Gombe Journal of Geography and Environmental Studies (GOJGES)

Vol. 1 N0.1 Dec. 2019

e-ISSN: 2714-321X

p-ISSN: 2714-3201

http://www.gojgesjournal.com

Gombe Journal of Geography and Environmental Studies (GOJGES) Vol. 1 N0.1 Dec. 2019, e-ISSN: 2714-321X; p-ISSN: 2714-3201

IMPACT OF FLUORIDE CONCENTRATION ON GROUNDWATER QUALITY IN KALTUNGO AREA OF GOMBE STATE, NIGERIA

SULE, S,; ABASHIYA, M.; MAINA, B.; KOLLOS, P.N.; NAFISAT A.M.
Department of Geography, Gombe State University, Gombe state, Nigeria.
Contact: ssule@gsu.edu.ng +2348034255655

Abstract

Ground water is the main source of water supply in most of rural communities, in some part of Nigeria ground water contain high fluoride. The beneficial effects of in digesting fluoride to human health are limited to fluoride level approaching 1.0 mg/l in potable water. It is reported that drinking of water with such level of fluoride improves skeletal and dental health, when water of greater than 1.0mg/l fluoridise is ingested for prolong period of time will cause burrowing and mottling of teeth refers to as dental fluosrosis (WHO, 1994). The paper focused on the impact of fluoride concentration in groundwater quality in Kaltungo. A total of six (6) sample of water from two sources (borehole and well water),three (3) samples from each source in three area (Kalargu, Kalaring, Banganje) were collected and the water sample were Analyzed to determine the concentration of fluoride using HACH DR/2000 model of spectrophotometer. A follow up survey on sixty (60) families was carried out using structured questionnaire to determine the severity of teeth mottling in the study area. The result of the water analysis shows a range concentration between 0.66mg/l to 1.23mg/l of fluoride in the groundwater of the study area. However, the survey result revealed that, between 48% to 59% of the people in the area have severe problem of teeth mottling and need immediate attention of government to save the larger fraction of the population who are potentially at risk. The authors recommended measures such as defluorinating the groundwater before use and recharging the groundwater by inter basin transfer need to be practiced to improve the groundwater quality in this area.

Keywords: Groundwater, fluoride concentration, dental fluorosis, teeth mottling, Kaltungo.

1. INTRODUCTION

Ground water is the main source of water supply in most of rural communities in Nigeria. Groundwater containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic use (Sule, et al 2019). Fluorides are mainly found in ground water when derived by the solvent action of water on the rocks and the soil of the earth's crust. Due to climatic factors, adsorption and leaching directly affect the migration and exchange of fluoride from soil to water (Wang *et al.*, 2002). Fluoride is an essential element for life. At low concentrations it is generally believed that fluoride deficiencies can arise but at high fluoride concentrations other deleterious effects can certainly transpire. In relation to drinking water the importance of this element in the human body cannot be ignored, as it is generally believed that too little or too much can affect bone and teeth structure (Edmunds and Smedley, 2003).

The dental effects of fluoride naturally present in public drinking water were established during the 1930s and 40s by Dean and his colleagues at the US Public Health Service. In a series of epidemiological studies across the United States they demonstrated that as the concentration of fluoride naturally present in drinking water increased, the prevalence and severity of dental fluorosis increased and, the prevalence and severity of dental caries (decay) decreased

(Murray et al, 1991). The original work of Dean established 1.0 mg/L as the most appropriate concentration of fluoride in drinking water, i.e. the concentration at which maximum caries reduction could be achieved while limiting dental fluorosis to acceptable levels of prevalence and severity. This figure was modified to a range of 0.7-1.2 mg/L to take into consideration that in hot climates the population drink more water than in temperate climates (WHO 2006). However, this standard was soon found to be inappropriate for tropical and subtropical areas of the world, since the prevalence of fluorosis was found to be excessive.

