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Assessment of Some Physicochemical Parameters around Gold Mining Areas of Rimi, Sumaila Local Government Area, Kano State, Nigeria

Musa Yahaya Abubakar[1], Mudwa Danladi Dwanga[2], Ansar Bilyamin Adam[3], Shitu Muhammad Abubakar[4]

[1,2,3]Federal University Wukari, Nigeria; [4]Federal University Jos, Nigeria
yahayaabubakarmusa2015@gmail.com

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Abstract

This study investigates the physicochemical parameters of ten hand-dug wells in Rimi Sumaila L.G.A. of Kano State. The parameters studied were pH, electrical conductivity, hardness, alkalinity, and turbidity. As a result of the studies, pH was between 7.18 and 8.55. The result shows that some areas, including Kofar Gabas, Kofar Kudu, Kofar Arewa, Company I, Company II, Company III, U.Kachaka, U.Dukawa, and U.Kuka, are alkaline in nature, while the pH in Kofar Yamma was 7.18, which is neutral. The electrical conductivity shows variation, such that the lowest value of conductivity was observed in Company III at 142 µS/cm, while the highest value was observed at Kofar Gabas at 708 µS/cm. The hardness was ranged between 173 and 370 mg/L. The highest values were observed at Kofar Gabas, and the lowest values were observed at Ukuka. The total hardness of water is the total soluble magnesium and calcium salts present in the water, expressed as CaCO3. The alkalinity analyzed ranged between 14 and 38 mg/L. The highest values were observed at U. Dukawa and the lowest values were observed at U. Kachaka, and the turbidity of the water analyzed ranged between 1 and 8.3 NTU. The highest

values were observed at Company I, and the lowest values were observed at K. Arewa and U. Kuka.

Keywords: Gold Mining Areas, pH, Electrical conductivity, Hardness, Alkalinity, Turbidity

INTRODUCTION

Gold mining operations, particularly in developing nations, frequently have a substantial negative impact on the environment. One of the main issues is the change of physicochemical parameters in adjacent soils, water bodies, and air. These parameters, which include dissolved oxygen levels, pH, electrical conductivity, turbidity, and concentrations of heavy metals, are important markers of environmental health, and evaluating them near gold mining areas can provide information about the degree of environmental degradation and possible threats to human and ecological health.

Water is the most vital substance for all life on earth and a valuable resource for human refinement. It is one of the basic requirements of life. About 70% of human body is composed of water. Increasing demand and shortage of clean water sources due to the growth of industries, population and droughts have become a concern worldwide (Mohammed, A. D, *et al.,* 2024).

Water is a crucial substance for living organisms, consisting of transparent, tasteless, odourless, and nearly colorless substances. It is the main constituent of Earth's hydrosphere and fluid of most living organisms. Its chemical formula is H2O, containing one oxygen and two hydrogen bonds. Water exists in solid, liquid, and gaseous states (CIA, 2010), studies have shown that over one billion people in the world lack access to safe drinking water and 2.5 billion people do not have access to adequate sanitation (tar *et* al., 2009) increasing number of people in urban and semi urban areas in the world defend on dug well and water vendors for water supply (Idowu *et* al., 2011).

Solutions with high concentration of hydrogen ions have a low pH and solutions with low concentration of hydrogen ion have a high pH. As samples pH changes, precipitation, co precipitation and coadoption can occur which affect the samples chemical composition and reaction rate. pH was found to be positively correlated with electrical conductance and total alkalinity (Guptaa, 2009).The pH of drinking water quality standard

is within 6.5-8.5 (WHO). The higher pH values observed suggest that carbon dioxide, carbonate, bicarbonate equilibrium is affected more due to change in physicochemical conditions (Karanth, 1987).The pH is measured using pH meter and it is expressed in moles per liter.

$$pH=-\log[H^+]$$

Alkalinity is the capacity of water to resist changes in pH that would make the water more acidic (Water research centre, 2014).It is measured in milligram per liter. The presence of calcium carbonate or other compounds such as magnesium carbonate contributes carbonate ions to the buffering system. Alkalinity is often related to hardness because the main sources are from carbonate rocks (limestone) which are mostly $CaCO_3$ (WHO). The recommended standard for portable drinking water of alkalinity is 100mg/L.

