November 2015 IJESR Volume 3, Issue 11 ISSN: 2347-6532

THE CONDUCTIVITY MEASUREMENT OF UNDERGROUNDWATER USING ELECTRICAL CONDUCTIVITY IN GWALE LOCAL GOVERMENT AREA KANO STATE, NIGERIA

Bashir.U.Sa'id*

Isiyaku.G.Gambo**

U.K.Gupta

Abstract: A study of measurement of groundwater by conductivity method around Gwale local government area was carried out using electrical conductivity method. A total of 41 water samples were collected from several wells, ponds and boreholes around the study area. The study was carried out with the aims of providing the effect that urbanization brought to the groundwater around the study area. The data obtained were interpreted using a computer modelling program. The result of the interpretation was used to produce Geo-electrical map sections, which gives out the distinct conductivity values of groundwater around the study area. Urbanization brings amenities to many people at one time and in some ways, raises the standard of living for residents in urban areas. However, there are also down sides to urbanization too, including effects on the environment. As one of the earth most precious resources, fresh water ecosystems, especially groundwater have the potential to be heavily impacted by urbanism. It is in view of this that the contemporary study was undertaken to examine the quality of the water in term of its resistivity level.It involves collection of water samples in hand-dug-wells and bore-holes around Gwale local Government area and measure their resistivity with the ultimate aim of understanding the effect that urbanization brought to the groundwater in the study area.

* Postgraduate Students Sharda University, India (Dept. of Mechanical

** Postgraduate Students Sharda University, India (Dept. of ElectricalEng.)

1.0 Introduction:

Ground water is the water that exist in the spaces and fractures in rocks and sediment beneath the earth surface. It originates as rainfall, or snow, and the moves down into the ground water system, where it eventually makes its way back to surface stream, lakes or ocean. The water moves down into ground because of the gravity, passing between particles of soil, sand gravel, or rock until it reaches a death where the ground is filled or saturated with water. The area that is filled with water is called saturated zone and the top of this zone is called the water table. The water table may be very near the ground`s surface or it may be hundreds of feet below. The water in lakes, rivers, oceans is called surface water . . . it`s on the surface. Ground water and surface water sometimes trade places. Ground water can move through the ground and into the lake or stream, water in a lake can sock down into the ground and become ground water Ground water is stored in the materials like gravel or sand. It`s kind of like earth is a big sponge holding all water. Water can also moves through rock formations likes sandstone or through cracks in rocks. An area that holds a lot of water which can be pumped up with well is called an aquifer and then pipes deliver the water to cities, houses in the country or to corps. [1] Human activities can alter the natural composition of ground water through the disposal or dissemination of chemicals microbial matters at the land surface and into soils or through injection of wastes directly into ground water. Groundwater pollution (or ground water contamination) is defined as undesirable change in ground water quality resulting from human activities, among others. Groundwater pollution occurs when pollutants are discharge directly into the water bodies of water and in almost all cases without adequate treatment to remove harmful compound. This, it affects plants and organism living in these bodies of water and in almost cases the effects are damaging both individual species and populations. But also to natural and biological communities. Groundwater pollutions work differently from surface water pollution, although they have many source s in common, such as fertilizers, pesticides and animal wastes. Small domestic well and monitoring well intersect only short thickness of an aquifer may vary significantly in pollutants concentrations over a period of less than six months, particularly if a string but variable source is nearby.

1.2 Material and Methodology:

Study Area:

The study area is Gwale Local Government Area. The Local Government was created in December 1996, when it was carved out of Dala Local Government. It is surrounded Dala L.G.A to the North, to the South by Kumbotso L.G.A, to the East by Kano Municipal and to the West by Ungoggo L.G.A. Gwale is a Local Government Area in Kano State, Nigeria within Greater Kano city. Gwale L.G.A is located on latitude 11^{o}58'N and Longitude 8o30'E of the Greenwich Meridian. Its headquarters are in the suburb of Gwale. It has an area of 18 km² and population according to the 1991census figures, has a total population of 282,115, also at the 2006 Census figures, has a total population of 362,059. The postal code of the area is 700[5].

