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Evaluating the Groundwater Quality of the Ogale Community for Irrigation Purposes in Rivers State.

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Abstract
The Ogale Community in Rivers state was the site of nine boreholes that were used to gather groundwater samples. The main objective was to find out whether the groundwater could be used for farming. The area in question was investigated for 10 physicochemical parameters using atomic absorption spectroscopy and other standard laboratory techniques. These readings were applied mainly to ascertain the usefulness of the water for irrigation. The results were then assessed using criteria established by the International Water Quality Guidelines framework (IWOS) and 2011 World Health Organization standards (WHO). The findings revealed pH level of 4.80 to 5.56 mg/l and an electrical conductivity ranging from 60.40 to 238 μscm-1. Total dissolved solids (TDS) levels ranged from 30.20 to 119 mg/l throughout the study zone, while salinity levels ranged from 0.058 to 25.72 mg/l. The location revealed a diverse array of values. The anions that were established as chloride, sulfate, and nitrate had concentrations that varied between 3.0 and 21.0 mg/l, 3.2 and 5.48 mg/l, and 0.135 and 0.329 mg/l, respectively. When testing groundwater, the four most common cations found are magnesium, potassium, sodium, and calcium. The concentrations that are stated are 7.32 to 12.48 mg/l, 2.65 to 3.40 mg/l, 4.17 to 6.34 mg/l, and 0.85 to 2.41 mg/l, in that order. Manganese levels were within the usual range of 0.01 to 0.03 mg/l, and heavy metal levels were similarly within the normal range. The range of iron concentrations found in the results was 0.32 mg/l to 2.90 mg/l. Physio-chemical variables were also defined as the concentration of dissolved oxygen (DO), the demand for biological and chemical oxygen, and other similar metrics (COD). A range of 4.83–5.44.8 mg/l, 88.74–124.8 mg/l, and 119.28–185.62 mg/l were all recorded. To calculate the sodium adsorption ratio, data on Na, Mg, and Ca were utilized (SAR). This test is crucial for determining if water is acceptable for irrigation. The low-salt of the groundwater is safe to use for farming since the findings were within the usual range of 0.32 to 0.48 mg/l. The findings revealed that majority of the parameters included in the analysis are within the acceptable ranges set by the WHO and the International Water Quality Standard for Irrigation. The only two measurements that did not fall within this range were metabolic oxygen consumption and electrical conductivity (BOD).
Keywords: *Irrigation, SAR, Concentration, Anions, Cations and Groundwater*

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I. INTRODUCTION

Groundwater is essential for all forms of life and is extensively utilized for irrigation purposes. The relationship between aquifer level, soil quality, and agricultural productivity is not easily discernible. A country's economic and general well-being can be gauged by the availability of potable water, which is crucial for crop health and fertility. Furthermore, access is contingent upon water quality. Poor waste management and oil leakages from damaged or destroyed hydrocarbon pipelines are the main causes of water pollution in the Niger Delta region. When trying to determine whether or not an aquifer is suitable for cultivation, knowing the quantity and composition of the water present is crucial.

The agricultural land in the Ogale village and the water sources that supply the majority of the area's drinking water have been contaminated by activities associated with hydrocarbon exploration. The locals are unable to water their crops with potable water as a result of this, there is the rapid spread of illnesses such as dysentery, cholera, and diarrhea due to the fact that the water has not been properly disinfected. The locals are unhappy about the situation. This has also affected plant reproduction negatively.

For this reason, groundwater derived from wells and boreholes are greatly depended upon for various purposes such as drinking, irrigation, domestic, and industrial usage, particularly in areas experiencing rapid population growth. In order to perform a precise evaluation of groundwater as a substitute water supply for

domestic and agricultural use, data collection from the relevant areas are required. For decision-making purposes, this data is crucial.

Study Area Description

The area under study is located at 007013 degree east, which is close to 04079 degree north. Ogale village is in Eleme Local Government Area, in Rivers State, (fig.1). The area is easy to access due to inter-connectivity of road network. The area for its wet and dry seasons. The rainy season starts in March and ends in October, this is when it rains the most, with an average of 400 millimeters per year. The temperature is around 300 degrees Celsius, and the relative humidity is about 82%. (Etu Efeotor J. O 1981).