Turbidity is the visible reduction in water clarity due to the presence of suspended matter, which absorbs or scatters light (Grobbelaar, 2009). Turbidity, also known as haziness or milkyness, is caused by fine particles scattering light at a 90-degree angle to the direction of the light entering the sample (Woodard, 2006).It is expressed in NTU (Nephelometric Turbidity Units).the world health organization recommended standard for portable water of turbidity is within 1-5NTU.

Conductivity in water is the capability of water to allow the passage or flow of electric current through it. This ability is directly related to the concentration of ions in the water (Wetzel and San diego, 2001). This conductive ion comes from dissolve salt and inorganic materials such as alkali, sulfides and carbonates compounds. The dissolved ions are known as the electrolytes (Langland *et al.*, 2003). The conductivity depends on the presence of ions, their total mobility, valence, relative concentration and temperature. Solutions of most inorganic acid, bases and salt are relatively good conductors (Muthukumaravel, 2010).

Water hardness is the amount of dissolved calcium and magnesium ion in water. Hard water usually consists of highly dissolved calcium and magnesium ions and sometimes traces of iron, strontium and aluminum many partum ions (Nsi, 2007). Ground water is usually prone to hardness since water moves through soil and rocks thereby dissolving small amount of naturally occurring minerals. Hardness is not usually caused by the presence of single dissolved ion but by a variety of dissolved polyvalent metallic ions. Hardness can either be permanent or temporary which can be expressed in terms of presence of carbonate and non-carbonate respectively (WHO). It is commonly expressed in milligrams of calcium carbonate equivalent per litre (WHO).

MATERIALS AND METHODS

Sample Collection and Preparation

Water samples were collected from ten (10) different hand dug well in Rimi village, Sumaila Local Government, Kano State using polythene plastic containers prewashed with detergent. Samples for heavy metal analysis were preserved by adding few drops of 1 Molar HNO_3 (Manilla and Frank, 2009).

Determination of pH

The pH of the water samples was carried out in-situ using digital pH meter standardized with buffer solution. The pH meter's electrode was dipped into 100 cm^3 of a water sample and the reading was recorded (APHA, 2005).

Determination of electrical conductivity

This was done using a conductivity meter. The meter's electrode was immersed into (50) mL of the water samples until a stable reading was recorded.

Determination of total hardness of water

1 to 2 drops of buffer solution were added to 50 cm^3 of the water sample in a conical flask and stirred for homogeneity. 3 drops of eriochrome black T indicator was added and a pink coloration was observed. The sample was then titrated against 0.1 M EDTA until a blue coloration was observed. The titre value obtained was multiplied with 10 as the approved conversion factor and the total hardness was expressed in mg/L. The same procedure was repeated for the other samples (Adelunleet al., 2007).

Turbidity Test

Turbidity of the sample was analysed using Turbidity meter, the test tube is rinsed with deionised water (turbidity free), filled to the 10ml line with deionised water, inserted into the colorimeter chamber and scanned to calibrate the instruments (blanking). The second tube is rinsed, filled to 10ml line with sample water, shook to re-suspend particulate matter and inserted into the chamber to scan the sample. The result was recorded (in NTU).

Determination of Alkalinity

10ml of water sample was measured in to a conical flask, 2 drops of phenolpthalein indicator was added, 2 to 3 drop of methyl indicator was also added and shake vigorously to produce orange color. The solution was then titrated agains sulphuric acid until a red

color was observed. The volume of acid was recorded and multiplied by 10 to obtain the value of Alkalinity in milligram per litre.

