Variations in Water Supply and Quality in Selected Groundwater Sources in a Part of Southwest Nigeria

Samuel Olajide Babawale, O. O. Ogunkoya

***Abstract*—**The study mapped selected wells in Inisa town, Osun state, in the guinea savanna region of southwest Nigeria, and determined the water quality considering certain elements. It also assessed the variation in the elevation of the water table surface to depth of the wells in the months of August and November. This is with a view to determine the level of contamination of the water with respect to land use and anthropogenic activities, and also to determine the variation that occurs in the quantity of well water in the rainy season and the start of the dry season. Results show a random pattern of the distribution of the mapped wells and shows that there is a shallow water table in the study area. The temporal changes in the elevation show that there are no significant variations in the depth of the water table surface over the period of study implying that there is a sufficient amount of water available to the town all year round. It also shows a high concentration of sodium in the water sample analyzed compared to other elements that were considered, which include iron, copper, calcium, and lead. This is attributed majorly to anthropogenic activities through the disposal of waste in landfill sites. There is a low concentration of lead which is a good indication of a reduced level of pollution.

***Keywords*—**Water quality, temporal changes, elevation, water table surface, land use, anthropogenic activities.

I. Introduction

HYDROCHEMICAL evaluation of groundwater systems, according to [2], is usually based on the availability of a large amount of information concerning groundwater chemistry. In turn, groundwater chemistry depends on factors, such as the degree of chemical weathering of the various types of rocks, general geology, inputs from sources other than water - rock interaction and quality of aquifer recharge. The occurrence of these factors coupled with their interactions accounts for groundwater quality complexity. The temporal, seasonal and spatial variations of groundwater chemistry and quality are as a result of hydrogeochemical processes [3].

Groundwater is considered as the ideal source of water to meet our domestic, industrial and agricultural requirements [7]. Unfortunately, the globally essential groundwater resources have been restricted in both quality and quantity by the radical increase in population, urbanization and modern land use applications (agricultural and industrial), and demands for water supply [5], [7], [9], [10]. This has necessitated the need to pay more serious attention to the rate of exploitation and conservation of the resource. The aim of the study is to assess and examine the temporal changes in groundwater level and quality in Inisa town, Osun state in Southwest Nigeria.

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II. Study Area

Inisa town is in the Odo-Otin Local Government Area of Osun State, Nigeria. It lies within the latitude 8°00’12.11’’N and 7°57’28.43’’E and longitude 6°37’16.34’’E and 6°40’37.27’’E. It is situated about 26 kilometers by road north of Osogbo, the state capital, and is about five hours by rail from Lagos, the commercial capital of Nigeria. It is situated on the margins of the southern forests of Nigeria on fairly raised land above 423 m above sea level. The prevalent climatic condition in the area is characterized by high temperatures, low pressure and moderate to high relative humidity all year round, comprising the rainy; March to October, and dry; November to February, seasons. It also experiences the short spell of the dry season referred to as the ‘August break’ often felt in August and caused by moisture-laden current redirection. But, as a result of climate change causing variation in the weather, the August break is sometimes experienced in July or September [6].

III. Materials and Methods

The study used both primary and secondary data. The primary data were coordinates, depths of well incision and elevation of water table from the floor of the wells. The coordinates were obtained through the use of a Global Positioning System (Garmin GPS map 76CSx), depth to water table surface through the use of a Sounder (OTT 30 meter Type 010), while depth of well incision was obtained using a weighted tape measure. Sampling bottles were also used for collection of water sample.

Secondary data were extracted from Google Earth Imagery and 1:50,000 topographic map of North West of Osun State (Sheet 243).

The spatial locations of wells were determined using Geographic Information System (GIS) and water samples were analyzed using AAS analyzer at the AAS laboratory of the Centre for Energy Research and Development (CERD). Statistical Package for Social Sciences (SPSS) and Microsoft Excel were also used in further analysis. Both descriptive and inferential statistical methods were used in determination of sampling pattern and graphical representations.

IV. Results and Discussion

Table I shows the different variables regarding quality parameters obtained from the analysis.

In this study, 32 wells were initially put under study from which 30 were considered. The deepest is well 23 which is 10.46 m deep and the shallowest is well 17 which is 2.95 m deep for better clarification. Sodium is the dominant metal in the water samples analyzed while lead has very low concentration and found in trace measures in all water samples. This is owing to the fact the area has little or no industrial activities, hence, less pollution and little concentration of particles from industrial activities. The concentration of sodium in surface and groundwater is influenced by human activities, such as the disposal of waste in landfill sites, the pumping of fresh water from coastal aquifers, which leads to the intrusion of saline water, the application of NaCl for the de-icing of roads, and the use of soaps derived from saponified fats. In this case the high presence of sodium can majorly be attributed to the human activities. The high sodium concentrations in the well water samples are related to the long weathering history of soil and long residence time of shallow groundwater which is a major attribute of the sampled wells [4].

