

# ASSESSMENT OF ARSENIC CONCENTRATION LEVEL IN GROUNDWATER IN YOLA NORTH, ADAMAWA STATE, NIGERIA

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## ABSTRACT

*The presence of high arsenic concentration level in the environment and in groundwater sources have become a serious cause for concern Worldwide. The concentration level of arsenic in boreholes and wells in the eleven wards of Yola North local government was determined using GA3202 HGA graphite furnace system. The mean concentration levels of arsenic in boreholes and wells in Limawa, Gwadabawa, Nasarawo, Doubeli, Rumde, Yelwa, Luggere, Jambutu, Alkalawa, Ajiya and Karewa wards are: 0.920, 0.709, 0.602, 0.218, 0.180, 0.176, 0.144, 0.1405, 0.092, 0.052 and 0.02mg/L respectively. The highest and the lowest mean arsenic concentration level was recorded in Limawa and Karewa wards respectively. All the groundwater samples analyzed in the eleven wards of Yola North had arsenic concentration levels alarmingly on the higher side above the permissible limit of 0.01mg/L World Health Organization Standard and Standard Organization in Nigeria. The degree of arsenic pollution in the groundwater was classified as high to very high water category indicating a potential health risk groundwater to consumers in the long run. The high arsenic concentration levels noticed in groundwater source in this area is a serious cause for concern to the public. Adequate water treatment to lower or remove arsenic from boreholes and well water is recommended to avoid long time exposure which might results to public health disorder.*

**Keywords:** Pollution, groundwater, heavy metal, environment, arsenic

## 1 INTRODUCTION

The supply of fresh water in Nigeria for domestic and drinking purposes are from three sources including surface (river, stream, pond and lake etc.), groundwater (boreholes and hand dug wells) and rainwater. Typically, ground water is a major source of water used for domestic purposes in Nigeria because it seems to be clean [1], while surface water is vulnerable to pollution than groundwater [2]. The distribution of the various water sources depends on the location, topography and geology of the area. In the coastal areas, water supply is mostly from the ground, rivers, lakes, swamps and sea. While, in the non-coastal areas groundwater is the main source of water supply. Water pollution often occur in Nigeria due to the discharge of wastes including municipal waste materials into the environment which are washed into the aquatic ecosystem via soil erosion. According to [3], the waste is mainly from homes, local markets, abattoir, oil and agricultural activities. In the processing of agricultural products into finished products, several wastes streams are generated which are discharged into environment without proper treatment. In northern Nigeria, mining of metals from ores often leads to pollution. According to [4] arsenic is one of the potential heavy metal pollutants released during mining activities. An assessment of ground water contamination especially from arsenic offers a unique opportunity for the protection of human health and the environment. Arsenic with symbol (As) is a naturally occurring metalloid that may be a significant risk factor for cancer after exposure to contaminated drinking water, cigarette, food, occupational environment and air [10]. Theses causes a serious health risk; higher level of arsenic is very poisonous to multi-cellular life. Among all these forms of arsenic pollution, contaminated drinking water is the major source of arsenic poisoning, more than 50% of households use untreated water for their daily activities like drinking, cooking, bathing and washing and most of these are from wells and boreholes which are obtained from groundwater. According to US national research

council, one in 10 people who drink water containing 500µg/L of arsenic may ultimately die from cancers caused by arsenic, including lung, bladder, and skin cancer. World health organization standard gives the recommended dose of 10µg/L of arsenic in drinking water [5]. Standard Organization of Nigeria has also adopted the WHO standard of 10µg/L arsenic in drinking water and any violation of this in the long run entails that consumers of the affected water may risk the potential of developing cancer [6]. Other notable effect of arsenic exposure to human health, agriculture and the environment includes lethality, inhibition of growth, photosynthesis, reproduction, anemia in pregnancy, mortality from respiratory diseases, diabetes in adult, still birth, neuro development problem and behavioral effect as reported by [7,8], are a serious cause for concern. Therefore, there is the urgent need to study and determine the concentration level of arsenic in ground water of Yola north in Adamawa State of Nigeria.