Materials

Water sample, phenolpthalein indicator, eriochrome black T indicator

RESULTS

Table 1: Mean and Standard Deviation Values of pH (mg/L)

SAMPLE SITE	1ST VALUE	2ND VALUE	3RD VALUE	MEAN ± STDV
Kofar Gabas	8.13	8.14	8.11	8.14 ± 0.040
Kofar Yamma	7.18	7.17	7.19	7.18 ± 0.010
Kofar Kudu	8.14	8.17	8.18	8.16 ± 0.020
Kofar Arewa	7.99	7.99	8.02	8.00 ± 0.017
Company I	8.54	8.54	8.57	8.55 ± 0.017
Company II	7.92	7.95	7.92	7.93 ± 0.017
Company III	7.73	7.76	7.73	7.75 ± 0.017
U. Kachaka	8.04	8.02	8.03	8.03 ± 0.010
U. Dukawa	8.18	8.24	8.22	8.22 ± 0.036
U. Kuka	8.48	8.51	8.51	8.50 ± 0.017

Table 2: Mean and Standard Deviation Values of Electrical Conductivity (mg/L)

SAMPLE SITE	1ST VALUE	2ND VALUE	3RD VALUE	MEAN ± STDV
Kofar Gabas	705.0	709	710.0	708 ± 2.65
Kofar Yamma	706.0	709	706.0	707 ± 1.73
Kofar Kudu	462.0	463	464.0	463 ± 1.00
Kofar Arewa	450.0	450	450.0	450 ± 0.00
Company I	356.0	359	362.0	359 ± 3.00
Company II	259.0	259	259.0	259 ± 0.00
Company III	140.3	142	144.0	142.1 ± 1.85
U. Kachaka	248.0	250	252.0	250 ± 2.00
U.Dukawa	153.1	156	156.2	155.1 ± 1.79
U. Kuka	314.0	317	317.0	316 ± 1.73

Table 3: Mean and Standard Deviation Values of Hardness (mg/L)

SAMPLE SITE	1ST VALUE	2ND VALUE	3RD VALUE	MEAN ±STDV
Kofar Gabas	369.0	372.0	369.0	370 ± 1.73
Kofar Yamma	306.0	310.0	311.0	309 ± 2.64
Kofar Kudu	268.0	268.0	271.0	269 ± 1.73
Kofar Arewa	250.0	250.0	252.0	250 ± 2.24
Company I	138.0	141.3	140.7	140± 1.75
Company II	116.0	116.5	118.5	117 ± 1.32
Company III	175.0	174.5	175.5	175 ± 0.50
U. Kachaka	119.5	122.0	121.5	121 ± 1.32
U. Dukawa	119.5	120.0	120.0	120 ± 0.50
U. Kuka	172.5	173.5	173.0	173 ± 0.50

Table 4: Mean and Standard Deviation Values of Turbidity

SAMPLE SITE	1st VALUE	2nd VALUE	3rd VALUE	MEAN ± STDV
Kofar Gabas	3.9	3.6	3.9	3.8 ± 0.173
Kofar Yamma	4.1	4.4	4.1	4.2 ±0.173
Kofar Kudu	3.0	3.0	3.0	3.00±0.000
Kofar Arewa	1.0	1.0	1.0	1 ± 0.000
Company I	8.3	8.2	8.4	8.3 ± 0.141
Company II	5.4	5.6	5.5	5.5 ± 0.141
Company III	2.8	2.8	3.1	2.9 ± 0.173
U.Kachaka	3.3	3.1	3.2	3.2 ± 0.141
U.Dukawa	3.1	3.2	3.0	3.1 ± 0.141
U.Kuka	1.0	1.0	1.0	1 ± 0.000

Table 5: Mean and Sandard Deviation Values of Alkalinity (mg/L)