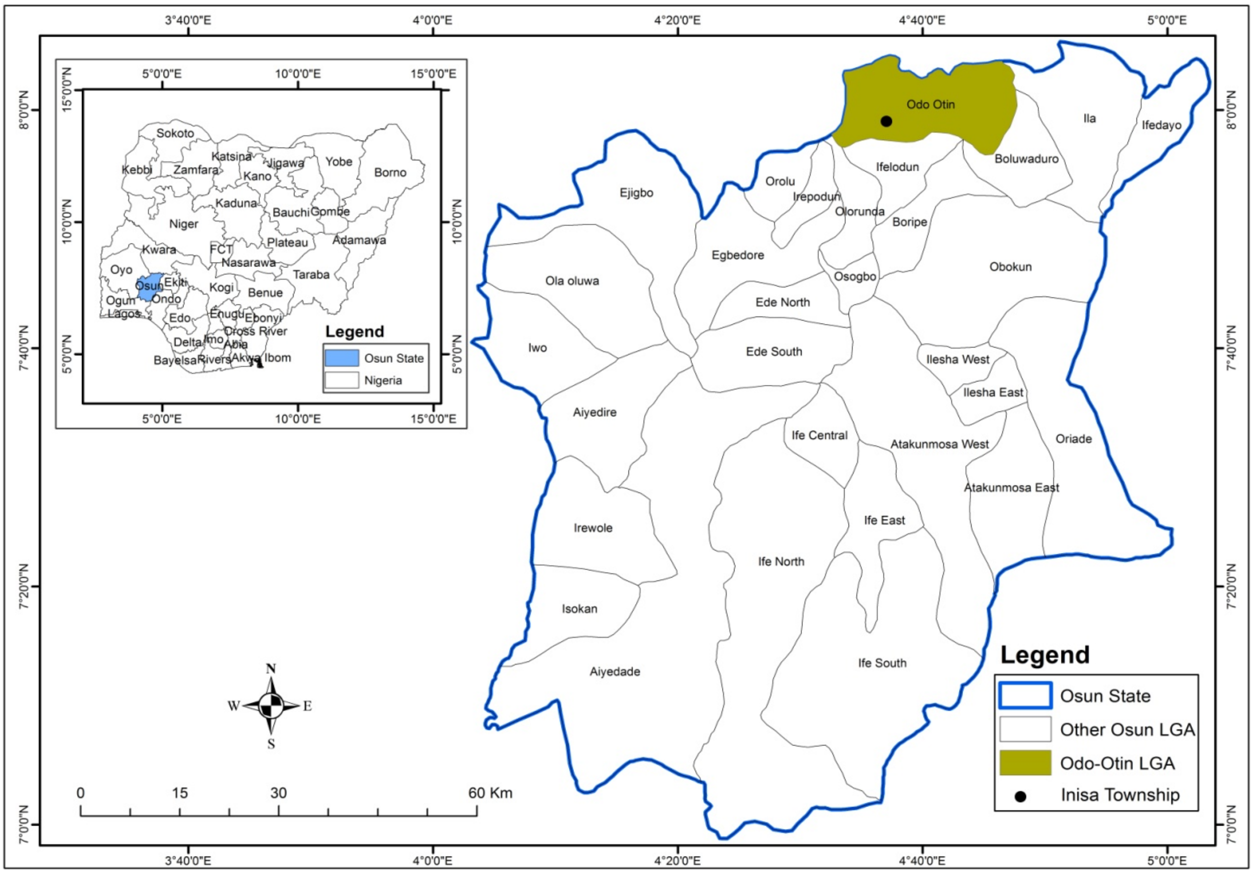

Fig. 1 Map of Osun state showing Odo – Otin with point indicating Inisa

V. Conclusion

The importance of water, sanitation and hygiene for health and development, as stated by [8], has been rightly emphasized in the outcomes of a series of international policy forums especially the Millennium Development Goal Number 7 and Sustainable Development Goal Number 6, which are concerned with providing access to safe and clean water. The most characteristic feature of groundwater is its long residence time which allows for a great quantity of dissolved substances [1]. Hence, groundwater is not pure. As a result, it must be ensured that groundwater in its use for both domestic and consumptive purposes be purified before being consumed. The World Health Organisation and United Nations have developed standards for water quality to ensure safe health for all which should be adhered to for the benefit of the human race at large because the quality of drinking-water is a powerful environmental determinant of health. Reference [11], on the occasion of World Water Day, 2010, stated that drinking-water quality management has been a key pillar of primary prevention for over one-and-a-half centuries and it continues to be the foundation for the prevention and control of waterborne diseases. It further posited that water is essential for life, but can and does transmit disease in countries in all continents – from the poorest to the wealthiest.

