

Bacteriological and Physico-chemical Analysis of Well Water from Villages in Edati, Niger State, North-central Nigeria

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Abstract:- The physico-chemical and bacteriological properties of water from hand-dug wells from villages in Edati communities was evaluated in this study. The water samples were analyzed in accordance with the standard procedures for water analysis. The results of the physico-chemical and bacteriological analysis revealed that all the parameters were below the maximum permissible limit for a safe drinking water recommended by Nigerian Standard for Drinking Water Quality except iron, manganese, E.coli and total coliform whose concentration in some locations were higher than the acceptable limit. The high iron and bacterial coliform may be attributed to the shallow well depth, distance to pit latrine/soakaway, improper well construction, inadequate of well lining and land use system in the area. The results obtained indicates that the groundwater quality of Edati fall between the maximum permissible limit of NSDWQ. It is therefore recommended that provision of hand dug wells and boreholes in this area should not be in proximity with the pit-latrines, septic and dump sites.

Keywords:- Quality analysis, Well-water, Edati community, Niger State, Nigeria

I. INTRODUCTION

Groundwater offers the most abundant source of water to man. Every aspect of agriculture requires adequate and timely supply of water to succeed. (Olasehinde, 2010). Groundwater under phreatic condition occurs in the mantle of weathered rock, alluvium and laterite overlying the hard rock, while within the fissures, fractures, cracks, joints and lava flow junctions within the hard rock, groundwater is mostly in a semi-confined state. Compared to the volume of water stored under semi-confined conditions within the body of the hard rock, the storage in the overlying phreatic aquifer is often much greater. In such cases, the network of fissures and fractures serves as a permeable conduit feeding this water to the well. The recharge to groundwater takes place during the rainy season through direct infiltration into the soft mantle overlying the hard rock and also into the exposed portions of the network of fissures and fractures. Since not every subsurface water is good for human consumption, investigation of groundwater quality is very essential in providing safe drinking, domestic and industrial water to the populace. Access to clean water is a human right and a basic requirement for economic development. The safest kind of water supply is the use of groundwater. Since groundwater normally has a natural protection against pollution by the covering layers, only minor water treatment is required. Detailed knowledge on the extent, hydraulic properties, and vulnerability of groundwater reservoirs is necessary to enable a sustainable use of the resources (Reinhard, 2006).

Study Area Description

Edati is located between longitude $5^{\circ}38'E$ to $5^{\circ}41'E$ and latitude $9^{\circ}06'N$ to $9^{\circ}09'N$ on Egbako sheet. A total surface area of 30km^2 was covered. Edati is accessible through a major road, minor road and foot paths. The area is low lying with more foot paths. It is a sparsely populated settlement with the major occupation of the dwellers as farmers. Edati is also a part of Bida Formation with majorly sandstone unit and minor siltstone.

Table 1: Showing the Coordinates and Heights above Sea Level

Sample Location	Longitudes	Latitudes	Elevation
Katamba Balogi	$7^{\circ}29'40.98''^{11}$	$10^{\circ}24'53.19''^{11}$	268
Goka	$7^{\circ}29'50.62''^{11}$	$10^{\circ}23'55.81''^{11}$	254
Majiko	$7^{\circ}29'58.18''^{11}$	$10^{\circ}25'07.36''^{11}$	260
Kukpa	$7^{\circ}28'48.33''^{11}$	$10^{\circ}26'27.89''^{11}$	205
Ndaba Zumaji	$7^{\circ}28'57.96''^{11}$	$10^{\circ}24'53.19''^{11}$	223
Gudu Majiko	$7^{\circ}27'41.60''^{11}$	$10^{\circ}25'53.60''^{11}$	230

Zumagi	7 ⁰ 28 ¹ 47.58 ¹¹	10 ⁰ 25 ¹ 58.46 ¹¹	208
Gogaa	7 ⁰ 30 ¹ 33.52 ¹¹	10 ⁰ 23 ¹ 51.28 ¹¹	217
Nuwangi	7 ⁰ 29 ¹ 18.68 ¹¹	10 ⁰ 27 ¹ 11.75 ¹¹	242
Tsuni	7 ⁰ 31 ¹ 07.24 ¹¹	10 ⁰ 25 ¹ 53.11 ¹¹	213

Physiography of the Area

The prevalent climatic condition of Edati is marked by high daily temperature and humidity with maximum temperatures (37.5 °C) records in the months of March and minimum temperature in the months of December and January during harmattan, which occurs during dry season months the annual rainfall is moderate with rainfall reaching its peak in September. The vegetation consists of broad leaves, Sahel savannah region and characterized by shrubs, close range trees and close grasses over the area, it is due to rural settlement of the area. The topography of the area consists of low lying terrains with few gentle hills. The area is typically flat landscape.