SAMPLING SITE	1ST VALUE	2ND VALUE	3RD VALUE	MEAN + STDV
Kofar Gabas	19.00	21.00	20.00	20 ± 1.00
Kofar Yamma	28.00	30.00	29.00	29 ± 1.00
Kofar Kudu	28.00	29.00	33.00	30 ± 2.64
Kofar Arewa	24.50	25.30	25.20	25 ± 0.43
Company I	30.00	30.00	30.00	30 ± 0.00
Company II	25.00	25.00	25.00	25 ± 0.00
Company III	19.00	22.00	22.00	21 ± 1.73
U. K achaka	12.00	13.00	17.00	14 ± 2.64
U. D ukawa	36.00	39.00	39.00	38 ± 1.73
U. Kuka	21.00	21.00	21.00	21 ± 0.00

Table 6: Physicochemical Parameters Compared with WHO Standard

SAMPLE SITE	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Turbidity (mg/L)
Kofar Gabas	8.13	708.0	20	370	3.8
Kofar Yamma	7.18	707.0	29	309	4.2
Kofar Kudu	8.16	463.0	30	269	3.0
Kofar Arewa	8.00	450.0	25	250	1.0
Company I	8.55	359.0	30	140	8.3
Company II	7.93	259.0	25	117	5.5
Company III	7.73	142.0	21	175	2.9
U. Kachaka	8.03	250.0	14	121	3.2
U. Dukawa	8.22	155.1	38	120	3.1
U. Kuka	8.50	317.0	21	175	1.0
WHO Standard	**8.50**	**1000**	**100**	**500**	**5.0**

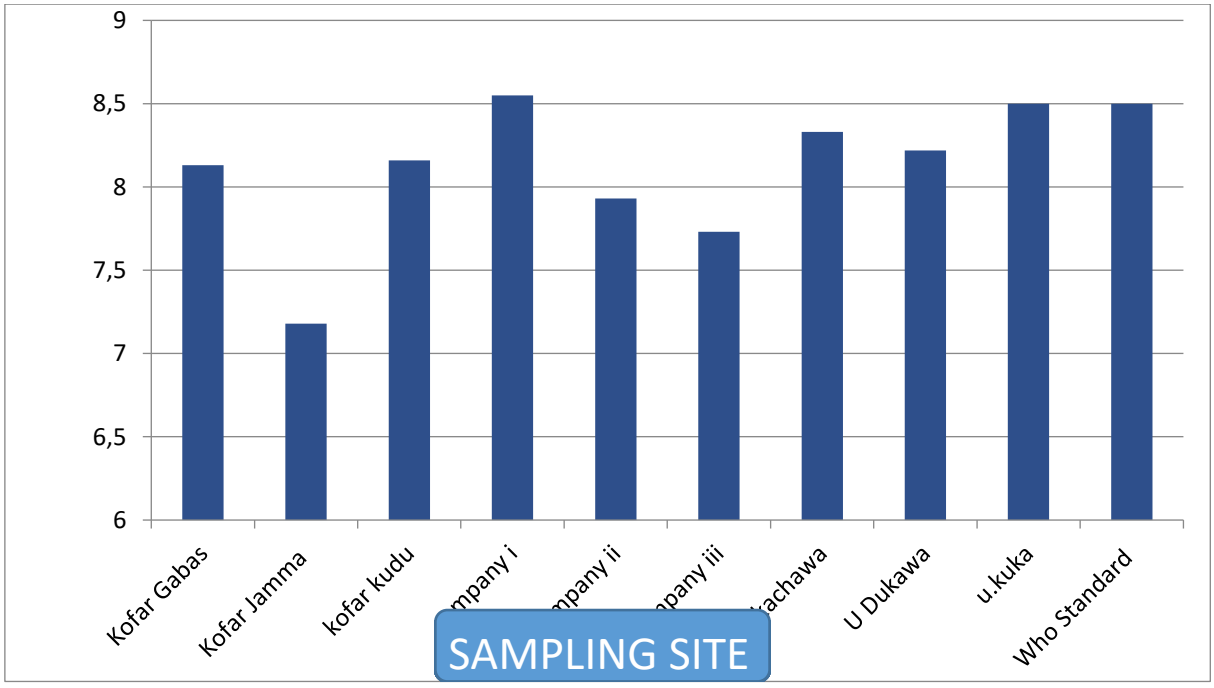

Figure 1.0 : A grapha of pH of the water sample around the mining area of Rimi, Sumaila LGA

