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Hydrochemical Assessment of Groundwater around Lapite Dumpsite for Irrigation Water Quality in Ibadan, Southwestern Nigeria

HYDROCHEMICAL ASSESSMENT OF GROUNDWATER AROUND LAPITE DUMPSITE FOR IRRIGATION WATER QUALITY IN IBADAN, SOUTHWESTERN NIGERIA

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ABSTARCT

Due to the increase in population and industrialization growth, most countries in the world depend on groundwater to meet agriculture demands for food production. The increase in water contamination due to indiscriminate solid wastes has necessitated the assessment of water quality and its suitability for agricultural usage. Twenty four groundwater and ten stream water samples were randomly collected from the downslope and upslope side of the dumpsite for all the major physio-chemical parameters. The pH of water samples indicates slightly acidic to alkaline in nature. High concentrations of nitrate, total dissolved solids and electrical conductivity suggest the impact of the waste on the water resource. Assessment of irrigation water quality based on Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP), Permeability Index (PI) and Magnesium content (MC) indicated that most of the water samples fall within the permissible standard for irrigation water. Thus, the water should be used with caution on crops for long time agricultural sustainability.

Keywords: Groundwater, Lapite dumpsite, water quality, agricultural sustainability, Nigeria.

INTRODUCTION

The ever increase in human population and industrialization growth has led to increase in demand of water resources for agricultural purposes. This has cause relentless pressure and scarcity on the water resources in an effort to meet food requirement for the growing human population. It has been predicted that by 2050, the current world population of 7.3 billion will increase to over 9 billion people with special reference to developing countries of the world and about 70% increase in the present agricultural productivity will be needed to meet the food required for the predicted population growth (Zaman et al, 2018).

Plants require optimum water for their growth through the soil water to plant root zone, this is easier during the rainy season, as the soil water storage in root zone is incessantly recharged with the rain water, however the reverse is the case in dry season, thus irrigation is needed to retain the water in the root zone to an optimum level for higher crop yields and agricultural productivity (Kirda, 1997). Thus, irrigation can be defined as the method of providing water needed to recharge and fill the soil water storage in the root zone other than rainfall.

The quality and quantity of crops that can be produced depend greatly on characteristics of water used which in turn may differ in quality in term of its source, climate and geology. Also, the physical, chemical and biological characteristics of water may be influenced by human activities such as urbanization and industrialization and this may affect the quality of water used for irrigated agriculture (Sham Sad and Islam, 2005; Islam et al, 1999; Akintola, 2014). Water irrespective of their source (Surface or ground) contains impurities and dissolved salts; however, their quality depends on their intended use.

Chemical properties of water can influence the growth of plants directly through deficiency or toxicity or ultimately by changing the availability of nutrients in the plants, thus there is need to identify the water characteristics that are essential for plant growths, their concentration in water and their acceptable limits. Since water used for irrigation is essential for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment, there is need to assess the quality of any water used as an alternative source to natural precipitation for sustainable agricultural production.

The continuous usage of groundwater for irrigation could augment groundwater level, accumulation of salt in the water, increase nitrogen content of the water, thus affecting its suitability for intended use. This may also affect the properties of soil by preventing the plants from absorbing the water (Ramesh and Bhuvana, 2012, Tahmasebi et al, 2018). Several works have been done on contamination status of water resource from waste dumpsite, with major focus on the extent of groundwater contamination using geochemical indices to identify the groundwater contamination extent (Akintola, 2014). However, the assessment of ground water quality around a dumpsite in the study area has not been extensively investigated.

Ibadan is one of the cities in Nigeria where the rate of solid waste generation is highest. This result from combined effect of the large population (2.6 million according to 2006 census), lack of proper planning of indigenous areas, scarcity of resources, careless and improper dumping of wastes in open spaces, river banks, road sides, etc. (Akintola, 2014). Groundwater contamination within the vicinity of dumpsites has elicited public health concern in recent time and studies have shown that contaminants may infiltrate into the groundwater through permeable soils, weathered and fractured bedrocks.