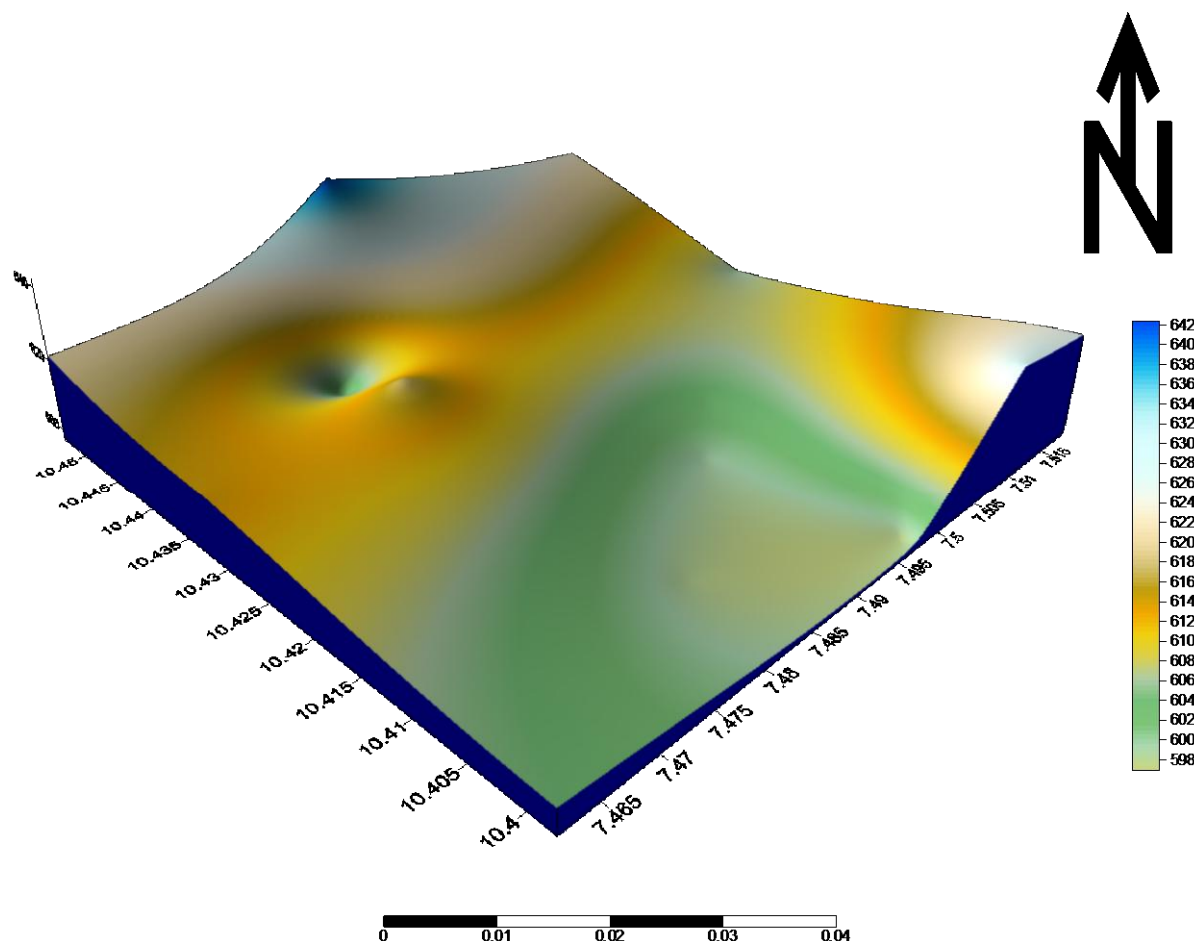


Figure 2: Digital terrain model (DTM) of the study area

A topographical mapping of the area was done using the GPS. Digital Terrain Model (DTM) of the area was made using Surfer 8.0 software as shown in figure 2. The highland is towards the north central part of the area.