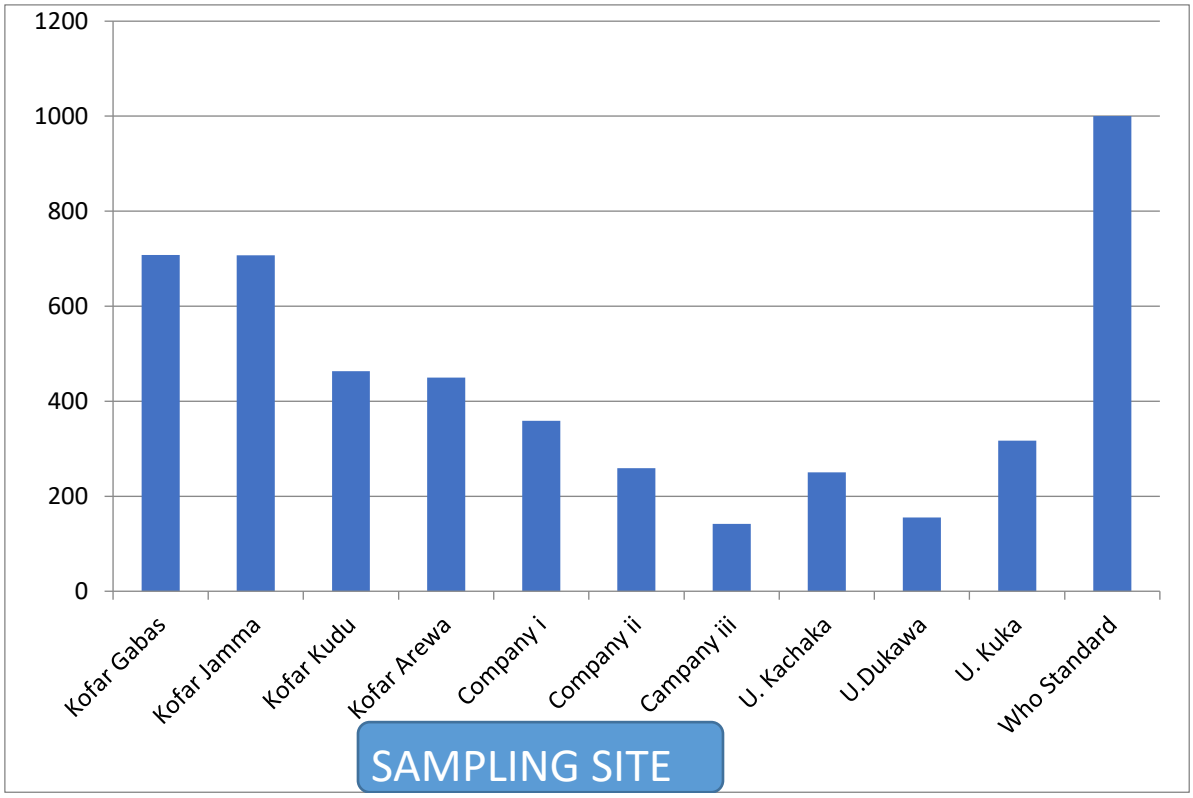

Figure 2.0: A grapha of Conductivity of the water sample around the mining area of Rimi, Sumaila LGA

