The International Journal of Engineering and Science (IJES)
|| Volume || 14 || Issue || 2 || Pages || PP 01-04 || 2025 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Nitrate Concentrations in the Groundwater System of Olokemeji, Ado – Ekiti, Southwest, Nigeria

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ABSTRACT

Water samples from 49 hand – dug wells were analysed for Nitrate concentrations in relation to well characteristics of Static Water level, Depth of Well and Elevation at Olokemeji – Ologede, Ado – Ekiti, Southwest, Nigeria,. The wells indicated varying levels of nitrate concentration with an average of 3.80 ± 11.29mg/l for the shallow wells having 6.15 ± 2.31m, 6.55 ± 2.43m and 414.88 ± 25.84m as average Static Water Level, Depth of well and Elevation respectively. About 10% percent of the wells in the study area indicated nitrate at levels exceeding the safe drinking water standard. The Nitrate concentration would decrease slightly with increasing static water level, depth of well and well - point elevation; the Correlation Coefficients being -0.02, -0.04 and -0.13 respectively. The weak association could be traceable to the hydro-geological scenario of the region.

Keywords*: aquifer; association; groundwater; migrate, nitrate*

Date of Submission: 05-02-2025 Date of acceptance: 16-02-2025

I. INTRODUCTION

One of the basic facilities in virtually all households in most cities in Nigeria including Ado - Ekiti is a hand-dug well drilled with the goal of supplying safe and accessible drinking water. Water abstraction of such wells is from shallow aquifers which may be susceptible to contamination from natural or man-made sources (Dada et al., 2011; Ayodele and Ajayi, 2015; Awopetu and Baruwa, 2017)

Nitrate is a naturally occurring form of nitrogen (N) which is very mobile in water. It is essential for plant growth and is often added to soil to improve productivity. Water moving down through soil after rainfall or irrigation carries dissolved nitrate with it to ground water. In this way, nitrate enters the water supplies of many households who use wells. Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/l), but nitrate concentrations grow due to human activities. Higher levels indicate that the water has been contaminated. Sources of nitrogen and nitrates may include runoff or seepage from fertilized agricultural lands, municipal and industrial waste water, refuse dumps, animal feedlots, septic tanks and private sewage disposal systems, urban drainage and decaying plant debris. Geologic formations and direction of ground water flow also may influence nitrate concentration (Gregory and Ronald, 1996; Ige and Adetunji, 2014; Ishaku et al., 2015)

The pandemic nature of nitrate contamination of groundwater and the inherent difficulty of remediating groundwater make it an important issue. Contamination of drinking water with nitrate presents a health hazard because nitrate ion can be reduced to nitrite ion in the gastrointestinal tract. Nitrite causes methemoglobinemia, a sometimes fatal disease to which infants are susceptible (AbdulRahaman, 1997; Gbadebo et al., 2010; Awopetu and Baruwa, 2017).

The quality of the construction of the wells varies greatly depending on available financial resources. It is noted that removal of the pollutant using household level technologies has proven to be illusive. In spite of the potential magnitude of this problem there has been no recorded data to furnish the households with adequate information which would aid the planning of these essential facilities and prevent undue poisoning (Tinuola and Owolabi, 2007; Olajuyigbe, 2010; Awopetu and Baruwa, 2017).

This paper attempts to assess the nitrate concentrations across the study area. It would also examine the relationships between nitrate concentrations and depth of hand – dug wells/static water levels in the wells and the elevations of the well points.

II. MATERIALS AND METHODS

Water samples were collected from 49 hand-dug wells in Olokemeji, Ado Ekiti. The samples were tested for Nitrate at the Public Health Laboratory in the Department of Civil Engineering of the Federal Polytechnics, Ado – Ekiti. Standard sampling and laboratory procedures were followed throughout the process (Dada et al., 2011; Ishaku et al., 2015; Awopetu and Baruwa, 2017). The results of the tests were recorded alongside the co-ordinates and elevation of the well - points using a GPS. The depths of the wells and the static water levels in the wells were measured. The data were fed into an electronic database. The electronic database was subjected to thorough data-checking exercises. With the GPS readings the map of the nitrate concentration across the entire study area was generated. The correlations of nitrates concentrations with the well parameters were determined. Mapping and statistical software were utilized to provide detailed analysis (Adelusi et al., 2004; Ifabiyi, 2008; Karunakaran, et al., 2009)