II. GEOLOGY AND HYDROGEOLOGY OF THE AREA

The geology of Edati falls within the sedimentary basins of Nigeria. The major rock type which shows it is of the sandstone suit. The rock in the study is mechanically formed sedimentary rock. These rocks have been formed from the accumulation of materials derived from other rocks which have been cemented together and the entire area is underlain by cretaceous sandstone. The quantity of groundwater in the study area is by spaces within the crevices and the inter-connectivity within these crevices. The quality of the groundwater is a function of the chemistry of the groundwater which is dependent on the amount of solute dissolved in the

groundwater and is controlled by the origin of groundwater and the composition of the host rock that stores the groundwater (Adefila, 1975).

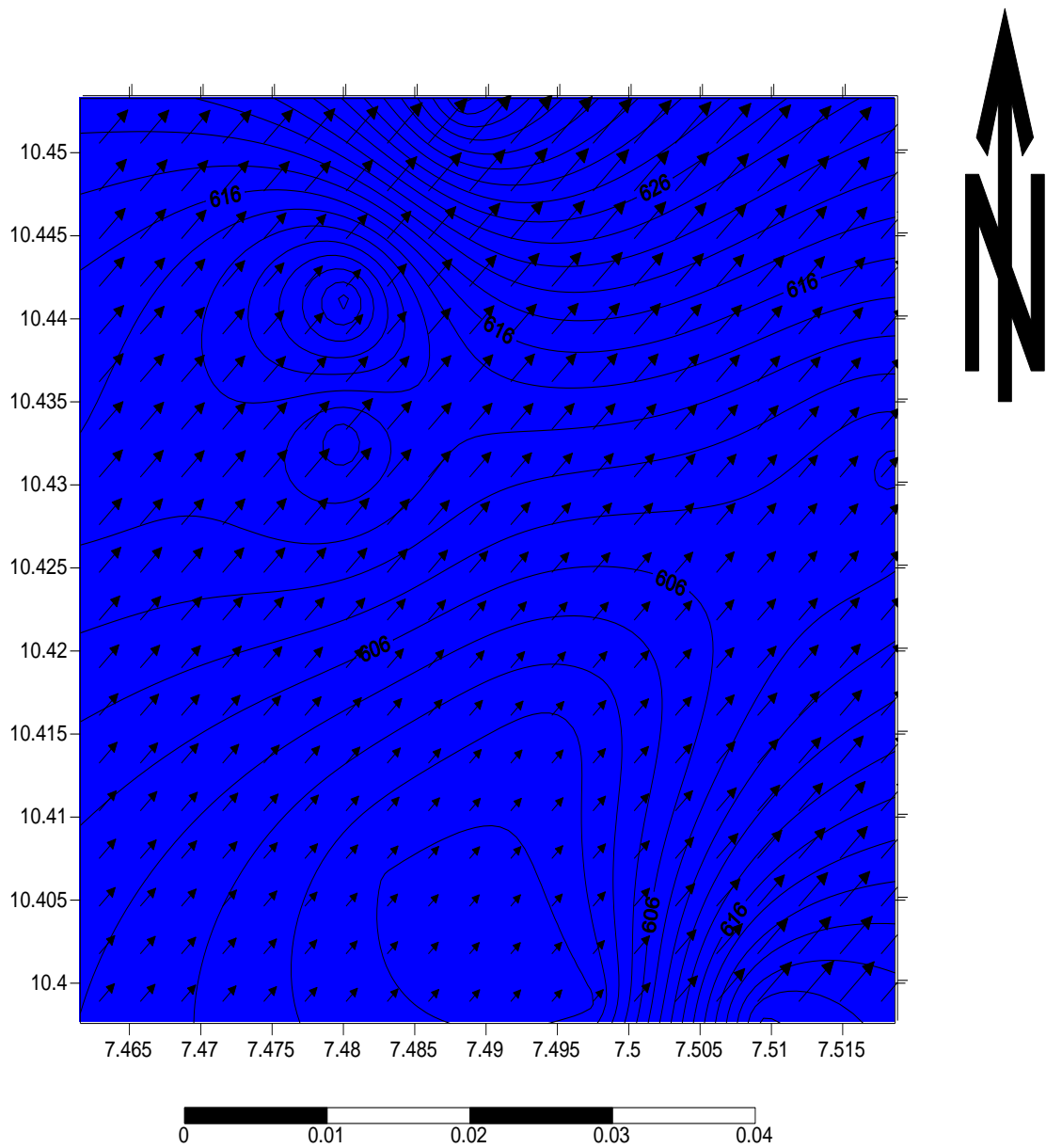


Figure 3: Map Showing Groundwater Flow Direction of Edati

The direction of flow in Edati area tends towards the Northeastern part which is the highest point of the area. The table of elevation of the area is shown in table 1 above. The mean value of elevation is 610.60 meter and it ranges between 597.53 and 642.53 meter above sea level.