Lapite Village, underlain by Basement Complex rocks, hosts one of the largest and most active dumpsite in Ibadan. Akintola (2014) stated that the dumpsite is located on permeable, weathered and fractured bedrocks and can permit infiltration of contaminants into the surrounding groundwater. Since the study area is semi-urban area and occupation of most people living in the area is farming, these make them to depend mostly on the surface and ground water during dry season for irrigation purposes. Thus, this study investigated the chemical characteristics of the water used for quality irrigation purposes.

MATERIAL AND METHODS

Study Area

The study area, Lapite village is within Akinyele Local Government area, Ibadan, Southwestern Nigeria (Figure 1). Ibadan which falls within two distinct seasons; the rainy season between April to October is characterised by high rainfall with a mean annual rainfall of about 1237 mm and dry season between November and March also characterised by dry dust laden winds originating from the Sahara' desert and experiences occasionally low rainfall (Olayinka et al., 1999). Average temperature reaches a peak of 28.8 ^{o}C in February and reaches a low of 24.5 ^{o}C in August. The study area which is within tropical rain forest of Nigeria is characterized by bush, herbs, shrubs, trees, grasses, palm vegetation with relatively high temperature and rainfall all through the year (Akintola, 2014). Most of the precipitation is received during the wet season and all the streams are perennial in nature.

The topography of the study area is generally undulating with height ranging from 246 to 265 m above sea level. The north-western part of the site has relatively lower elevation about 252 m compared to the other part of the site while the ground surface slopes gently towards a small stream (Akintola, 2014). The study area is well drained by streams and rivers and the direction of drainage is dendritic and controlled by fractures in the rocks.

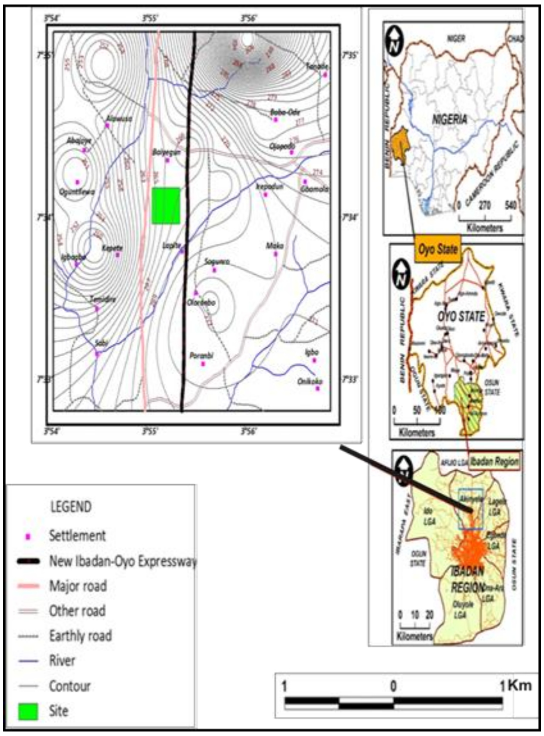

Figure 1: Location map of the study area (Akintola, 2014).

Geologically, the study area fall within Crystalline Basement Complex rocks of Southwestern Nigeria. They comprise igneous and metamorphic units such as gneisses, migmatites including older granite ridges and pegmatite. The major rock types in study area and it's environ are migmatite and banded gneisses and these are invariably fractured (Akintola, 2014). The rocks are coarse grained in texture and light grey in colour. Intrusions such as dolerite dyke, concordant and discordant quartz and pegmatite veins were seen in the rocks and these according to Akintola (2014) are 'Probable Avenue' for leachates to infiltrate into the groundwater source.