During the Tertiary period, the Niger Delta depositional belt was formed by subsidence and depositional processes that happened because the Atlantic Ocean moved back and forth over time (Avbovbo A.A 1979). Because of this, three lithostratigraphic units were deposited in the Niger Delta Basin. The three Formations are the Akata Formation, the Agbada Formation, and the Benin Formation. They are listed in order of how old they are. The oldest sedimentary rock Formation in the Niger Delta is kwon as the Akata Formation, this Formation is where oil is generated. The Agbada Formation is younger in age than the Agbada Formation and is made up of alternating sands and shale, and this Formation is the oil reservoir formation in the Niger delta. The geological environment found in Niger delta includes fluvial, coastal, and fluvio-marine. (Ovuru 2020), the age is Miocene to Recent. The Benin Formation is made up of freshwater continental (fluviatile) sands, gravels, and clay layers that are sometimes present in the basin, the thickness of this formation is about 2100 meters. This formation is the aquiferous zone in the Niger Delta basin.

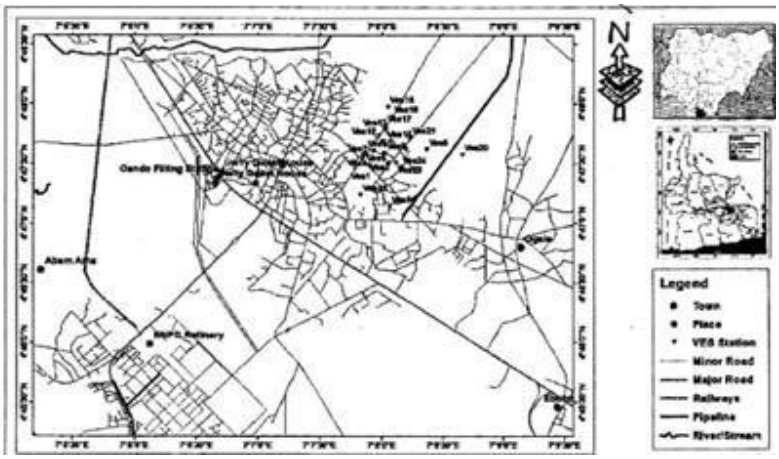

Fig 1: Map of Ogale Community showing the study area

Climate

The climate of the area being investigated is quite similar to that of a tropical rainforest, with very similar wet and dry seasons. The month of April through October, is the peak period of the rainy season, it pours nearly continuously. Conversely, dry weather and high temperatures characterize the dry season. Rivers state have high amount of rainfall, though the kind and quantity of its rain varies with the seasons. The average length of a rainstorm varies throughout the year. Although the northern regions get less precipitation than the southern ones. The far northern region of the state receives approximately 1,700 millimeters of precipitation annually, whereas the coast receives an average of 4,700 millimeters.

Vegetation

The highland region of River state was once covered in rainforest, but that has been drastically altered due to human activities. In most regions, the flora of economically significant plants, particularly oil palms, that have been preserved was referred to as "oil palm bush."

Drainage

Rivers are defined by low-lying terrain, large amounts of surface water, and heavy precipitation (between 3,420- and 7,300-millimeters of rain or more). There is an inadequate capacity for water drainage along these rivers. Several smaller creeks, as well as the Bonny River, Ntamogba Stream, Okpoka Stream, and Eleme River, supply water to River State. They all empty into the Atlantic Ocean. Small streams also drain the state.

II. METHODOLOGY

A total of nine groundwater samples were collected from nine boreholes in the study site. The samples were collected from the wellhead using clean plastic bottles. In order to prevent the bottles from being exposed to oxygen once they were filled, they were promptly corked. Within 24 hours of collection, the samples were transferred to an analytical facility and refrigerated at 4 degrees Celsius (24 hours). Because of the dynamic nature of both temperature and pH, measurements were taken in the field. pH meter was used to measure the solution's acidity and a mercury thermometer was used to measure its temperature. Several additional physio-chemical parameters were measured using an atomic absorption spectrometer in addition to conventional laboratory procedures.

