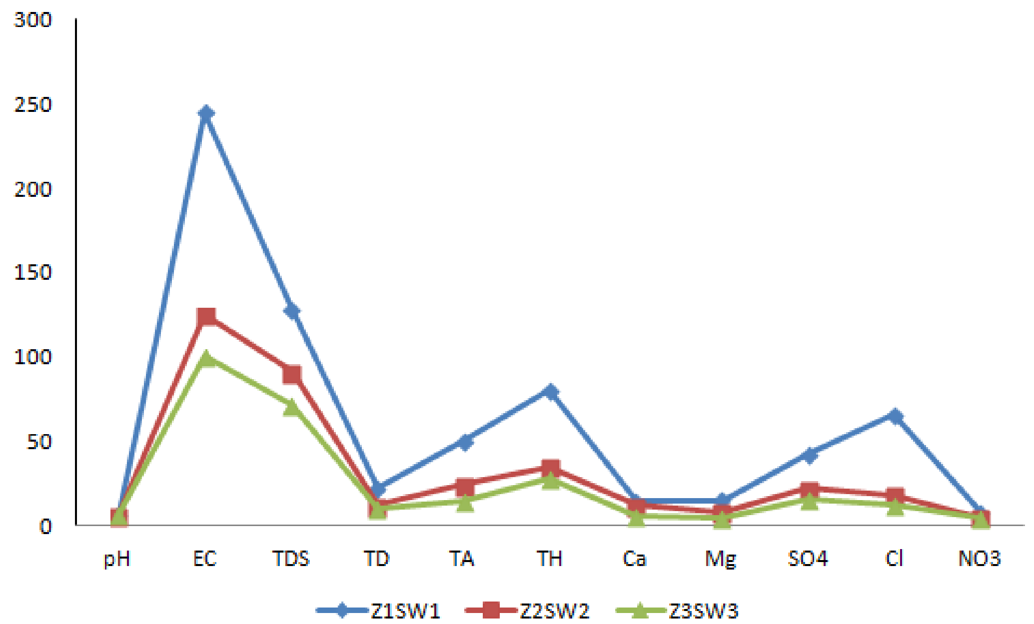

Figure 2. Variation between the Physicochemical Analyses of Surface Water

Table 5. Mean and Standard Deviation of the Physicochemical Parameters of the Leachate

Parameters	Z_1L_1	Z_2L_2	Z_3L_3	FEPA
pH	7.8 ± 0.3a (7.3–8.5)	6.3 ± 0.2ab (6.1–6.8)	4.5 ± 0.2b (5.2–6.6)	6–9
EC (Sd/cm)	53650 ± 5250a (52450–58390	35650 ± 4950b (33450–35480)	32650 ± 4650c (31650–33990)	NA
TDS (mg/L)	3945 ± 312a (3803–4185)	2475 ± 275b (2389–2537)	2432 ± 272b (2260–2429)	2000
TD (NTU)	56 ± 9a (50–66)	37 ± 7b (30–48)	30 ± 5b (24–36)	NA
TA (mg/L)	11011 ± 242a (9968–11268)	1782 ± 126b (1767–1924)	1680 ± 121b 1669–1717)	NA
TH (mg/L)	11812 ± 272a (11531–12095)	11520 ± 146b (11380–11649)	11224 ± 141b 11204–11366)	NA
Ca (mg/L)	253 ± 38a (219–298)	304 ± 44b (290–349)	276 ± 35b (242–313)	200
Mg (mg/L)	166 ± 8a (156–176)	204 ± 5b (199–210)	176 ± 6b (176–189)	200
SO_4 (mg/L)	835 ± 66a (760–926)	958 ± 45a (895–998)	902 ± 35a (885–950)	1000
Cl (mg/L)	1305 ± 131a (1285–1336)	1250 ± 123b (1231–1277)	1242 ± 121b (1120–1266)	600
NO_3 (mg/L)	40.4 ± 5.3a (31.5–46.8)	20.2 ± 4.3b (16.8–24.6)	18.4 ± 3.6b (15.2–22.5)	20

The above values are the means of the four replicates (n = 4) in all treatments. The results presented are the mean values of each determination ± SEM. The means indicated by the same letter do not differ ($P \geq 0.05$), as assessed by Duncan's multiple range test (horizontal comparisons only).