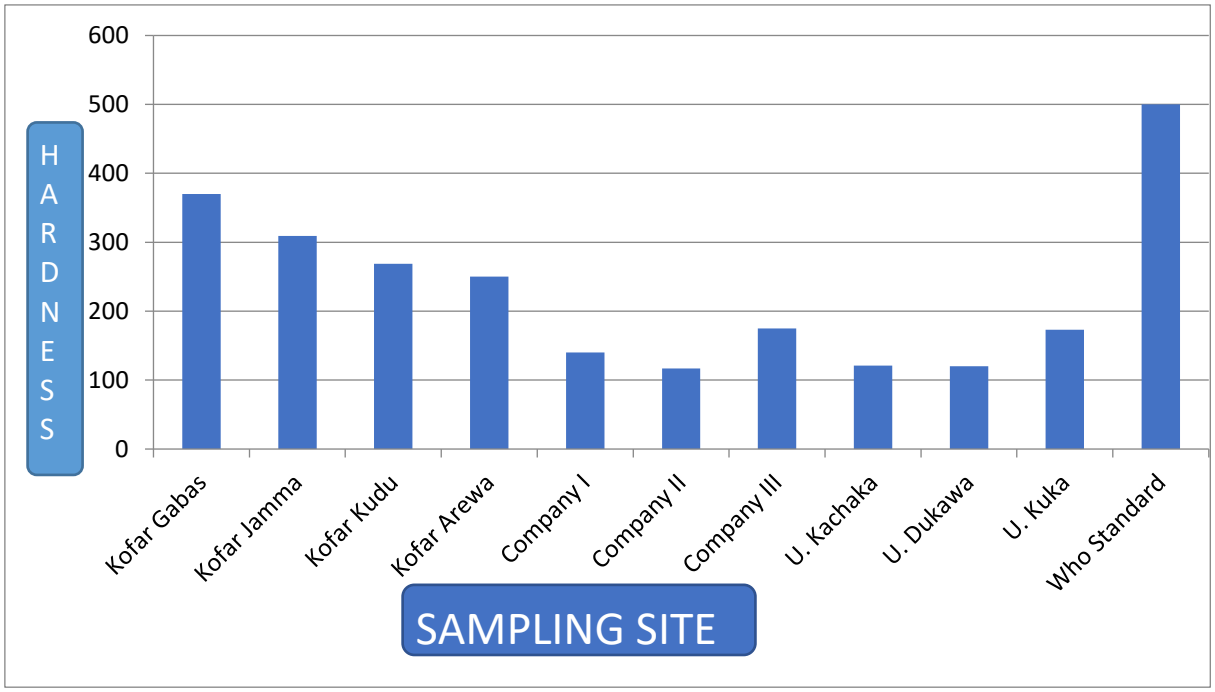

Figure 3.0: A grapha of hardness of water sample around the mining area of Rimi, Sumaila LGA