III. RESULT AND DISCUSSION

Table 1: Result of Physio-chemical Analysis of Water Sample

S/N	Sample Code	GPS Coordinates	ph	Sal	Cond	Turb	TDs	Tss	No3	Cl	So4	Ca	mg	Na	K	Do	Bod	Cod	Mn	Fe
1	BH1	4.790913^{0}N 7.132039^{0}E	4.80	0.03	60.50	0.062	30.25	0.054	0.137	10.00	3.30	7.83	2.71	4.24	0.854	5.42	88.76	119.30	0.012	0.34
2	BH2		5.00	0.02	60.60	0.060	30.30	0.056	0.135	11.00	3.28	7.32	2.83	4.66	0.915	5.40	88.74	119.32	0.010	0.32
3	BH3	4.791377^{0}N 7.131462^{0}E	4.90	0.04	60.40	0.058	30.20	0.055	0.136	3.00	3.32	8.34	2.65	4.17	1.010	5.44	88.78	119.28	0.011	0.36
4	BH4	4.792228^{0}N 7.131462^{0}E	5.38	0.11	238	25.72	119	2.52	0.217	20.00	4.54	13.45	3.18	7.24	1.56	4.87	124.6	185.54	0.034	2.84
5	BH5	4.927228^{0}N 7.130128^{0}E	5.40	0.10	237	25.70	118	2.50	0.219	21.00	4.52	13.57	3.40	7.78	1.70	4.85	124.8	185.60	0.036	2.82
6	BH6	4.792994^{0}N 7.130916^{0}E	5.42	0.90	236	25.68	118	2.48	0.215	19.00	4.56	13.68	3.20	7.36	1.60	4.83	124.4	185.62	0.038	2.86
7	BH7	4.792638^{0}N 7.131337^{0}E	5.54	0.07	135.5	24.58	67.75	1.53	0.325	18.00	5.48	11.98	3.36	6.00	2.412	4.84	106.48	178.52	0.024	2.28
8	BH8	4.793375^{0}N 7.132205^{0}E	5.56	0.08	135.4	24.54	67.70	1.55	0.327	17.00	5,00	11.75	3.14	5.88	1.97	4.86	106.50	178.54	0.028	2.30
9	BH9	4.793058^{0}N 7.133656^{0}E	5.55	0.06	135.6	24.56	67.80	1.54	0.329	19.00	5.46	12.48	3.24	6.34	1.88	4.87	106.52	178.56	0.026	2.26
Range			4.80-5.55	0.02-0.11	60.40-238	0.058-25.72	30.20-119	0.054-2.52	0.135-0.329	3.00-21.0	3.28-5.48	7.32-13.68	2.65-3.40	4.17-7.78	0.854-2.412	4.83-5.44	88.74-124.8	119.28-185.62	0.010-0.038	0.32-2.86
WHO 2011			6.5-8.5		400		1000	500	50	250		100	50	200	20		30		0.1-0.5	0.3

Graphical Representation and Interpretation of Parameters

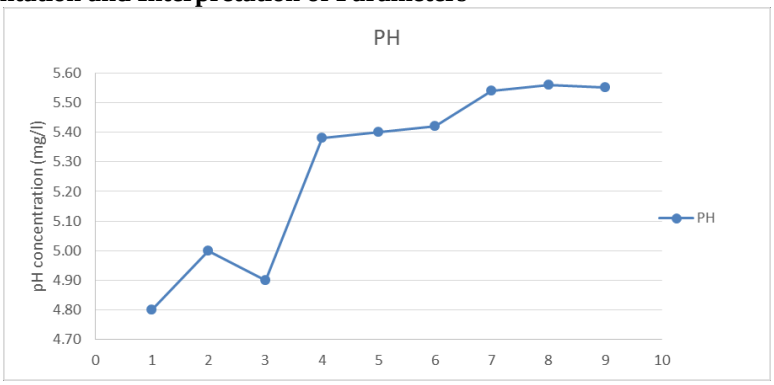

Fig. 2: Graph of pH

P^H Concentration

The results demonstrate that the groundwater samples meet the worldwide requirement for irrigation water quality, which falls within the permissible range of 6.5 to 8.5 mg/l. Since the P^H levels of the groundwater samples range from 4.80 mg/l to 5.55 mg/l, we can conclude that the water is safe to drink. This indicates that the water is suitable for irrigation purposes.