TD, TA, TH, Ca, Mg, SO_4, Cl and NO_3 were (7.3–8.5; 6.1–6.8; 5.2–6.6); (52450–58390; 33450–35480; 31650–33990) mg/L; (3803–4185; 2389–2537; 2260–2429) mg/L; (50-66; 30–48; 24–36) NTU; (9968–11268; 1767–1924; 1668–1717) mg/L; (11531–12095; 11380–11649; 11204–11366) mg/L; 219–298; 290–349; 242–313) mg/L; (156–176; 199–210; 176–189) mg/L; (760–926; 895–998; 885-950) mg/L; (1285–1336; 1231–1277; 1120-1266) mg/L, and (31.5–46.8; 16.8–24.6; 15.2–22.5) mg/L respectively. The compositions of the leachate in the zones exceeded the permissible limits by FEPA (1999) [25], except for pH and SO_4. The findings indicated that the composition of leachate in Z_1 was highest among the zones, except for Ca, Mg, and SO_4, whose values are the lowest (Table 5). The composition of leachate in Z_1 was significantly different ($P \geq 0.05$) from the other zones. The difference in the compositions of leachate among the zones may be attributed to the factors, including solid waste composition, operation mode of a landfill, climate and hydro-geological conditions, as well as conditions inside the landfill (biochemical activity, moisture, temperature, pH, and age of landfill). In Z_1, the leachate was alkaline in nature (pH 7.3–8.5), which indicates an old landfill. By contrast, the other zones were acidic (pH 5.2–6.8). The pH values in Z_2 and Z_3 were 6.1 and 5.2, respectively. These values are lower than that of Z_1 (pH 7.3), as reflected by the presence of carboxylic acids and bicarbonate ions, which contributed to higher values of SO_4, Mg, and Ca concentrations in Z_1 and Z_2. Therefore, Z_1 and Z_2 were proved as new landfills and indicated leachates that are generated during the initial period of waste decomposition. The pH concentration in leachate serves as an indicator for the age and mineralization status of dumpsites, and it influences the other chemical properties of the leachate. These findings are consistent with Slomwcznska and Slomcyznski (2004) [3], Jhamnani and Singh (2009) [4], and Longe and Balogun (2010) [1], who stated that the age of landfills controls the quality of leachate produced, and old landfills produce leachates that are alkaline in nature (pH 8.0–8.5). The old landfill as was indicated in zone 1, have majority, 72.7% of their physicochemical properties were high than other zones could have contributed to high values of groundwater and surface water that occurred in zone 1. This finding also agrees with Slomwcznska and Slomcynski, (2004) [3], who stated that the composition and volume of leachates generated, as well as the location of the dumpsite in relation to water bodies (groundwater and surface water), influence the degree of contamination of such water bodies. Therefore, the high composition of leachate in Z_1 reflects a high concentration of the physical and chemical compositions of groundwater and surface water in that zone.

4. Conclusion

The effects of open dumpsites on ground and surface water were evaluated. The results of this study indicate the following:

The concentration of the water qualities of groundwater in the different zones of the study area were within the recommended levels for domestic use, except for TD.

The compositions in Z_1 were the highest among the zones, except for pH, which was almost the same. The compositions of the surface water in the three zones were within the recommended levels, except for TD, Mg, and NO_3 in Z_1 that are suitable for domestic uses only.

The compositions in Z_1 were highest among the zones, except for pH, which was almost the same. The compositions of surface water in Z_1 was significantly different ($P \geq 0.05$) from the other zones. The compositions of the leachate in the zones exceeded the permissible limits by FEPA (1999) [25], except for pH, and SO_4 for effluent discharges into the environment. The compositions of leachate in Z_1 were the highest among the zones, except for Ca, Mg, and SO_4. The composition of the leachate in Z_1 was significantly different ($P \geq 0.05$) from the other zones. The depth of water table and distance from the landfill were attributed to the variations in the composition of ground and surface water. The pH concentration in leachate serves as an indicator for the age and mineralization status of dumpsites, and it influences the other chemical properties of the leachate.

Private participation in waste management should be encouraged at the local level. Moreover, proper monitoring and establishment of permanent dumpsites should be implemented.

Therefore, a dumpsite system should be developed to prevent the leakage and contamination of surrounding soil and groundwater. Furthermore, water sources should be located far from any recognized dumpsite; this suggestion is applicable to septic tanks at home.

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