1.2.1 Methodology:

The study area was initially inspected, then sample of water from the boreholes, lake, pound and wells were collected alongside then location using global positioning system (G.P.S). During the inspection, the total of fourty one (41) water samples were collected in plastic bottles from different boreholes, pound and wells within the study area. The plastic bottles were thoroughly rinsed with water sample before finally filling bottles. The geographical coordinate of each area where the water collected was measured using Global positioning system (G.P.S). The analysis was undertaken in the laboratory using Electrical Conductivity meter (EM meter).

1.2.2 Electrical Conductivity:

Conductivity is the ability of a material to conduct electric current. The principle by which instrument s measure conductivity is simple two plates in sample, a potential is applied across the plates (normally a sine wave voltage), and the current is measured. Conductivity (G) determined from the voltage and the current values according to ohms law.

$$G=I/R= I\ (amp)/E\ (volts).$$

Since the charge on ions in solution facilitates the conductance of electrical current, the conductance of electrical current, the conductivity of a solution is proportional to its ions concentration. In some situation, however, conductivity may not correlate directly to concentration. The basic unit of conductivity is the Siemens (s) formerly the mho. Since cell geometry affects conductivity values, standardized measurements are expressed in specific conductivity units (s/cm) to compensate for variations in electrode dimensions. Conductivity measurements are temperature dependent. The degree to which the temperature affects conductivity varies from solution to solution. All meters have either fixed or adjustable automatic temperature referenced to a standard temperature usually 25^{0}C.Meter with adjustable temperature compensation let you to adjust more closely to match your measured solution. Conductivity meters and cells should be calibrated to a standard, choose one that has the approximate resistivity of the solution to be measured. [8]

S/N	SOLUTION	CONDUCTIVITY (SOURCE)
1	Absolute pure water	0.055uS/cm
2	Power plant boiler water	1.0uS/cm
3	Good city water	50uS/cm
4	Ocean water	53mS/cm

Table: 1.0 Electrical Conductivity different source of water

A polarized or fouled electrode must be clean to renew the active surface of the cell. In most situations, hot water with mild liquid detergent is an effective cleanser. Acetones easily clean most organic matter, and chorus solutions will remove algae, bacteria or mood. To prevent cell damage, abrasives or sharp objects should not be used to clean an electrode. Cotton buds works well for cleaning but care must be taken not to widen the distance of cell. Conductivity is the reciprocal (inverse) of electrical resistivity ρ, and has the SI units of Siemens per meter (sm-1) and CGSE units of inverse second (s-1);

$$\sigma = 1/\rho.$$

Electrical conductivity is commonly represented by the Greek letter σ (sigma), but κ (kappa) (especially in electrical engineering) or γ gamma are also occasionally used.

An EC meter is normally used to measure conductivity in a solution. The degree of doping in semiconductors makes a large difference in conductivity. To a point, more doping leads to higher conductivity. The conductivity of a solution of water is highly dependent on its concentration of dissolved salts, and other chemical species that ionize in the solution. Electrical conductivity of water samples is used as an indicator of how salt-free the sample is; or impurity-free the sample is; the purer the water, the higher the conductivity (the lower the resistivity). Conductivity measurements in water are often reported as specific conductance.

1.2.3 Electrical Method of Geophysical Prospecting:

The various materials that constitute earth crust posse's surely electric properties of wide variation. The most commonly used method in geophysical prospecting is resistivity. The usual methods of investigating depends on passing a current through a section of the earth between two suitably implanted electrodes placed at a fixed distance apart after exploring the nature of the ground adjacent to or between them by means of two other potential electrodes inserted into the ground at a specially selected points.The basic electrical theory under lying the development of this system is not new, but it was until the beginning of the twentieth century that successful filed method were evolved.

In general, electrical investigation involves detection of subsurface effects produce by electric current flowing into the ground on the nature of the source of the measurable quantity method are regarded as natural or artificial source.

a. Natural source include,
b. Self-potential method(SP)
c. Telluric and magneto telluric current (TMT)
d. Audio frequency magnetic field (AFMAG)

a. Self-potential (SP): This method employs the natural potential development in the ground. The potentials are either background or mineralization potentials are caused by bioelectric activities, fluid streaming, and electrolytic concentration (especially where there is high amount of vegetation because of fluid migration running the root).