Conductivity Concentration

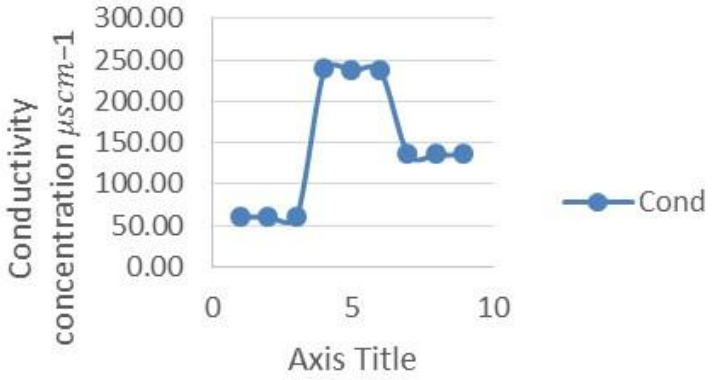

Fig.3: Graph of Conductivity

The range of conductivity values measured in the experiment's location was 60.40 µS/cm. to 238 µS/cm.. While these readings are greater than the IWQS cutoff of 0.7 µS/cm., they fall short of the 1000 set by WHO. High conductivity makes the water to be unfit for irrigation, this might affect the yields in farming. Regardless of how one will use the water, it is good news that the water can be used for drinking purposes and for domestic purposes in general.

Total Dissolved Solid (TDS) Concentration

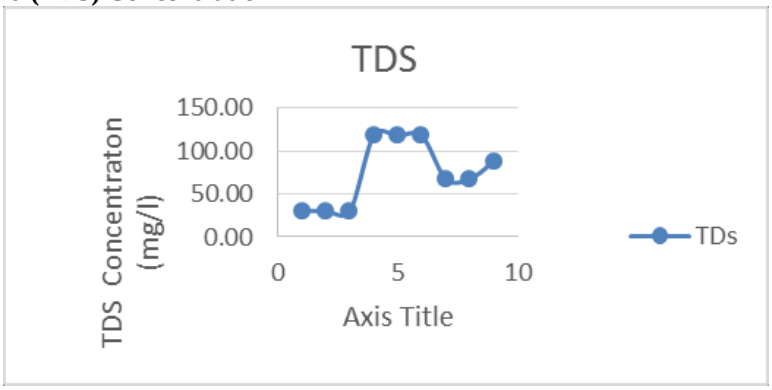

Fig.4: Total dissolved solid (TDS) concentration

Total dissolved solids (TDS) has its maximum allowable concentration of water which have been set down by the World Health Organization and the IWQS respectively. The range of values that fall into this level are in between 30.20 mg/l and 119 mg/l. Because of this, the water can serve dual purposes: as drinking water and as plant food.

NO_3 Concentration

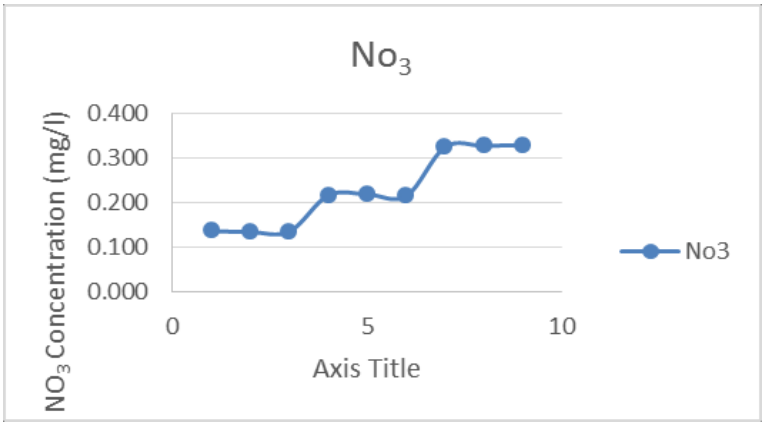

Fig.5: Graph of NO_3

NO_3 content in the groundwater samples from the research region provide satisfactory levels for irrigations, falling within the permissible limits ranging from 0.135 mg/l to 0.329 mg/l. From the aspect of water quality, 50 mg/l is the value set by WHO and other international organizations. Nitrogen is a forming factor of the protein molecules, and nitrate ions are used by both plant and animal organisms.