Sample Collection, Preparation and Analyses

Two samples each were collected from twenty four groundwater water points resulting into a total of forty eight water samples twenty four hand- dug wells from upslope and downslope sides of the dumpsite. Ten water samples were also collected from two streams (5 samples each) located at the downslope side of waste dump. All samples were collected by rinsing the bottles with the sample water and finally filled it with the water. Two sets of the water samples were collected into 60ml and 1-litre bottles at each sampling location and labelled accordingly. The water samples in 60ml bottles were acidified with 2 drops of nitric acid for stabilization to reduce the chemisorptions of trace metal ions onto the surfaces and to prevent the hydrolysis and precipitation of cations. Physiochemical parameters of the water (pH, Total Dissolved Solids, Electrical Conductivity and Temperature) were determined in the field using a DIGITAL SATO SK-632 pH/ Temperature meter and COND.METER MODEL CM-1K. The chemical analyses were done using the method of APHA (1998) for water analysis. Major ions such as Na^+ , K^+ , Mg^{2+} , Ca^{2+},Cl^-.NO_3^-. SO_4^{2-} andHCO_3^{--} were analysed using Ion Chromatography instrumentation technique (Metrohm 940 Professional IC Vario Model, Switzerland) while the trace elements (Zn, Cu, Ni and Pb) were determined using Atomic Absorption Spectrophotometer (AAS) model Accufys 211.

Analytical Procedure

Electrical conductivity (EC), TDS, pH, Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP), Permeability Index (PI) and Magnesium content (MC) were used to assess the appropriateness of water quality for irrigation purposes. The following equations were used to calculate some of the parameters used in assessing irrigation water quality.

Sodium adsorption ratio (SAR) is calculated using the equation 1 and the ionic concentrations are expresses in Meq/l (Ayers and Westcott, 1985 and Haritash, 2008)

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca2+ \; + Mg2+}{2}}} \quad (1)$$

Where, Na^{+}, Ca^{2+} and Mg^{2+} are in Meq/l. The milliequivalent per liter (meq/l) is calculated by dividing the concentration values in mg/l by atomic weight of ion and its ionic charge.

Soluble sodium percentage or percentage sodium can be expressed using equation 2 as stated by Joshi et al (2009) and Jala and Kamel (2012).

$$SSP = \frac{Na}{Ca + Mg + Na + k} \times 100 \quad (2)$$

Magnesium content, one of the most important qualitative criteria for assessing irrigation water quality is calculated in equation 3 by the formula given by Pitchaiah (1995).

$$MC = \frac{Mg}{Ca + Mg} \times 100 \quad (3)$$

All ions are expressed in Meq/l.

Permeability index is calculated in equation 4 by the method suggested by Domenico and Schwartz (1990) as follows:

$$PI = [(Na^{+} + HCO_3^{-}) / (Ca^{2+} + Mg^{2+} + Na^{+} 100)] \quad (4)$$

RESULTS AND DISCUSSION

Hydrochemical Studies

Temperature of the groundwater samples ranged from 27.01 ºC -27.10 ºC while that of the stream water range from 32.90 ºC -33.00 ºC (Table1). The pH of the groundwater samples from downstream side of the dumpsite were 5.5-6.50 with mean value of 6.30 while those from the upstream were 6.4 – 6.6 with mean value of 6.45. Values of pH for surface waters range from 5.50-6.90 (Table 1). The reduced pH observed in the studied water from the downslope side of the dumpsites could be attributed to the presence of humic acid associated with the biological decomposition of wastes and negative redox potential resulted from depletion of oxygen by organic matter organic matter could have depleted oxygen which could have resulted in a negative redox potential (Efe et al, 2005, Akintola, 2014). The mean values of pH for water samples are within the permissible values for irrigated agriculture given by DOE (1997).

Total Dissolved Solids (TDS) of groundwater samples from downstream and upstream are 201.11-700.01 mg/l and 187.87- 267.99mg/l respectively while that of stream water samples ranged from 719.07- 773.87 mg/l. The high values of the total dissolved solids in some of the water samples may indicate presence of more cations and anions in the water of the study area. Electrical Conductivity (EC) values of the groundwater samples from downstream and upstream are 267.56–1076.10 µS/Cm and 200.21-412.22 µS/Cm respectively while that of stream water samples ranged from 1100.02-1209.87µS/Cm. Electrical conductivity is an indication of amount of contaminants and dissolved solids in water or soil thus, EC levels of water greater than 200 µS/cm indicates the presence of the cations, anions and heavy metals (Akintola, 2014). However, both TDS and EC values of all the water samples were within the food and agricultural organisation (1998) standard for irrigation water.