To measure S.P. metal electrode are inserted into the ground and the potential difference between them is the S.P. many unsatisfactory theories are being put forward to explain chemical process leading to S.P. such s oxidation, pH variation above and below water level and electrochemical galvanic cell system (difference in concentration). Telluric and magnetic field and terrestrial current system introduced by this field. The source of the field is ionospheric process. The induction mechanism is an electromagnetic field propagating with slight attenuation over a large distance in the space between ionosphere and the earth surface somewhat in the manner of guarded wave between parallel conducting plates thus this empty file can penetrate the earth surface to produce telluric (earth current.) The weak current induced in the subsurface is used in the TMT method. While electromagnetic field (primary) are employed in AFMAG survey.

b. AFMAG: This method employs primary electromagnetic field cause by light discharges (thunderstorm) as its source of energy. It uses frequency in the range 1-1000HZ

Artificial method source include

I. Electromagnetic method (EM)
II. Induced polarization (IP)
III. Resistivity method

I) Electromagnetic method: in this method, the sources is A.C. power, coil suspended by poor conductor in air or on the ground or buried inside the earth which provide primary field. The method can be used in air-borne survey.

II) Induced polarization (IP) this method involves the establishment and detection of double layers of electric charges at the interface between an electrolytic and electronic conducting material (metal) or between an electrolyte and clay when electric is made to pass through the interfaces. The IP phenomenon manifest in time and frequency domain.

III) Electrical resistivity method:- this method involves a low frequency A.C. or D.C. which is introduce into the ground via metal electrode and the potential at the vicinity of the current electrode is measured using potential electrode. The prospecting (technique) is found useful in groundwater hydrology especially when the rock is water logged since the resistivity of rocks depends on the sensitivity of water and water is very sensitive to its ions. Also it's found useful in mapping out the stratigraphic unit in a geological section for the exploration of a good conductor such as sulfide ores, nickel, iron and copper (CU) [12].

2.0 Result Analysis and Discussion

Table 3.1 is showing the location of the wells, pond and boreholes that were studied. The locations are given in terms of latitude and longitude with the data obtained using Global positioning system (GPS).

S/N	SAMPLE AREA NAME	LONGITUDE (E)^0	LATITUDE (N)^0	RESISTIVITY (Ωm)	CONDUCTIVITY (Ωm^{-1})	TEMPERATURE (^{O}C)
1)	G/Shehu Kwari, Motorized Borehole	11.990667	8.507278	0.471	2.12	27^{0}c
2)	BabanBaki Pond	11.989928	8.507056	0.466	2.15	27^{0}c
3)	SabonTitiFilinKorama Motorised Borehole	11.990581	8.505556	0.473	2.11	28^{0}c
4)	MazaunaTanko Borehole	11.987306	8.499500	0.480	2.08	29^{0}c
5)	MazaunamaiTasa Well	11.987611	8.501139	0.443	2.25	28^{0}c
6)	'Yan Kabalu Borehole	11.985694	8.501000	0.464	2.16	29^{0}c
7)	Tal'udu MotorisedBorehole	11.986806	8.497861	0.466	2.15	28^{0}c
8)	SaniMainagge Girl Secondary, Well	11.990806	8.502972	0.473	2.11	28^{0}c
9)	S/ 'Yan Dabino Well	11.990861	8.501222	0.473	2.11	27^{0}c
10)	Jan Ruwa Well	11.993917	8.501556	0.468	2.14	27^{0}c
11)	Mangwarori G/Wanka Motorised Borehole	11.993722	8.503056	0.478	2.09	28^{0}c
12)	FilinMangwarori	11.993222	8.503639	0.461	2.17	29^{0}c

	Borehole					
13)	‘Yar Mai Shinkafi Borehole	11.994250	8.509306	0.463	2.15	29^0c
14)	‘Yan Durma Borehole	11.992417	8.507083	0.447	2.24	28^0c
15)	GaranGamawa 1 Borehole	11.994639	8.507444	0.445	2.25	28^0c
16)	GaranGamawa2 Well	11.995167	8.509021	0.432	2.36	27^0c
17)	Sudawa Borehole	11.996417	8.509500	0.426	2.35	28^0c
18)	Diso Borehole	11.986889	8.512500	0.499	2.00	29^0c
19)	Gwale Sect. Borehole	11.986944	8.509389	0.499	2.00	30^0c
20)	‘YarKasuwa Well	11.986778	8.506222	0.438	2.28	27^0c
21)	Mai Allo Pond	11.983472	8.502167	0.58	2.18	27^0c
22)	Gadon Kaya BabanLayi, Borehole	11.999944	8.496167	0.454	2.20	30^0c
23)	Gadon Kaya Aminu Kano way, Borehole	11.982472	8.493556	0.456	2.19	29^0c
24)	GotonDutseMakabarta Well	11.991111	8.489889	0.461	2.17	29^0c
25)	Kansakali G/Wanka Motorised Borehole	11.996333	8.483833	0.474	2.11	30^0c
26)	G/ University Motorised Borehole	12.007694	8.488528	0.466	2.15	30^0c
27)	Kabuga	11.987139	8.482528	0.443	2.25	27^0c