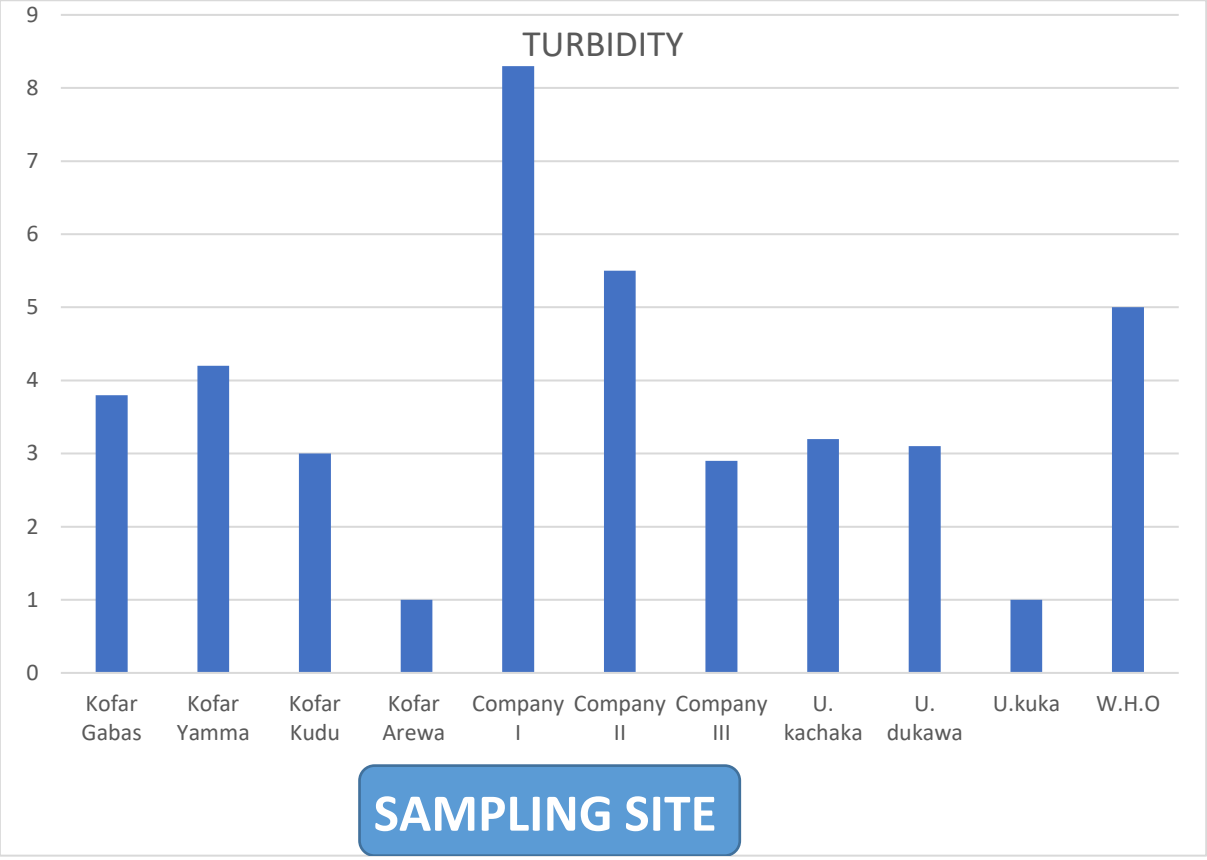

Figure 4.0 A graph of turbidity of water sample around the mining area of Rimi, Sumaila LGA