Results of the major ions as presented in Table1 were as follows; Sodium ion (Na^+) concentrations in groundwater samples from downstream ranged from14.19 - 38.56 mg/l with mean value of 25.77 mg/l while those from upslope side were 12.22 - 26.7 1mg/l with mean values of 19.41 mg/l. Sodium ion (Na^+) concentrations in stream water samples ranged from 68.10- 70.25 mg/l with mean value of 69.18 mg/l/. Concentrations of K^+ in groundwater samples from downstream ranged from 9.99–14.30 mg/l with mean value of 10.72 mg/l while those from upslope side were 5.10 – 10.10 mg/l with mean values of 7.04 mg/l. Concentrations of K^+ in stream water samples ranged from 17.60- 18.20 mg/l with mean value of 17.90 mg/l.

Concentrations of Ca^{2+} in groundwater samples from downstream ranged from 23.99–37.83 mg/l with mean value of 29.40 mg/l while those from upslope side were 19.99 – 26.87mg/l with mean values of 21.74 mg/l. Concentrations of Ca^{2+} in stream water samples ranged from 33.20- 34.06 mg/l with mean value of 33.63mg/l. The concentrations of Mg^{2+} in groundwater samples from downstream ranged from13.22–22.40 mg/l with mean value of 17.30mg/l while those from upslope side were 10.16 – 17.00 mg/l with mean values of 15.00 mg/l.

Concentrations of Mg^{2+} in stream water samples ranged from 21.00 – 23.89 mg/l with mean value of 20.80 mg/l. Generally, about 22.23% of cations are in the order of Na>Ca>Mg>K while the other 77.77% are in the order of Ca>Na>Mg>K. High values of Ca to Na may be accredited to the mineralogical composition of rocks in the study area. Low concentration of cations in water may be attributed to diminutive or no interface with the underlined rocks (the principal source of cation) since all the water is collected within the vadose zone (Akintola, 2014). Chloride (Cl^-) concentration in groundwater samples from downstream ranged from176.40–288.10 mg/l with mean value of 234.11mg/l while those from upslope side of the dumpsite were 121.85 – 250.86 mg/l with mean values of 147.90 mg/l. Concentrations of Cl^- in stream water samples ranged from 235.20 -291.60 mg/l with mean value of 263.40 mg/l. Chloride generally increases as the mineral contents increases and water containing more than 250 mg/l of Cl^- is usually tasty (Dubey, 2010). However, it was observed that about 40% of all the studied water contains chloride concentration less than 250 mg/l. The low chloride concentration in some of the water samples may be attributed to the presence of low mineral contents in the water. Concentrations of NO_3^- in groundwater samples from downstream ranged from 27.89 – 63.50 mg/l with mean value of 29.73 mg/l while those from upslope side of the dumpsite were 6.11 – 15.20 mg/l with mean value of 9.85 mg/l. Concentrations of NO_3^- in stream water samples ranged from 49.75 – 72.20 mg/l with mean value of 60.98 mg/l. Sources of nitrate in groundwater could be from natural sources, waste material and irrigated agricultural practices (Canter, 1996). The natural source of nitrate is usually less than 10 mg/l and concentration above this value suggests anthropogenic sources (Hermandez- Grace and Custodio, 2004, Oloruntola and Adeyemi, 2014)). Thus, water samples from downslope side of the dumpsite are being impacted by the wastes from the dumpsite since their values are more than 10 mg/l. Bicarbonate (HCO_3^-) concentrations in groundwater samples from downstream ranged from 165.30 – 232.12 mg/l with mean value of 193.39 mg/l while those from upslope side of the dumpsite were 92.11 – 200.91 mg/l with mean value of 111.29 mg/l.

Table 1: Statistical values of some of the determined parameters in the water samples.