III. RESULTS

A summary of the key findings are presented in Table 1. The nitrate concentration in the study area ranged from 0.00 and 50.00 mg/l with an average value of 3.80 ± 11.29mg/l. High values of 15.70mg/l, 40.50mg/l, 48.10mg/l and 50.00mg/l were recorded in Wells W33, W20, W08 and W25 respectively. Average values of 6.15 ± 2.31m, 6.55 ± 2.43m and 414.88 ± 25.84m were obtained for static water level, depths of wells and elevation of the well points respectively.

The contour map of nitrate concentrations in the wells across the study area is shown in Figure 1. Only a few wells were indicative of high nitrate levels as delineated along the SW – NE axis of the study area.

The correlation coefficients of nitrate concentration with depth of well, static water level and elevation were of -0.02, -0.04 and -0.13 respectively.

Ifabiyi (2008) recorded an average nitrate concentration of 8.01mg/l with standard deviation of 14.89mg/l in his study of depth of hand – dug wells and water chemistry in a part of Ibadan. He also showed that Nitrate concentration reduced with increasing depth of well.

Correlation is the mutual relationship between two variables. Direct correlation exists when increase or decrease in the value of one parameter is associated with a corresponding increase or decrease in the value of the other. The correlation is said to be positive when increase in one parameter causes the increase in the other parameter and it is negative when increase in one parameter causes the decrease in the other parameter. The correlation coefficient (r) has a value between +1 and -1. The correlation between the parameters is characterized as strong, when it is in the range of +0.8 to 1.0 and -0.8 to -1.0, moderate when it is having value in the range of +0.5 to 0.8 and -0.5 to -0.8, weak when it is in the range of +0.0 to 0.5 and-0.0 to -0.513 (Karunakaran, et al, 2009)

IV. DISCUSSIONS

About 10% percent of the wells in the study area contained nitrate at levels exceeding the safe drinking water standard of 10mg/l (WHO, 1999; SON, 2007). These wells were situated along the North Eastern and South Western flanks of the study area as shown in Figure 1. The map vividly showed the nitrate level across the region.

The correlation coefficients of nitrate concentration with depth of well, static water level and elevation of -0.02, -0.04 and -0.13 respectively were indicative of weak association. An increase in the values of these parameters would slightly enhance a decrease in the nitrate concentration. Locating drinking water supplies up hill (high elevation points) and away from all possible sources of contamination has been suggested by Adelusi et al., (2004)**.** The weak association suggests that other factors such as the overburden protective capacity would be helpful in checkmating the flow of nitrates into the shallow aquifers. Geologic formations and direction of groundwater flow also may influence nitrate concentration**.** Oyedele, et al, 2005, Taiwo et al., 2011 and Ayodele and Ajayi, 2015 had recommended that geophysical evaluation and appraisal of a site be carried out before drilling a well. This will also aid the planning of waste-disposal facilities at the site.

It is difficult to remove nitrates from water as they are soluble in water. Treatment of drinking water to remove nitrates is thus expensive. Simple household treatment procedures such as boiling, filtration, disinfection, and water softening do not remove nitrate from water. Boiling actually increases the nitrate concentration of the remaining water. However, nitrate can be removed using water treatment systems like distillation, reverse osmosis, and ion exchange (Gregory and Ronald, 1996; Tinuola and Owolabi, 2007; Ayodele and Ajayi, 2015).

Measures must be taken to protect wells from direct contamination by surface water. Surface runoff must be diverted away from the wellhead. The well casing should extend above ground. Proper well protection including gravel-packing / grouting around the outside of the well casing and placing a concrete slab around the wellhead must be practiced. Comprehensive physico-chemical analysis should be carried out for all newly constructed private wells. Additional testing may also be useful if there are any known sources of nitrate or if high nitrate levels are detected in nearby wells. Periodic testing of the wells should be practised.

V. CONCLUSION

The hand - dug wells in the region indicated an appreciable safe regime of nitrate concentration. An inverse relationship had been found between the nitrate concentration and well characteristics of the Depth of Well, Static Water Level and Elevation, respectively. The weak association might be a reflection of the geologic formations and direction of groundwater flow in the region.