	Borehole					
28)	Jan Bulo Borehole	11.986472	8.479861	0.474	2.11	29^0c
29)	B.U.K Old Side Pentagon, Motorised Borehole	11.980111	8.479361	0.452	2.21	30^0c
30)	D/ KarshenWaya Well	11.965278	8.481944	0.471	2.12	29^0c
31)	D/ GarejinKamilu Borehole	11.961333	8.479889	0.454	2.20	30^0c
32)	D/ 'Yan Kifi Borehole	11.962417	8.476917	0.461	2.17	31^0c
33)	D/ Unguwar Bello Motorised Borehole	11.960500	8.474222	0.466	2.15	30^0c
34)	D/ Tunga Borehole	11.965083	8.469583	0.452	2.21	31^0c
35)	TsmiyarKuturu Borehole	11.965278	8.486889	0.461	2.17	29^0c
36)	Gadar 'Yanmata	11.963056	8.502944	0.451	2.22	29^0c
37)	Rinji Well	11.964333	8.502306	0.454	2.20	27^0c
38)	KwanarGanduje Borehole	11.954078	8.491389	0.458	2.18	28^0c
39)	Jain Well	11.951000	8.490556	0.454	2.20	29.00^0c
40)	J/ UnguwarLelle Well	11.947056	8.484444	0.450	2.22	29^0c
41)	J/ Masallachi Well	11.944917	8.482917	0.464	2.16	27^0c

The graphs of conductivity against temperature are shown below for the twenty stations out of fourty one stations in order to show the trend of the path.in fig 1-2.0 below.

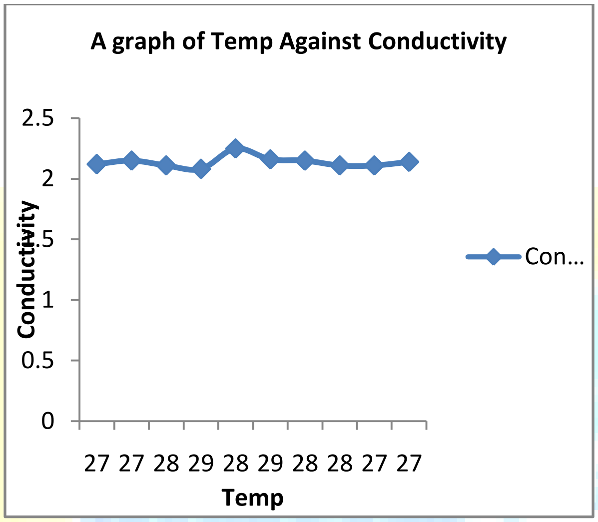


Fig 1.0

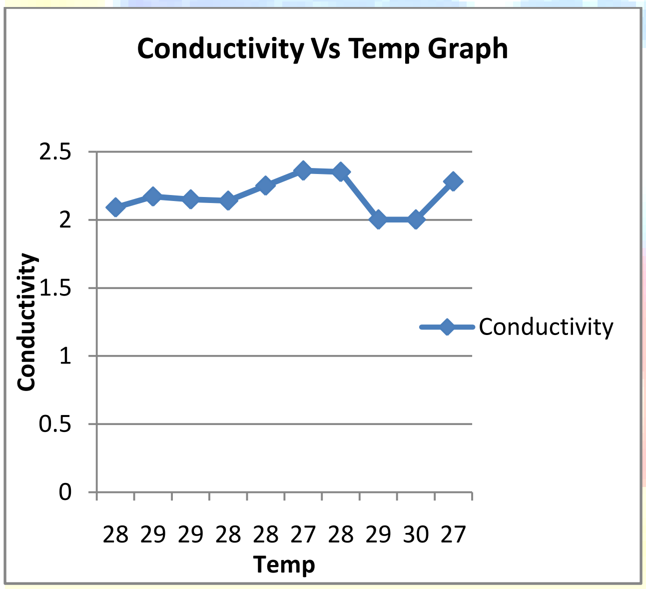
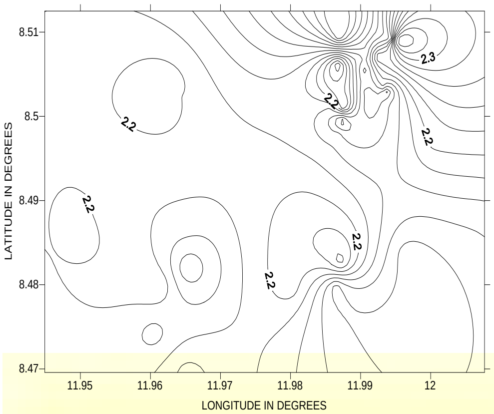