III. METHODOLOGY

Geochemical investigation of Water samples were collected in a clean polythene bottles from wells in Edati randomly which were analyzed in the regional water quality laboratory of Federal Ministry of Agriculture and Water Resources, Minna to determine the amount of different parameters such as pH, electrical conductivity (EC), hardness, total dissolved solid (TDS), calcium (Ca^{2+}), sodium (Na^{2+}), magnesium (Mg^{2+}), iron (Fe^{2+}), lead (Pb^{2+}), potassium(K^{+}), trace metals, bicarbonate(HCO_3^-), chloride (Cl^-), sulphate (SO_4^{2-}), carbonate (CO_3^{2-}) and nitrate (NO_3^-) for the probable cause of contamination. Before the analysis of the samples, the physical parameters were determined in the field using standard equipments. The longitude, latitude and elevation of each location were used to generate the groundwater flow direction and the digital terrain model of the area.

IV. RESULTS AND DISCUSSION

Table 2: Summary of the water analysis

Parameters (mg/l)	Minimum	Maximum	Mean	NSDWQ (2007)
Temp. (°C)	27.00	29.00	28.00	Ambient
pH	6.45	7.75	6.65	6.50 – 8.50
Cond. (µs/cm)	16.8	347.0	104.01	1000.00
DO	3.40	6.50	5.06	10.00
BOD	0.55	3.40	2.41	6.00
COD	5.60	17.40	11.04	10.00
Total Hardness	7.00	156.00	48.86	500.00
Alkalinity	18.00	360	94.90	250.00
Cl ⁻	14.18	63.81	24.25	250.00
NO ₃ ⁻	0.01	0.56	2.19	50.00
TDS	10.92	232.49	69.58	500.00
Na	0.98	170.33	22.30	200.00
K	0.21	19.68	6.67	150.00
Mg	0.33	1.68	0.88	200.00
Mn	0.01	1.01	0.12	0.30
Cu	0.00	0.01	0.01	1.00
Ca	0.61	61.20	11.15	200.00
Fe	0.00	0.50	0.11	0.30
Pb	0.00	0.00	0.00	0.01
CO ₃ ⁻	9.20	15.72	12.76	100.00
HCO ₃ ⁻	9.20	15.72	12.76	100.00
SO ₄ ²⁻	3.60	7.20	5.09	200.00
E.coli	0.00	8.00	3.50	0.00
T.coliform	0.00	25.00	12.00	10.00

Physical Parameters

The ambient temperature ranges from 27°C to 29°C with mean value of 25.33°C from the water analysis of Edati in Table 2 which indicates that it's good for drinking purposes. Groundwater with lower temperatures reveal presence of pollution while those with warm temperatures as above is preferred as healthy for the environs since the important minerals are dissolved in the process making it rich for human consumption. The pH value ranges from 6.45 to 7.75 with a mean value of 6.35 which is slightly acidic but can still be recommended for drinking and domestic purposes since it meets up with the NSDWQ 2007 (6.5 -8.5). The slight acidity can be due to infiltration of leachates to the subsurface. The maximum conductivity value is 347 (µs/cm) with no complications at all. The total hardness falls between 7mg/l and 156 mg/l with a mean value of 48.86 mg/l which is far less below when compared to NSDWQ about 500 and so poses no threat to groundwater quality of Edati.

Chemical Parameters Cations

Potassium and sodium are alkali ions. Potassium is virtually low when compared to sodium with values of the samples ranging from 0.21 mg/l -19.68 mg/l with a mean value of 6.67 mg/l while sodium varies from 0.98-170.33 mg/l with a mean value of 22.30 mg/l. The values of sodium and potassium are generally low when compared with the NSDWQ maximum permissible limits of 150 mg/l for potassium and 200 mg/l for sodium (NSDWQ, 2007). Calcium and magnesium are alkaline earth metals were determined at close range. Calcium values ranges from 0.61 mg/l to 61.20 mg/l with an average value of 11.15 mg/l while magnesium concentration varies from 0.33 mg/l to 1.68 mg/l and a mean value of 0.88 mg/l. These values are far below the recommended value of 200mg/l for calcium and magnesium respectively (NSDWQ, 2007). Magnesium and calcium metal ions are responsible for water hardness. Their low concentration implies that the well water within Edati is relatively soft.