The optimal concentration of fluoride varies according to climatic conditions with the range 0.5mg/L-1.0mg/L being generally recommended (WHO 1994). However, WHO emphasises that in setting national standards for fluoride it is particularly important to consider climatic conditions, volumes of water intake, and intake of fluoride from other sources (e.g. food and air). Fluoride level of 0.5mg/L are recommended in warm climates because more water is consumed and level as high as 1.5mg/L are regarded as optimum in cold climate where less water is consumed (Khan et al, 2004). The WHO concluded that in communities served with optimally fluoridated water supplies a small proportion of the population will continue to be affected by very mild fluorosis, evident as diffuse white lines and patches, which is not aesthetically damaging and which usually cannot be seen by the untrained eye. In communities where additional sources of fluoride are available the prevalence of fluorosis may increase. WHO recommended that dental fluorosis prevalence should be regularly monitored, using indices sensitive enough to detect early changes in enamel following minor changes in fluoride intake, and that when mild or more severe fluorosis is found to a significant extent in a community, steps should be taken to reduce fluoride ingestion during the ages of tooth development (WHO 1994).

The presence of fluorine concentration in ground water is often recognised only when people exhibit symptoms of fluorosis. Dental fluorosis has become a common feature among children and adult in Kaltungo. In addition to the already affected population, still a larger fraction of the population is potentially at risk. Nevertheless, there has been no inclusive health survey conducted for dental fluorosis to address the problems in the past and there is a very minor difference in the concentration of fluoride that imparts a beneficial or hazardous effect on human health. Therefore, it is against this background, that the present research considers the need to assess the variation of fluorine content in ground water and its relationship with dental fluorosis prevalence in some selected communities of Kaltungo town.

2. STUDY AREA

Kaltungo LGA is located between latitudes 9^0 46' to 11^0 00' N and longitudes 11^0 15' to 11^0 30' E. It covers an area of 905.9 km^2 and bounded by Akko LGA to the North, Shongom LGA to the South, Balanga LGA to the East and Billiri LGA in the West (fig 1). Base on the 2016 projected population the area have a population of 162,392.