Location	Water source	Statistical Parameter	Temp (^{O}C)	pH	TDS (mg/l)	EC (µm/S)	Na	K	Ca	Mg	No_3^-	Cl^-	HCO_3^-	SO_4^{2-}
							Mg/l							
DWSD	GW	Minimum	27.07	5.50	201.11	267.56	14.19	9.99	23.99	13.22	27.89	176.40	165.30	247.29
		Maximum	27.20	6.50	700.21	1076.01	38.56	14.3	37.83	22.40	63.50	288.10	232.12	360.79
		Mean	27.12	6.30	351.33	537.32	25.77	10.72	29.40	17.30	29.73	234.11	193.39	248.20
	SW	Minimum	32.90	5.50	719.07	1110.02	68.10	17.60	33.20	21.00	49.75	291.60	224.10	385.20
		Maximum	33.00	6.60	773.82	1209.87	70.25	18.20	34.06	23.89	72.20	263.40	230.00	415.70
		Mean	32.95	5.55	746.45	1159.95	69.18	17.90	33.63	20.80	60.98	235.20	227.05	400.45
UPSD	GW	Minimum	27.01	6.40	187.87	200.21	12.22	5.10	19.99	10.16	6.11	121.85	92.11	151.75
		Maximum	27.10	6.50	267.99	412.22	26.71	10.10	26.87	17.00	15.20	250.86	200.91	279.25
		Mean	27.08	6.45	210.13	304.97	19.45	7.04	21.74	15.00	9.85	147.90	111.29	189.97

DWSD- Downslope side of the dumpsite, UPSD- Upslope side of the dumpsite, Gw- Groundwater; Sw-Surface water.

Table 2: Statistical values of some of the determined trace elements in the water samples.

Location	Water source	Statistical Parameters	Trace elements (Mg/l)					
			Fe	Zn	Cu	Pb	Ni	Mn
DWSD	GW	Minimum	0.38	0.36	0. 10	0.10	0.10	0.01
		Maximum	3.46	3.51	3.40	3.20	3.41	1.20
		Mean	1.73	1.05	1.09	1.03	0.89	0.47
	SW	Minimum	0.21	0.60	0.06	0.79	0.21	0.29
		Maximum	3.66	4.04	1.52	0.69	2.21	1.25
		Mean	1.92	3.32	0.78	0.74	1.21	0.77
UPSD	GW	Minimum	0.31	0.43	0.32	0.31	0.05	0.09
		Maximum	0.52	0.75	0.88	0.54	0.14	0.12
		Mean	0.41	0.56	0.31	0.34	0.09	0.12

Concentrations of HCO_3^- in stream water samples ranged from 224.10 – 230.00 mg/l with mean value of 227.05 mg/l. Also, sulphate (SO_4^{2-}) concentrations in groundwater samples from downstream ranged from 247.29 – 360.79 mg/l with mean value of 248.20 mg/l while those from upslope side of the dumpsite were 151.75 – 279.29 mg/l with mean value of 189.97 mg/l. Concentrations of SO_4^{2-} in stream water samples ranged from 385.20 – 415.70 mg/l with mean value of 400.45 mg/l. However, some of the groundwater samples have the concentrations of sulphate more than 250 mg/l suggested for good irrigation water quality by Raghunath (1987).

Results of trace elements in the water samples were presented in Table 2. The respective mean values of Fe, Zn, Cu, Pb, Ni and Mn in groundwater samples from the downslope side of the dumpsites were 1.73, 1.05, 1.09, 1.03, 0.89 and 0.47 mg/l while those from the upslope side were Fe (0.41 mg/l), Zn (0.56 mg/l), Cu (0.31 mg/l), Pb (0.34 mg/l), Ni (0.09 mg/l) and Mn (0.12 mg/l). The mean concentrations of the trace elements in the stream water samples were Fe (1.92 mg/l), Zn (3.32 mg/l), Cu (0.78 mg/l), Pb (0.74 mg/l), Ni (1.21 mg/l) and Mn (0.77 mg/l).

Generally, the results of study indicated higher concentrations of the determined parameters in the water samples from the downslope side of the dumpsite than the upslope and this suggest the impact of the wastes on the water resources in the study area.

Irrigation Water Quality Assessment

The various parameters used in assessing the water in the study area for irrigation purposes are presented in Table 3.