Anions

Bicarbonate and carbonate were determined and analyzed together since the dissolution of carbonate rock in the ground by water leads to the formation of bicarbonate. The concentration of bicarbonate ranges from 9.2 mg/l to 15.72 mg/l with a mean value of 12.76 mg/l. the values of carbonate also ranges from 9.2 mg/l to

15.72 mg/l with a mean value of 12.76 mg/l. The value of bicarbonate is by far below the NSDWQ recommended value of 100mg/l for bicarbonate. But for the carbonate, the values are higher than that of NSDWQ. This can be attributed to the infiltration of acid rain into the subsurface water within the Edati area.

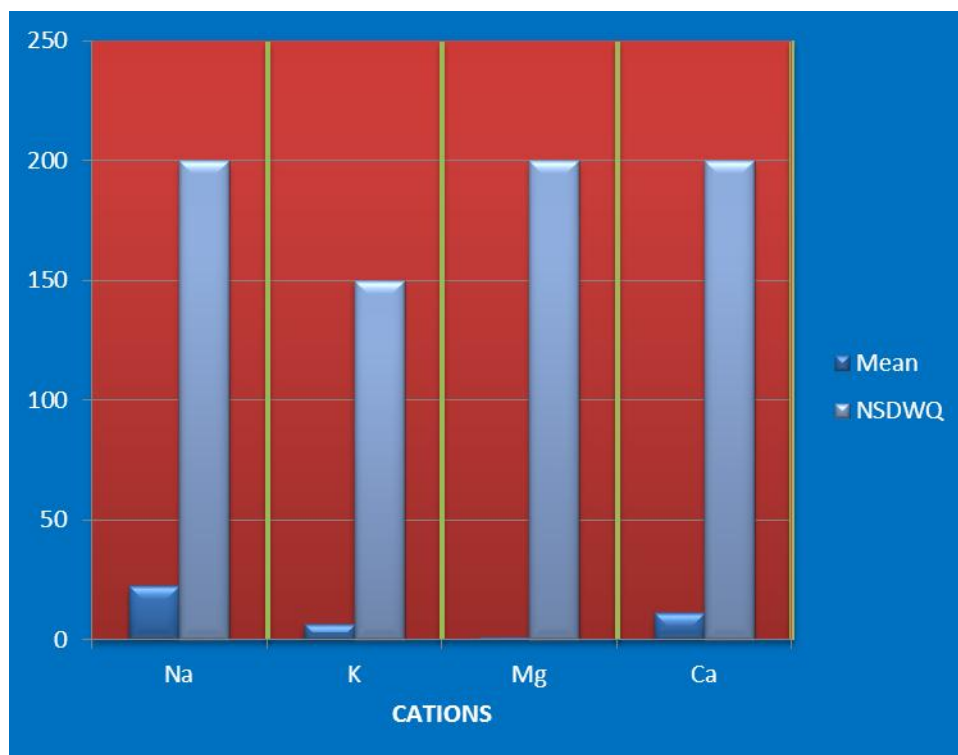


Figure 4: Correlation of the Mean concentration of Cations versus NSDWQ Values

The values of sulphate lie between 3.6 mg/l to 7.2 mg/l with a mean value of 5.09 mg/l. This falls below the recommended maximum permissible limit of 200 mg/l (NSDWQ, 2007). The chloride concentration varies from 14.18 mg/l to 63.81 mg/l with a mean value of 24.25 mg/l. This value is below the NSDWQ maximum permissible limit of 250mg/l (NSDWQ, 2007).

The concentration of nitrate ranges from 0.01 mg/l to 0.56 mg/l and an average value of 2.19 mg/l. This value is far below the maximum allowable limit of 50 mg/l (NSDWQ, 2007).