The study can empirically conclude that groundwater in Inisa, Southwest Nigeria, is safe for consumption as it contains a minute amount of lead which seems the only harmful metal considered. The water is safe for domestic use but further purification is advised for drinking to cater for the substances that are contained therein as a result of impurities introduced by anthropogenic activities, as explained by [11] that there are several variants of the faucal-oral pathway of water-borne disease transmission which includes contamination of drinking-water catchments (e.g. by human or animal faeces), water within the distribution system (e.g. through leaky pipes or obsolete infrastructure) or of stored household water as a result of unhygienic handling. However, the following recommendations are made:

1. Well owners are encouraged to test their water periodically to ensure the water is safe to drink.
2. Consult Public Health at the Local Health Authority or Water and Environmental Sanitation Department in the Local Government for advice regarding the specific parameters to test for and how often testing should be done.
3. The leadership of the town is also advised to come up with an action plan to help water suppliers and communities develop a well protection plan to minimize the threat of land use activities on groundwater quality.
4. Removing sodium by pitcher-type filtration units or boiling is not an option; in fact, it may further increase the concentration. Though expensive for use in small water systems, water treatment methods such as distillation, or reverse osmosis are the only effective methods of sodium removal.

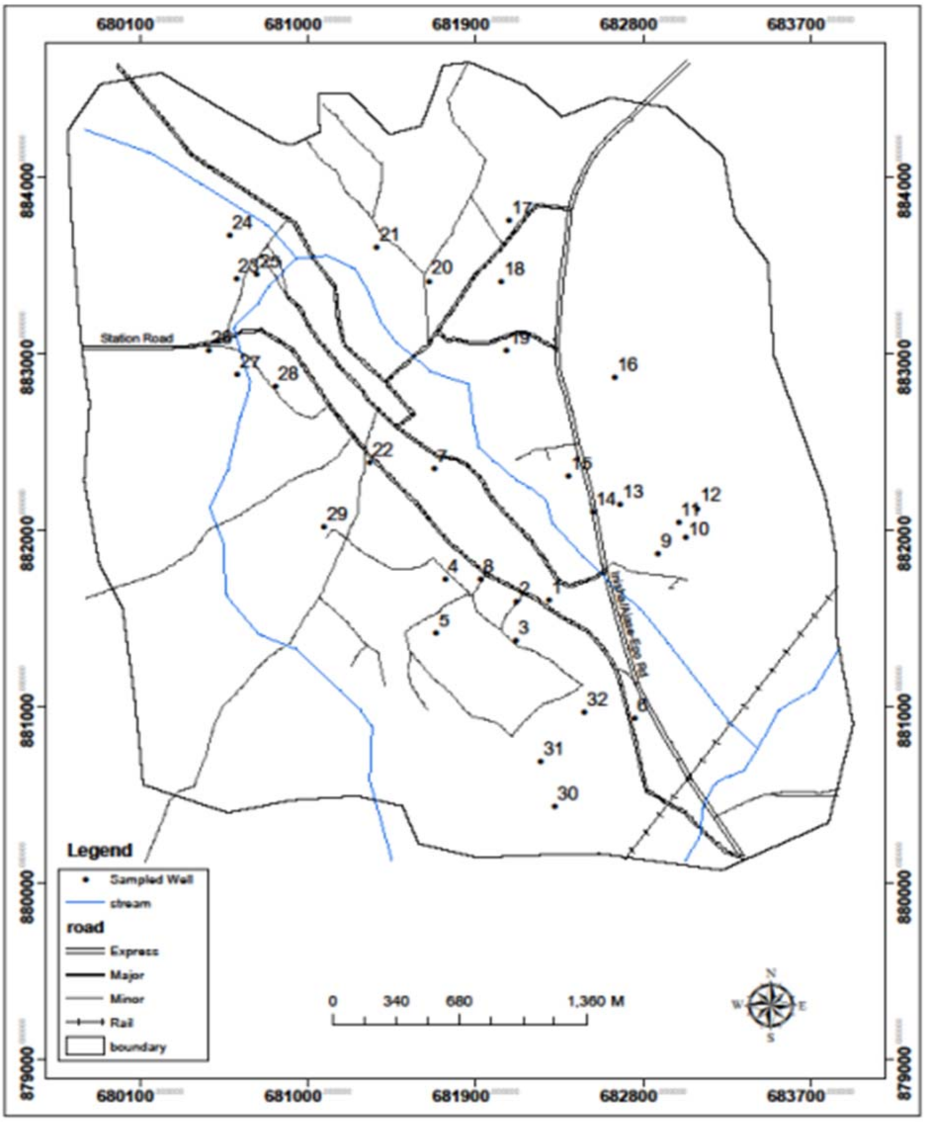

Fig. 2 Spatial location of sampled wells

TABLE I
CONCENTRATION (IN PPM) OF METALS IN THE WATER SAMPLES

S/N	Iron (Fe)	Lead (Pb)	Copper (Cu)	Sodium (Na)	Calcium (Ca)
1	0.104±0.0008	0.008±0.0006	0.111±0.0017	0.192±0.0014	0.078±0.0004
2	0.093±0.0003	0.006±0.0004	0.109±0.0018	0.280±0.0023	0.096±0.0005
3	0.060±0.0003	0.010±0.0002	0.079±0.0014	0.093±0.0026	0.098±0.0002