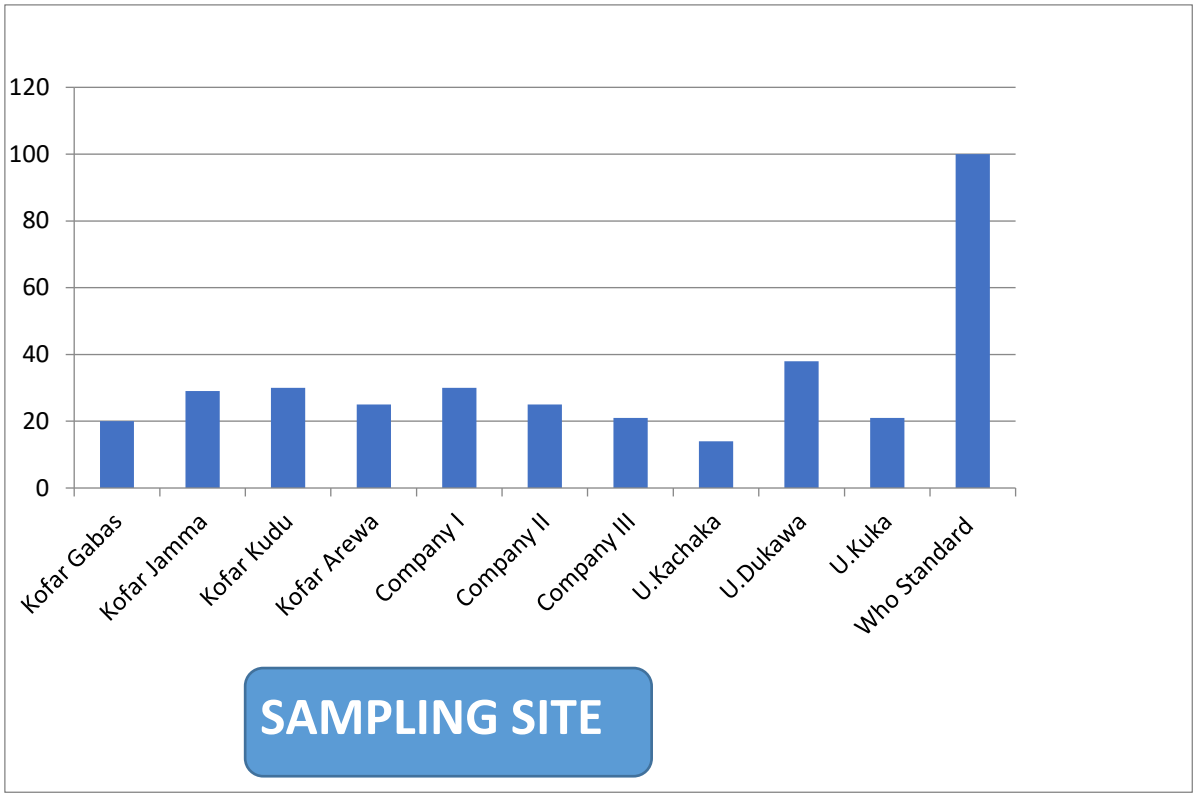

Figure 5.0: A grapha of alkalinity of water sample around the mining area of Rimi, Sumaila LGA

DISCUSSION

The pH of ten hand dug well water in Rimi sumaila L.G.A is range between 7.18-8.55 the result shows that some areas include kofar gabas, kofar kudu, kofar arewa, company i , company ii, company iii, U.kachaka , U.dukawa , and U. kuka are alkaline in nature and kofar yamma with pH 7.18 is namely neutral as shown below the pH .The pH recommended by (WHO, 2008) for drinking purpose is range between 6.5 – 8.5, The highest pH value of water forces the dissolve ammonia to its toxic and unionized from which gravely effects aquatic organism (USEPA, 2003).Neutral pH, the nearly neutral pH levels observed could be due to dilution factor as water flows downstream according to (Loredo *et.al,* 2009).The basic nature pH shows that the water contains some carbonate and bicarbonate (WHO, 2008).

The electrical conductivity of the ten (10) hand dug well in Rimi shows variation such that, the Lowest value of conductivity was observed in company III 142 µS/cm while the highest value was observed at kofar gabas with 708µS/cm.The maximum permissible limit

of Electrical conductivity by (WHO 2008) for drinking water is (8-1000 μS/cm), by comparing with the results of conductivity obtained, all values are within (WHO 2008) permissible limit.

Hardness analysed were ranged between (173 – 370 mg/L) the highest values was observed at kofar gabas and the lowest value was observed at U .kuka. The total hardness in water is the total soluble magnesium and calcium salts present in the water expressed as $CaCO_3$. The permissible limit of Total hardness of water is 500mg/L, according to (WHO, 2008). By consideration with the WHO (2008) acceptable limit all ten (10) hand dug water in Rimi are within permissible limit.

Turbidity analysed were ranged between (1 – 8.3NTU) the highest values was observed at Company I and lowest value was observed at k.arewa and u. kuka. Turbidity is mainly due to particles in suspension and therefore, typically corresponds to the total suspended solid concentration in a water, it can also may be as a result of dissolve metals or dissolved organic matter (UNICEF 2008). The permissible limit of Turbidity in water is 5NTU, according to (WHO, 2008). By consideration with the WHO (2008) acceptable limit 8 hand dug well water in Rimi are within permissible limit and only 2 that is company I and company ii are beyond the permissible limit.

Alkalinity of water analysed were ranged between (14 – 38 mg/L) the highest values was observed at U. Dukawa and the lowest value was observed at U. kachaka. The permissible limit of Alkalinity of water is 100mg/L, according to (WHO, 2008). By consideration with the WHO (2008) acceptable limit all ten (10) hand dug water in Rimi are within permissible limit.

CONCLUSION

From the result obtained All the physicochemical parameters analysed were below WHO permissible limit with the exception of company I and II with turbidity 8.3 and 5.5 NTU respectively. And company I with pH 8.55 which shows that it is alkaline in nature.

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