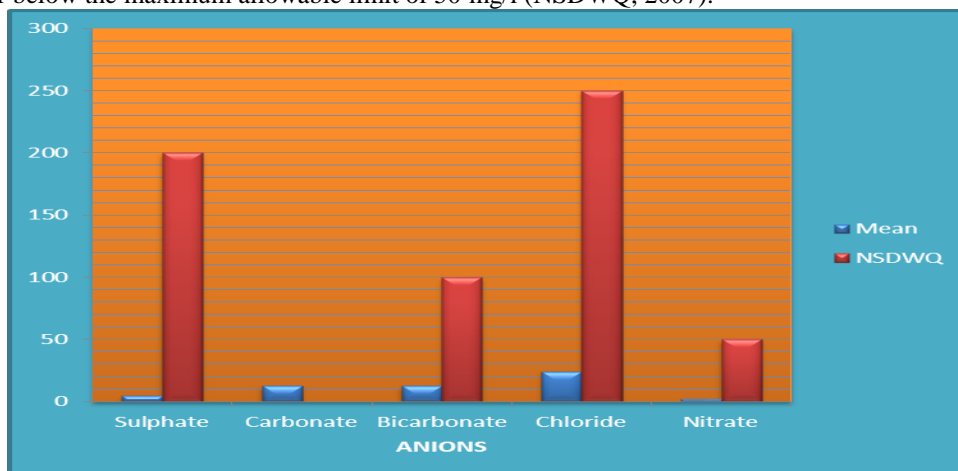


Figure 5: Correlation of the Mean concentration of Anions versus NSDWQ Values

Trace Metals

The concentration of iron varies from -0.0 mg/l to 0.5 mg/l with an average value of 0.11 mg/l. The values of iron are lower than the NSDWQ maximum permissible limit of 0.3 mg/l which is also good indication of groundwater pollution free of the area. The concentration of copper varies from -0.00 mg/l to 0.01 mg/l with a mean value of 0.01 mg/l. These values are far below the NSDWQ maximum permissible limit of 1.0mg/l. There was no change in the concentration of lead in its 0.00 mg/l. This value shows that Edati area is in

conformity with the NSDWQ maximum permissible limit of 0.01mg/l and can be a good zone for groundwater prospection.

The concentration of Manganese varies from 0.01 mg/l to 1.01mg/l with a mean concentration of 0.12 mg/l. These values do not exceed the standard permissible limit of NSDWQ standard of 0.30 mg/l.

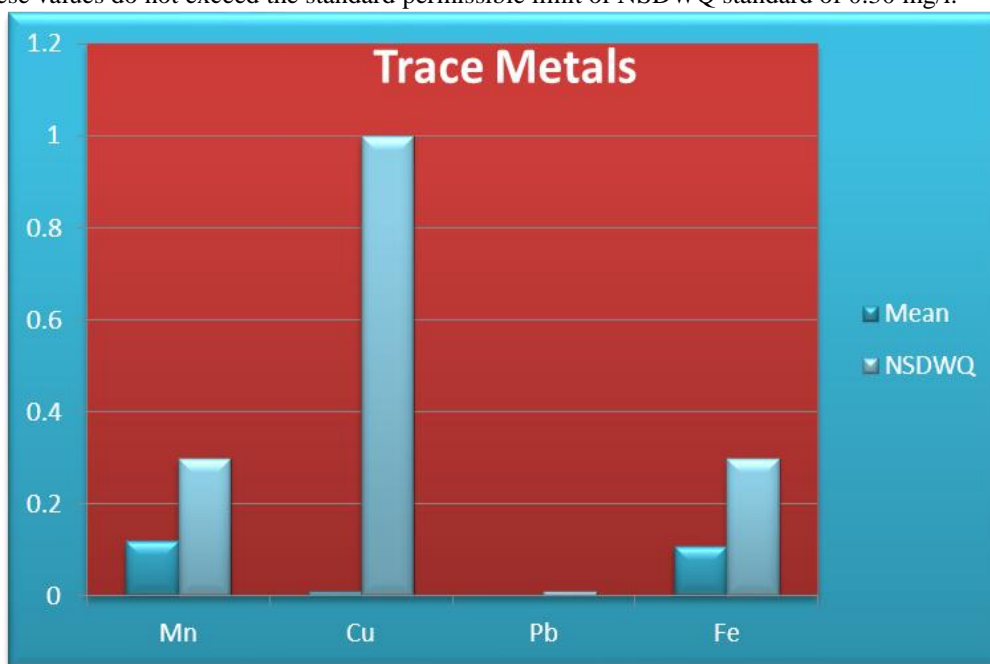


Figure 6: Correlation of Mean concentration of Heavy Metals versus NSDWQ Values.

V. CONCLUSION

The study of groundwater quality in Edati as revealed from the charts deduced in relation to NSDWQ (2007) shows that it is a viable area to access for subsurface water. The physical and chemical parameters studied are far below the permissible maximum limit required in NSDWQ making it an area free from groundwater pollution. But care should be taking to avoid future contamination through citing of boreholes close to the septic tanks and pit latrines. The use of fertilizers should be minimized to avoid leaching hazardous chemicals into the subsurface which can be a major problem to groundwater quality in Edati in future.

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