ACKNOWLEDGMENT
The authors gratefully acknowledge all useful suggestions regarding this work.

Table 1: Summary of Results

S/No	Parameters	Range	Mean	Standard Deviation
1.	Nitrate Concentration(mg/l)	0.00 – 50.00	3.80	11.29
2.	Static Water Level(m)	1.55 - 13.12	6.15	2.31
3.	Depth of Well(m)	2.60 - 14.10	6.55	2.43
4.	Elevation(m)	300.00 - 449.00	414.88	25.84

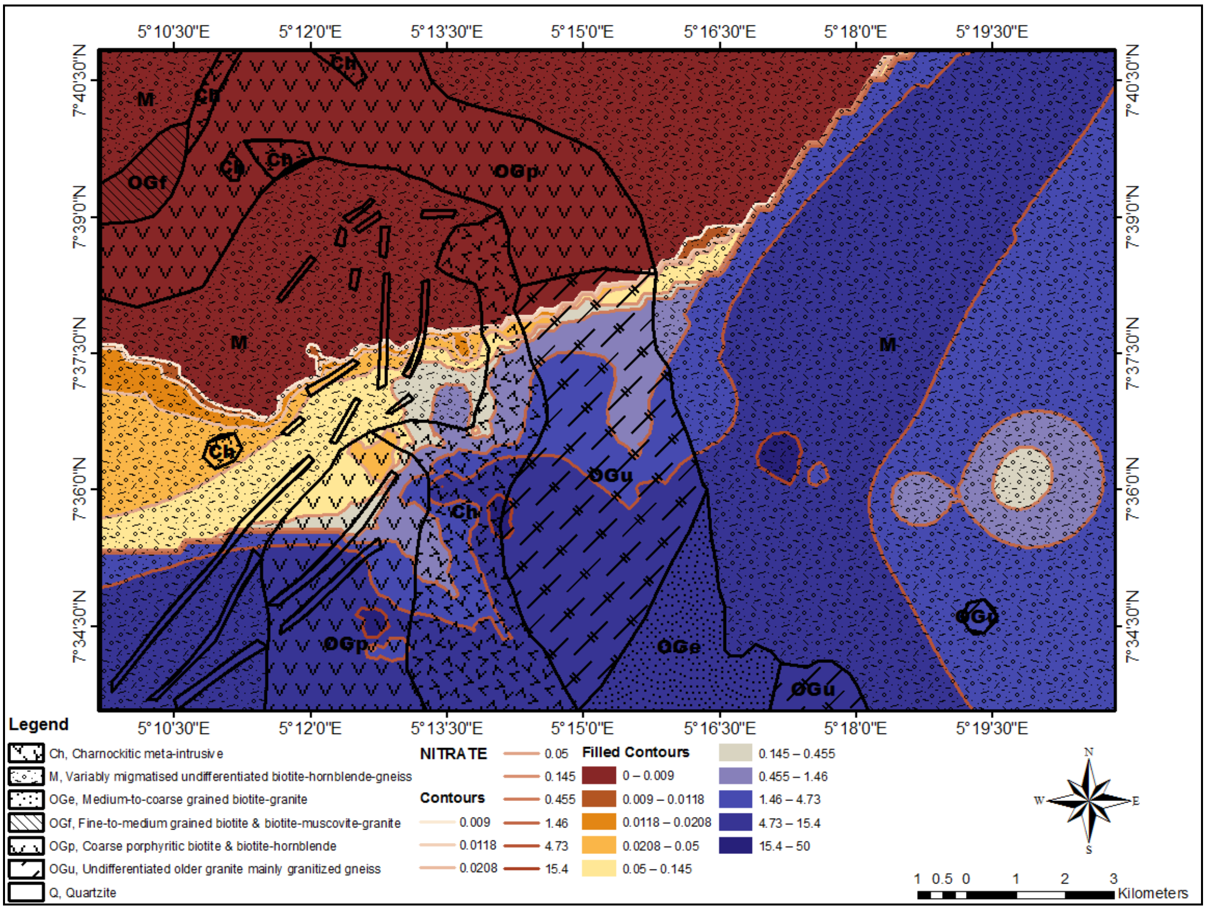

Figure 1: Nitrate Concentration Map

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