Iron Concentration

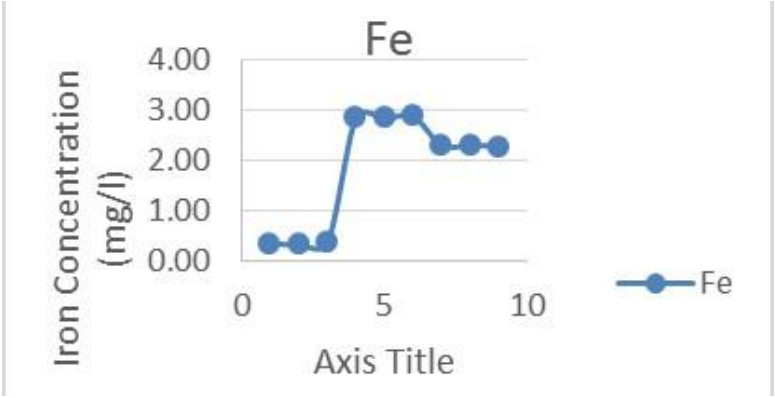

Fig.6: Graph of Iron

Iron content in the sampled area shows a range between 0.32 and 2.86 mg per liter. These results occupy a place in the acceptable range of irrigation water quality standards which are equal to 5.00 mg/l on average at the international level, but doing so, they exceed the standards set by WHO, which are, on average, equal to 0.3 mg/l. Out of this it is therefore clear that the water is suitable for irrigation purposes and not for drinking purposes.

Sodium Adsorption Ratio (SAR) Concentration

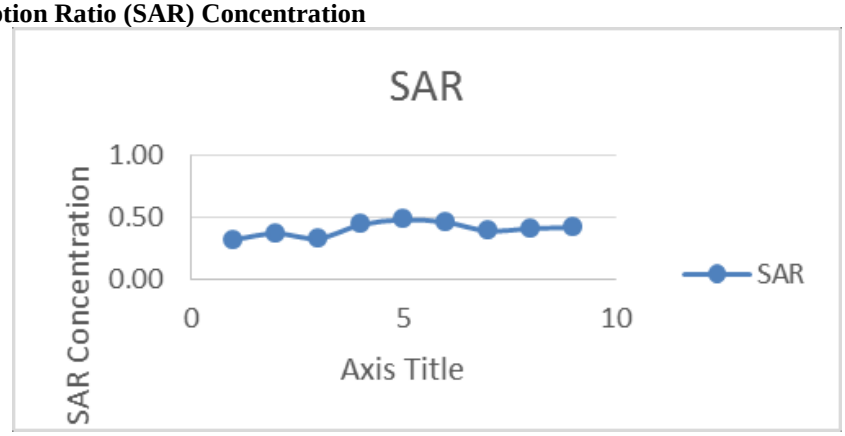

Fig. 7: Graph of SAR

Thus, the calculated SARs vary within the range of 0.32 to 0.48 mg/L depending on the studied area. The water can be used in the irrigation as the reading marks below the permissible limit as suggested by WHO standards. The quality of water for irrigation range from 0-10 mg/L.

. SAR Calculation Using Standard Method for Irrigation and BHs in the study area
Conversion factors of chemicals from milli equivalence to equivalence
Ca = 0.04990. Mg = 0.08226. Na = 0.04350 and the formula is given as

$$SAR = \frac{Na^{+}}{\sqrt{\frac{ca^{+2} + mg^{+2}}{2}}}$$

Chloride Concentration (mg/l)

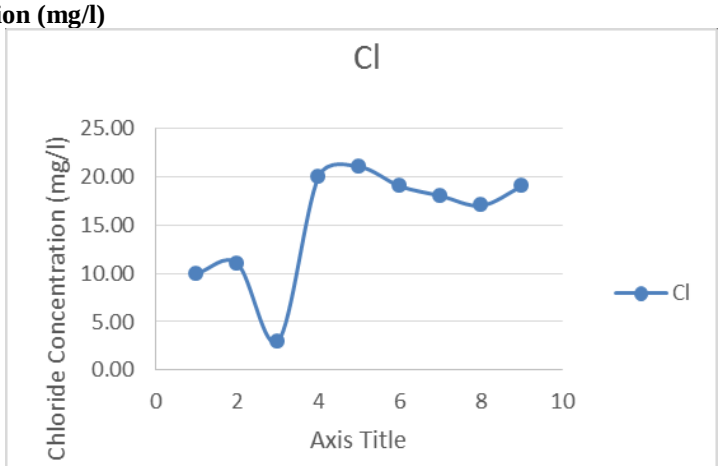

Fig.8: Graph of Chloride concentration

The concentration of chloride ion in the area of interest ranged from 3.0 - 21.0 mg/l. Maximum permissible level up to which lead may be present has been set by the World Health Organization at 250 mg/ L. Perhaps based upon these results we may reach a conclusion that the water is fit for agriculture and for human consumption.