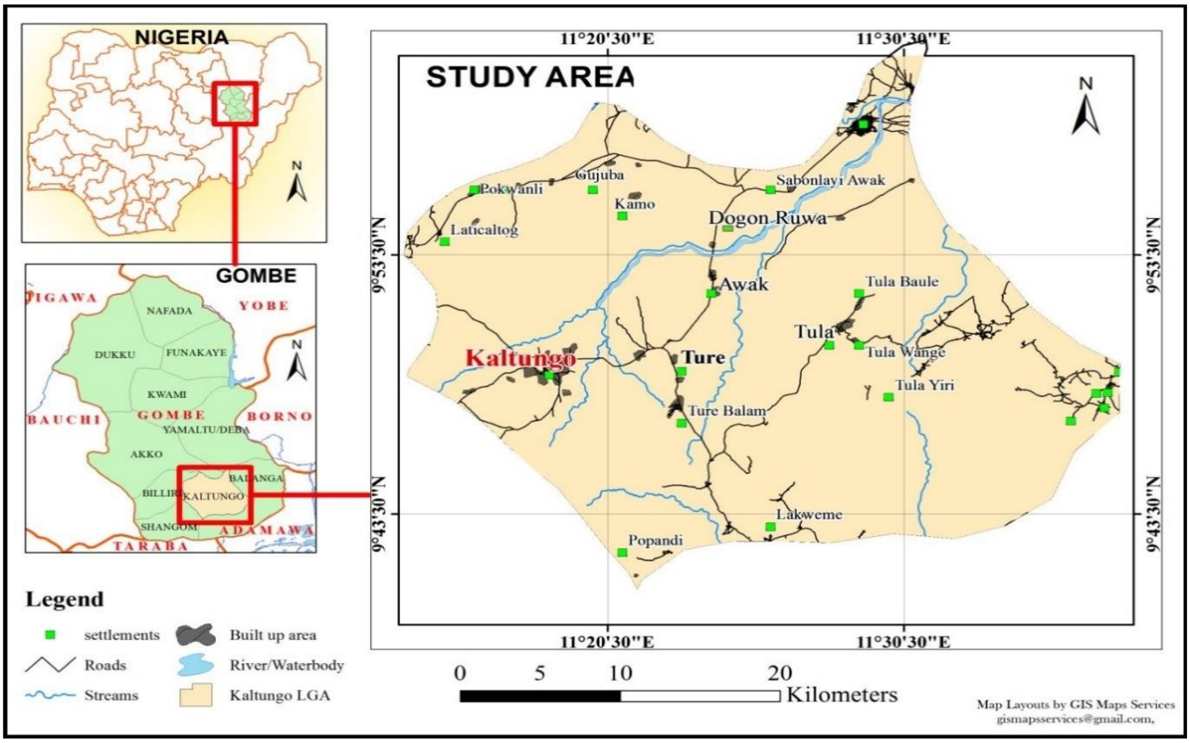

Fig 1: Map of study area.

Source: GIS and Remote Sensing Unit, Department of Geography, Gombe State University, Gombe.

The study area is located within the tropical climatic zone of Nigeria. In summer, there is much more rainfall in the study area than the winter. The minimum and maximum daily temperature is 23.6^{O}C and 40^{O}C respectfully (Oladipo, 1995). The driest month is January with 0mm; most precipitation falls in the month of August, with an average temperature of 30.5^{O}C. In December temperature is 27^{O}C, it is the lowest average temperature of the whole year. Geologically, the area belongs to Benue trough and is therefore, characterized by tectonically movement from upper cretaceous probably until (Carter et al, 1963). The study areas which composed of basement complex more or less clayey weathered grit are widespread and cover different thickness on the pediment surfaces (Mbiimbe, et al., 2019). At some places they changes in more clayey sediments if clay stones or shade are exposed at the surfaces (Fritscher, 1995). The rock types of the Kaltungo area which is as a result of sedimentary, volcanic and plutonic activities include Kaltungo/Tangale porphyritic granites of the Older Granite Suites, the Bima Sandstone, Yolde Formation, Fika Shale, Pindiga Shale and Basalt Flows. (Benkhelil and Robineau, 1983). The area is situated within the Sudan savannah vegetation types covered with grasses and shrubs, and with some useful economic trees such as baobab, acacia, and fig (ficus) families (Mbaya, 2016).

3. Material and Method

Both primary and secondary data were used. Primary data was collected through water sampling and structured questionnaires in addition to field observation. Water sample were collected from two different sources (hand dug well and Borehole) each, in the three sampled areas (Kalaring, Kalorgu and Banganje) within Katungo town with sampling bottles of one litre capacity, the sample bottles were cleaned and rinsed with the sample water before they were filled. At each sampling points the coordinates were taken using Global Positioning System (GPS/Garmin 76S) to help in plotting the map of the study area.

A total of 60 questionnaire of which 20 were administered in each area, a systematic random sampling method was used to select the households. The selection procedure involved a random start of which every 5th household in each of the areas were interviewed until the selected numbers of sampled were exhausted. It should be noted that the selection of the sample of men and women did not come in to the issue because the unit of analysis of the study was not individuals, but households. Consequently every normal adult person in any selected household was therefore eligible and made to answer the questions.

The water samples collected were analysed using SPADN method (spectrophotometry). The materials used includes Spectrophotometer (HACH DR/2000), SPADNS reagent, distilled water, beaker (50ml) plastics strings (5.0ml) needles and measuring cylinder. Procedure was - Spectrophotometer was powered and then the stored program number (190) for fluoride determination was entered through the button. This spectrophotometer can only determine fluoride at wavelength of 580 from the screen, when this was achieved, the read/enter was pressed as the screen displayed (mg/litre F) which indicates the readiness of the instrument. 25ml of distilled water and 5ml of the SPADNS reagent were measured and mixed together. This was use to calibrate (standardized) the spectrophotometer to avoid instrumental error when the instrument was calibrated. Thereafter, 25ml of pre-treated sample and 5ml of SPADNS reagent were measured, poured in to the same sample cell and mixed thoroughly. The solution was allowed to stand for one minute (reaction time) and the sample was then run in spectrophotometer.

Finally the concentration of fluoride (F) present in the sample was recorded in mg/l. The same analytical procedures were used for the entire samples. The results obtained from water quality analysis and questionnaire administered were analysed using descriptive statistics such as bar graphs, tables and relative frequencies. While non-parametric test statistic was used to determine a significant spatial difference in the volume of fluoride concentration in water sources from boreholes and wells.