4	0.099±0.0006	0.007±0.0002	0.093±0.0021	0.600±0.0019	0.070±0.0002
5	0.114±0.0011	0.009±0.0008	0.120±0.0019	0.771±0.0022	0.080±0.0003
6	0.100±0.0004	0.011±0.0004	0.117±0.0011	0.129±0.0022	0.090±0.0005
7	0.172±0.0004	0.013±0.0005	0.160±0.0041	0.885±0.0017	0.110±0.0007
8	0.097±0.0001	0.007±0.0006	0.121±0.0009	0.584±0.0015	0.077±0.0007
9	0.088±0.0003	0.005±0.0004	0.099±0.0042	0.755±0.0014	0.081±0.0003
10	0.045±0.0002	0.008±0.0006	0.092±0.0028	0.566±0.0028	0.066±0.0008
11	0.073±0.0008	0.012±0.0008	0.110±0.0016	0.535±0.0023	0.045±0.0010
12	0.074±0.0002	0.010±0.0001	0.104±0.0011	0.539±0.0018	0.039±0.0002
13	0.085±0.0035	0.009±0.0003	0.085±0.0038	0.320±0.0023	0.049±0.0006
14	0.046±0.0008	0.006±0.0004	0.080±0.0002	0.254±0.0020	0.091±0.0001
15	0.114±0.0006	0.008±0.0003	0.105±0.0012	0.520±0.0027	0.085±0.0002
16	0.219±0.0002	0.017±0.0005	0.139±0.0004	1.221±0.0015	0.153±0.0002
17	0.150±0.0003	0.015±0.0004	0.147±0.0030	2.490±0.0012	0.184±0.0006
18	0.152±0.0005	0.016±0.0004	0.182±0.0012	3.052±0.0027	0.132±0.0003
19	0.187±0.0009	0.012±0.0003	0.208±0.0015	1.199±0.0013	0.156±0.0004
20	0.172±0.0011	0.019±0.0008	0.193±0.0021	2.723±0.0022	0.153±0.0003
21	0.202±0.0004	0.021±0.0005	0.215±0.0008	1.311±0.0014	0.160±0.0008
22	0.261±0.0007	0.016±0.0007	0.220±0.0012	2.150±0.0011	0.147±0.0004
23	0.196±0.0002	0.014±0.0000	0.184±0.0031	1.676±0.0018	0.145±0.0002
24	0.144±0.0004	0.022±0.0002	0.192±0.0014	0.823±0.0026	0.122±0.0003
25	0.182±0.007	0.020±0.0007	0.177±0.0015	1.891±0.0015	0.171±0.0003
26	0.103±0.0006	0.025±0.0006	0.203±0.0017	0.252±0.0027	0.149±0.0006
27	0.140±0.0009	0.026±0.0002	0.181±0.0015	0.830±0.0029	0.130±0.0005
28	0.191±0.0005	0.022±0.0007	0.198±0.0017	1.778±0.0015	0.165±0.0005
29	0.174±0.0004	0.018±0.0002	0.207±0.0021	0.811±0.0020	0.171±0.0008
30	0.188±0.0005	0.020±0.0002	0.192±0.0017	0.931±0.0025	0.162±0.0007

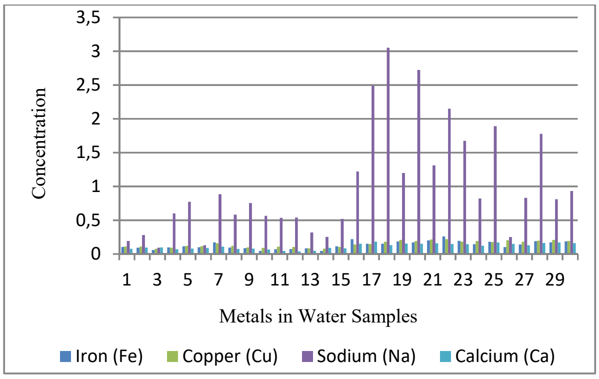

Fig. 3 The comparison of levels of concentration of metals in water samples

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