Manganese (MN) Concentration

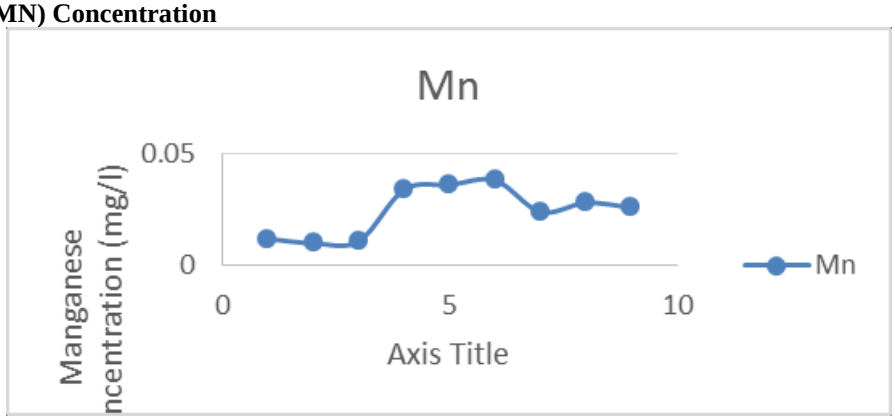

Fig.9: Graph of Manganese Concentration

Manganese concentrations in the research region are ranged between 0.010 mg/l and 0.038 mg/l. Both the World Health Organization (WHO) and the International Water Quality Standards (IWQS) recommend manganese concentrations less than legal limit of 0.020 mg/l (2011). Thus, the water is good for irrigation, domestic and for industrial purposes.

Biochemical Oxygen Demand (BOD) Concentration

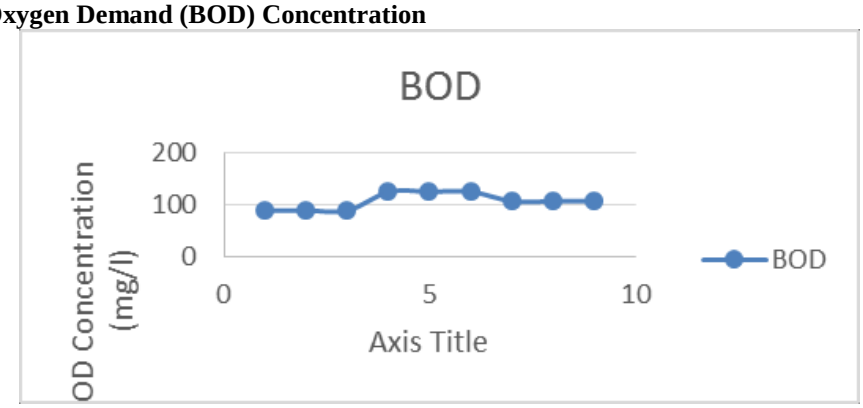

Fig.10: Graph of Biochemical Oxygen Demand (BOD) Concentration

The samples of groundwater tested had BOD levels above the WHO set limit of 30mg/l for drinking water. The concentrations range lies between 88.74 mg/l and 124.8 mg/l. Calculated oxygen is the amount of oxygen

necessary for bacterial respiration for the breakdown of complex particles into its part-elements called Biochemical Oxygen Demand (BOD). Among the method for estimating the level of organic matter in water, the biological oxygen demand (BOD) is used. Among all steps, biological oxygen demand (BOD) is a measurement for determining the level of water pollution. If the BOD level is less, then the water is safe for drinking otherwise it is unsafe to drink. Analyses on the available water revealed that this groundwater is not safe for agricultural use or for human consumption.

IV. CONCLUSION

It could also be observed from the results that most of the parameters analyzed on the groundwater samples seem to fall within the IWQS 2004 as well as the WHO, recommended guidelines for permissible levels of the respective parameters as set out in the 2011 version. The only values that were significantly high were conductivity, Iron and the biological oxygen demand (BOD). Unfortunately, the conductivity values which are over the standard range mean the presence of cations and anions in excess. High BOD suggests that the water supply contains pollutants that are likely to spoil the water. The water is polluted because of oil spills and poor discharge of sewage wastes in that locality. To calculate the sodium adsorption ratio, follow these steps: (SAR). The obtained values of SAR are below the permissible limit of 10. It is now beyond a doubt that water abstracted from aquifers can be used for irrigation, and a range of other commercial and domestic purposes.

V. RECOMMENDATIONS

When the results of the various parameters in Ogale community on groundwater for irrigation is compared to the WHO/IWQS guidelines, it was determined that many of the results falls within the allowable range. This leads to the following recommendations:

1. The geoundwater can be used for Irrigation
2. The water needs regular monitoring and testing to improve its quality.

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