4. Results and Discussion

4.1 Spatial concentration of fluoride

The result obtained in the laboratory analysis of concentration of fluoride in groundwater was presented in table 1 below. The fluoride concentration value of borehole water and well water sampled from three different areas within Kaltungo, value ranging from 0.66mg/L to 1.23mg/L in borehole water and 0.93mg/L to 1.10mg/L in well water. Thus, exceeded the optimum fluoride level of 0.5mg/L recommended in the warm climate region (Khan et al, 2004). As well as the optimum fluoride level of drinking water 1.0mg/L recommended worldwide (WHO, 1994). However, one borehole in Kalargu and a well in Kalaring were within the optimum fluoride level recommended worldwide.

Table 1: Concentration of fluoride

S/n	Location	Fluoride volume(mg/l)	
		Borehole	Well
1	Kalaring	1.03	0.93
2	Kalargu	0.66	1.10
3	Banganje	1.23	1.04

Source: Authors' Fieldwork

Chi-square X^2 test of homogeneity or independence (K-Sample cases) was used to test whether there is a significant spatial difference in the volume of fluoride concentration in water sources from boreholes and wells in the three sampled communities of Katungo town. Formula is $X^2 = \sum_{i=1}^{n} \frac{(O_i - \epsilon_i)^2}{\epsilon_i}$ Where O = Observed fluoride volume of boreholes and wells, ∈ = expected volume (mg/l). The result shows that the calculated value of X^2 is 0.126, the degree of freedom is 2, while the critical value at 0.05 (95%) level of significance is 5.99. Therefore, since the calculated value of X^2 (0.126) is less than the critical value (5.99) this implies that there is no statistically significant difference in the volume of fluoride concentration in water sources from boreholes and wells in the three sampled communities of Katungo town.

4.2 Adverse effect of fluoride concentration

A total of 60 households were administered questionnaire, 20 from each of the three (3) key communities selected in the study area, in other to asses the adverse effect of fluoride on teeth discolouration. A total population of 576 were involved in the survey, 186 from Kalaring, 194 in Kalargu and 196 in Banganje. The data collected showed that 309 people out of the total population have stain teeth. 90 (29.1%) were from the households in Kalaring, 104 (33.7%) were in Kalargu and about 115 (37.2%) were found in Banganje. Table 2 show the distribution of people with stain teeth by age group in the study area.

Table 2: Distribution of stain teeth by age group

Location	**Surveyed Population**	**Stain Teeth Between Age Group**				**People with stain teeth**
		0-5	6-10	11-15	15+	
Kalaring	186	6	8	34	42	90
Kalargu	194	9	15	39	41	104
Banganje	196	11	22	43	39	115
Total	576	26	45	116	122	309

Source: Authors' Fieldwork

From the result of the stain teeth between age group as indicated in table 2, shows that out of the 309 respondents with stain teeth, 26 (8.4%) were within the age group 0-5years, 45 (14.6%) were of the age group 6-10years while the remaining 238 (77.0%) were within the age group 11 and above. This finding is in support of Teotia, et al (1988) who specifically stated that high manifestations of dental fluorosis are mostly found among the children age group 12 and above. However, the severity of fluorosis depends on the concentration of fluoride in the drinking water, daily intake, continuity and duration of exposure, and climatic conditions. This is shown in the finding of this research where the concentration of fluorite in the water sources from boreholes and wells range between 0.66mg/L to 1.23mg/L which is greater than the optimum fluoride level of 0.5mg/L recommended in the warm climate region but within the 1.0mg/L recommended worldwide (WHO, 1994), thus above 50% of the total population from the sampled communities have stain teeth. This had actually confirm that in setting national standards or local guidelines for fluoride or in evaluating the possible health consequences of exposure to fluoride, it is essential to consider the intake of water by the population of interest and the intake of fluoride from other sources (e.g., from food and air). Where the intakes are likely to approach, or be greater than, 6 mg/day, it would be appropriate to consider setting a standard or local guideline at a concentration lower than 1.0 mg/L.