PH

The pH of most of the water samples are within the permissive range of 6.5 to 8.4 for irrigation water (Bauder and Brock, 2001; Ramakrishnaia et al., 2009; Bauder et al., 2010). However some of the water samples were below 6.5 and this according to Akintola et al., (2017) may cause corrosion in the irrigation system due to their acidic nature. The pH of irrigation water greater than the permissive range may cause a dietetic disproportion as well as inclusion of toxic ions that may cause hazard effects on the crop production.

Total Dissolved Salts (TDS)

The values of TDS in groundwater samples from all the wells ranged from 187.87 to 700.21 mg/l while surface water samples are between 719.09 and 773.82 mg/l (Table 3). Comparing this with Table 4, the water samples from the study area can be considered as permissible for irrigation but leaching will be needed before use.

Electrical Conductivity (EC)

The most significant irrigation water quality is salinity hazard and it is measured in terms of electrical conductivity values in the water (Ahmed et al., 2004). In this study, electrical conductivity (EC) values in groundwater samples ranged from 200.21 - 1076.01 µS/cm while surface water range between 1020.90 and 1100.01 µS/cm (Table 3). The water samples can be considered as permissible for irrigation as indicated in Table 4.

Chloride Hazard

The chloride concentration of groundwater samples in this study ranged from 121.85–288.10 mg/l while that of stream water samples ranged from 235.20 -291.60 mg/l. The water samples fall within good to moderate irrigation water quality classification given by Mass (1990).

Table 3. Range values of important Parameters used in assessing Irrigation Water Quality.

Water sample source	Statistical parameter	pH	TDS(mg/l)	EC(µs/cm)	Cl^-	SAR	SSP	MC	PI
Groundwater	Minimum	5.50	187.87	200.21	121.85	1.00	19.22	45.46	61.03
	Maximum	6.50	700.21	1076.01	288.10	1.42	25.01	49.19	101.10
Stream water	Minimum	5.50	719.09	1020.90	235.20	1.25	20.09	49.34	111.21
	Maximum	6.60	773.82	1100.01	291.60	1.65	31.52	50.11	124.21

Table 4: Permissible limits for classes of irrigation water (URL1).

Classes of water	Electrical conductivity(µs/cm)	Total dissolved solids(Mg/l)
1 Excellent	250	175
2 Good	250-750	175-525
3 Permissible[1]	750-2000	525-1400
4 Doubful[2]	2000-3000	1400-2100
5 Unsuitable[2]	>3000	>2100

[1] *Leaching is needed if used*
[2] *Good drainage is needed and sensitive plants will have difficulty.*

Table 5: Sodium hazard of water based on Sodium Adsorption Ratio (SAR) values.

SAR	Sodium hazard of water	Comments
0-10	Low	Use on sodium sensitive crops must be cautioned
10-18	Medium	Amendment and leaching are needed
18-26	High	Generally unsuitable for continuous use
>26	Very high	Generally unsuitable for use

Source: URL 1

Mass (1990) classified water as excellent (<70 mg/l), good (70-140 mg/l), moderate (141-350mg/l) and as poor irrigation quality when it is greater than 350mg/l/. Chloride as important as it is to plants can be toxic to sensitive crops at high concentrations (Bauder et al., 2010). High chloride content between 0.3 and 1.0 percent can cause leaf burn in high evaporation conditions (Akintola et al, 2017).

Sodium Hazard

High concentration of sodium in soil can result into soil dislodgement and dryness which in turn can cause dispersion thus affecting the soil structure, stability and aggregates (Rengasamy and Olsson, 1993). Thus, the high concentration of cations in water (calcium, sodium, potassium and magnesium) when used for irrigation can result into soil sodicity. Factors such as texture, organic matter content, plant species and types, climate, geology among others can also affects sodium hazard in irrigation water (Akintola et al., 2017).

Sodium hazard as explained by Sodium Adsorption Ratio (SAR) is the ratio of sodium to calcium and magnesium. It is one of the useful criteria for assessing the suitability of irrigation water for sustainable agricultural production. Table 3 showed the values of SAR for all the water samples in the study area. The values which ranged between 1.00-1.65 in the water samples can be considered as low sodium hazard based on the classification given in Table 5. However, the water should be used with care on sodium sensitive plants.