Fig: 2.0

Fourty one (41) samples of ground water were collected from different locations within the study area for Electrical conductivity measurement. When the electrical conductivity of water samples was measured in the laboratory, the conductivity data was recorded as in table 3.1 above. The data is then interpreted using computer software. The electrical conductivity map of groundwater around Gwale local government area is shown in the figure 4.1 below



From figure 4.1 the map shows distinct conductivity of water around the study area with some areas having higher conductivity is intermediate. The higher conductivity resulted due to the high population of people living in the area (congested area), and as result of that , many human activities are taking place in the area such as animal waste application of fertilizer , pesticides and in some areas pit-bathroom are closer to their wells e.t.c which can alter the natural composition of groundwater in the area. Telford et al have given the range in resistivity values for natural water as 0.5 to 150Ωm. When this value is converted to conductivity its gave range of 0.006 to 2.00 Ω/m [13].When the interpreted data was compared with Telford et al values for the resistivity of natural water, the result fall within his given range which shows that the work is quite appreciable.

3.0 Conclusion:

A total of 41 water samples were collected from different wells and boreholes around the study area and their conductivity was measured to determine how much they vary in ion content within the area. From the interpretation of the data obtained, the study area shows distinct conductivity values of groundwater around the area. The interpreted data show layers that vary from 10-17 with the conductivity rate that comprises mostly of high, low, an intermediate conductivity respectively. Though the research did not cover the overall water samples around the area, we can see as displayed in figure 4.1 there is high conductivity in some areas and low and intermediate conductivities in the other areas and we observed that the high conductivity resulted from the presents of many minerals and runoff from fertilizers etc. (due to the high population of the people in the area) that increase conductivity. Moreover, from the result of this work, most of the electrical conductivity of water samples around the study area is in the range of 2.00 -2.36

REFERENCE

1. Bowen, R (1986); Ground water. Elsevier, Applied Sciences.
2. Keary, P. and brooks, M 1991. An introduction to Geophysical exploration (2nd ed), Blackwell scientific publ. oxford.
3. Dobrin, M.B. (1975, 1985); introduction to geophysical prospecting. MC Graw Hill Book; Co inc. New York.
4. SHARP, John M. Jr, Dept. Geological Sciences, Jackson School of GeoScience, the University of Texas, 1 University station-C1100, Austin, TX 78712-0254 jmsharp@jsg.utexas.edu.
5. "Post Office-with map of L.G.A," NIPOST.Retrived2009-10-20 and Gwale Local Government Profile Hand Book.
6. Robinson, E.S and Coruh, C. 1988. Basic Exploration Geophysics John Wiley & Sons, New York.
7. Faure, G 1986. Principle of isotope Geology (2nd ed), John Wiley & sons New York.
8. Sheriff, R.E 1989. Geophysical method, prentice Hall, New jersey.
9. William Lowrie 1997 Fundamental of Geophysics (The Edinburge, Building, Cambridge (B2 2RU, UK Cambridge University press.
10. Heilans, C.A 1940 Geophysics exploration, chapter 10, prentice-hall New York (General).
11. Dobrin B.M, and savit, C.H. 1988 introduction to Geophysical prospecting (4th ed.), MC GrawHil, New York.
12. Willismslowrie; C. (1997); Fundamentals of Geophysics Cambridge University press London.
13. Telford, W.M. Geldart, L.P. and Sherriff, R.E Applied Geophysics (2nd ed), (2001) Cambridge University press UK.