5. Conclusion and Recommendations

Groundwater containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic uses. Fluorosis is dreaded disease caused by consumption of water having excess fluoride content. The optimal concentration of fluoride varies according to climatic conditions with the range 0.5mg/L to 1.0mg/L being generally recommended (WHO 1994). However, Fluoride level of 0.5mg/L are recommended in warm climates because more water is consumed (Khan et al, 2004). Very low doses of fluoride (<0.6 mg/l) in water promote tooth decay, when consumed in higher doses (>1.0 mg/l), it leads to dental fluorosis or mottled enamel which is characterized initially by opaque white patches on the teeth and in advanced stages leads to dental fluorosis (teeth display brown to black staining) followed by pitting of teeth surfaces. This problem is severe in Kaltungo and need immediate attention of government, donors and philanthropists to save our people. Suitable measures such as defluorinating the groundwater before use and recharging the groundwater by inter basin transfer need to be practiced to improve the groundwater quality in this area.

REFERENCES

Benkhelil, J., and Robineau, B. (1983). *Fault Rocks of Kaltungo Lineament of North-eastern Nigeria and their Relationship with the Benue Trough Tectonics.* Journal of the Geological Society. 143, 567-569

Carter, J. D., Barber, W. and Tait, E. A. (1963). *The Geology of Parts of Adamawa, Bauchi and Bornu Provinces in North-Eastern Nigeria.* Geological Survey of Nigeria, Bulletin No. 30, pp. 1 – 99.

Dean, H. T. (1942) *Fluoridation: Mass Control for Dental Caries*, The American Journal of Nursing,52, (2), pp. 210-212.

Edmunds, W.M. and P.L. Smedley (2003): Fluoride in natural waters occurrence, controls and health aspects. In: Medical geology. New York (Ed.: O.Selenus). Academic Press.

Fritscher K, Leyeas C. and Peters, M. (1995) *Development in High Temperature Corrosion and Protection of Materials*.

Khan A. A., Whelton H., O'Mullane D. (2004) *Determining the optimal concentration of fluoride in drinking water.* Pak community dent Oral Epidemol. 32: 166 – 72.

Mbaya, L. A.(2016).*Climate Change Induced Tree Mortality in the Savanna Woodland and its Implication on Rural Livelihoods in Gombe State,* Nigeria.Nigerian Journal of Tropical Geography 7(1)pp952-968.

Mbiimbe, E.Y., Tabale, R.P. and Barka, J. (2019). *Geology of Gombe State.* In: Mbaya, L.A., Wanah.B.B.,Dan,Y .and Ahmed,B.Y.(eds). Gombe:People,Environment and Development. Pp50-58.Nonimod J. Ventures Jimeta-Yola,Nigeria. ISBN:978-978-976-413-6.

Murray JJ, Rugg-Gunn AJ, Jenkins GN. Fluorides in caries prevention. 3rd ed. Oxford: Wright, 1991:7-37.

Oladipo, E. O. (1995) *Some statistical characteristics of drought area variations in the savannah region of Nigeria.* Theoretical and Applied climatology (50) pp 147-155.

Sule, S. Abashiya, M. and Musa, I (2019). *Groundwater quality and its potential in Gombe State.* In: Mbaya, L.A., Wanah. B. B., Dan, Y. and Ahmed, B. Y.(eds). Gombe: People, Environment and Development. Pp92-103.Nonimod J. Ventures Jimeta-Yola, Nigeria. ISBN:978-978-976-413-6.

Teotia, S. P. S. and Teotia, M.,(1988) *Endemic skeletal fluorosis*: clinical and radiological variants. Fluoride, , 21, 39–44.

Wang W, Li R.A, Tan J, Luo K, Yang L, Li H and Li Y (2002) *Adsorption and leaching of fluoride in soils of China*. Geographical Sciences and Natural Resources Research 122 Research report Fluoride 35 122-29

World Health Organisation (1994); Fluorides and Oral Health: Report of a WHO Expert Committee on Oral Health Status and Fluoride Use. WHO Technical Report, Series 846.

WHO, (2006.) *Fluoride in drinking water*, World Health Organization, Geneva, London IWA.H.Fluoride 7 32-35.