USSL salinity chart (Figure 2) suggests that 29.41 % of the water samples were within C1-SI (low sodium to low salinity hazard), 47.06 % of the water samples fall under C2-S1 (low sodium to medium salinity hazard) while the remaining 23.53 % were within the C3-S1 (low sodium to high salinity hazard).

Soluble Sodium Percentage (SSP)

The values of SSP in water samples are between 19.22 and 31.52% and this fall within excellent to good class for irrigation water quality based on the classification given by Srinivasa Reddy (2013). Ninsanthiny et al., (2010) stated that SSP of irrigation water greater than 60% may lead to soil sodicity and can affect soil structure, infiltration, aeration and permeability of the soil.

Magnesium Content (MC)

Magnesium content of water has been used by several researchers for determination of irrigation water quality (Pitchaiah, 1995; Akintola et al., 2017, Tahmasebi et al., 2018). Magnesium content of the studied water varies from 40.07 mg/l to 52.50 mg/l (Table 3). Thus, the water samples may be considered as permissible for irrigation purpose based on the classification given by Pitchaiah, 1995. When the magnesium concentration in water is high, the soils become more alkalinic in nature and will have negative impact on the crops (Akintola et al., 2017; Khanoranga, 2019; Xu et al., 2019).

Permeability Index (PI)

This is used to appraise the sodium hazards of irrigation water. Permeability index (PI) was proposed by Doneen (1966) to measure the likely influence of long term usage of water for crops on soil permeability, soil structure, infiltration, and texture as well as some chemical properties of water.

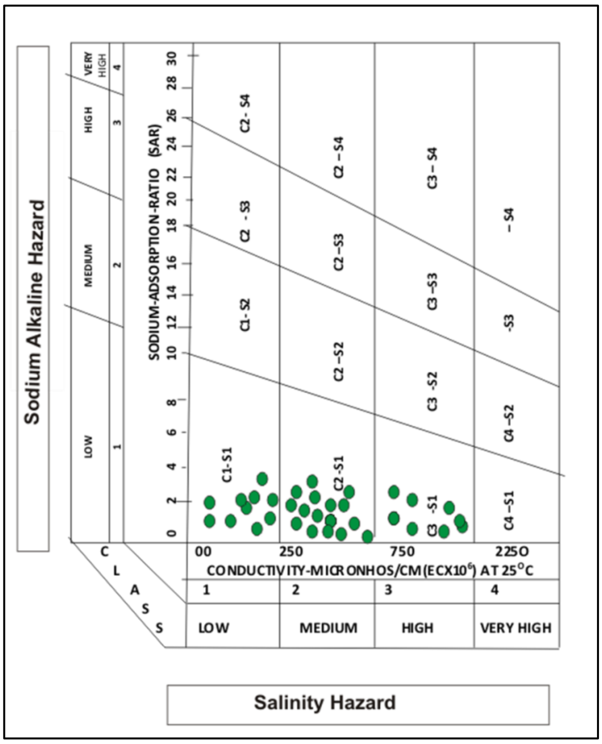

Figure 2: Plot of SAR and EC on USSL Salinity chart (USSL, 1954).

The irrigation water quality was classified into three classes based on PI: class1 (> 75%, excellent for irrigation), class 11 (50 -75%, permissible) and class 111 (< 50% unsuitable for irrigation. The PI values of all the water samples in this study ranged between 54 and 124.21 % and these fall within the permissible class for irrigation water quality as given by Doneen (1966).

CONCLUSION

The determined parameters in the water samples from the downslope side of the dumpsite were higher than those from upslope and this suggest the impact of the wastes on the water resources. Most of the determined parameters were within the permissible standard for irrigation water quality. The water samples fall within low sodium hazard as well as low to high salinity hazard. This study has thus showed that water resource in the area are permissible for use for irrigation purposes and should be used with caution on crops for long time agricultural sustainability.

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