## 2 The Study Area

Yola north local government area is located in the northeastern part of Nigeria and the Capital of Adamawa State. It has an estimated population of 307,714 people with an approximate land area of 1104.30 km<sup>2</sup> with a radius of 3.55km [9]. It can also be located between the latitude of 9° 14' 31.8" (9. 24 22°) North and Longitude 12° 31' 29.5" (12.5249°) East of Greenwich meridian with an average elevation of 166 meters (545 feet) [10]. Yola north local government has eleven (11) wards areas, namely: Ajiya, Alkalawa, Doubeli, Gwadabawa, Jambutu, Karewa, Limawa, Luggere, Nasarawo, Rumde and Yelwa wards which experiences a distinct rainy and dry season with a temperature range of 27 - 40°C annually (Figure 1).

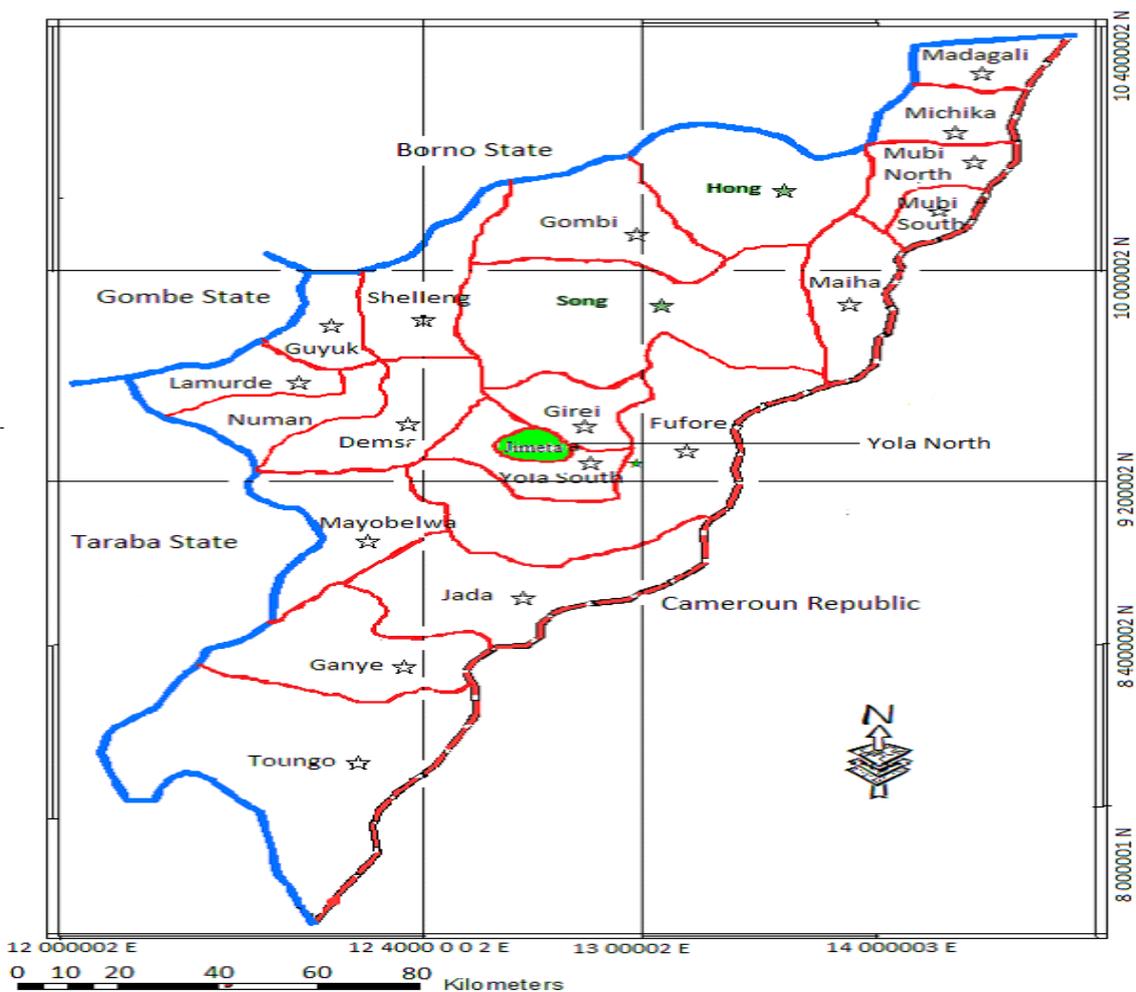


Figure 1. Map of Adamawa State and LGAs showing the study area in green color

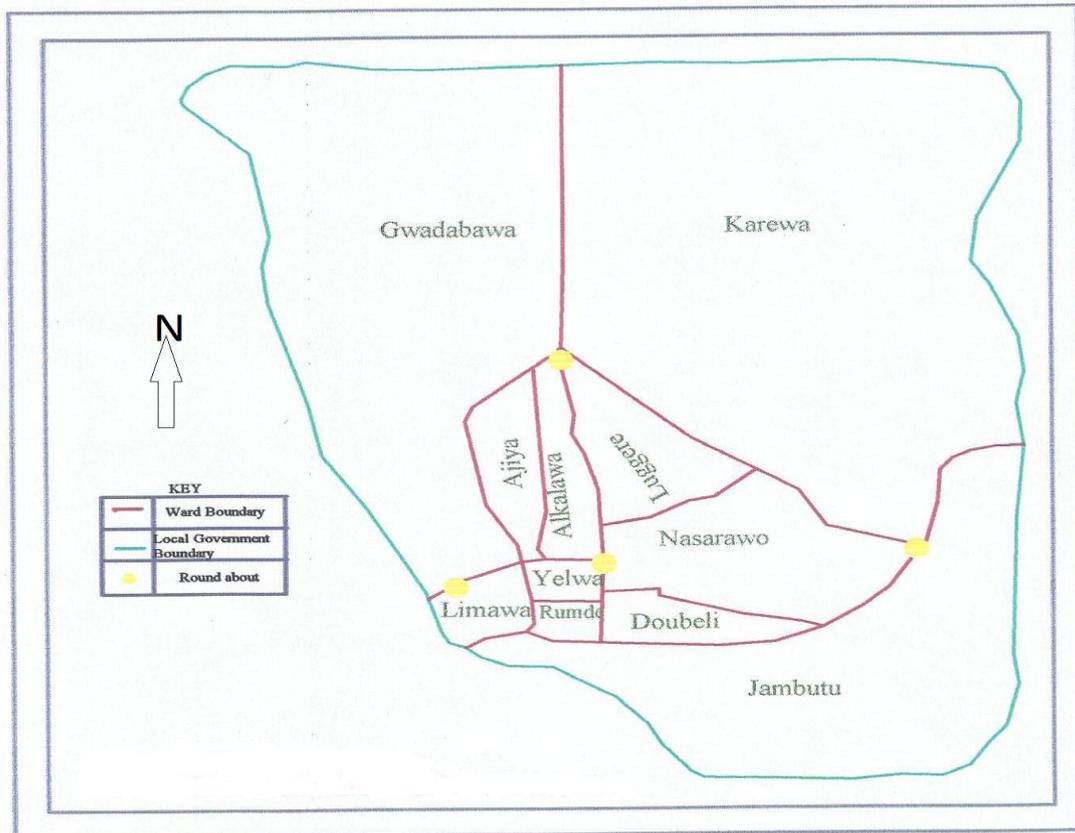


Figure 2. Map showing sampling location in the study Area

### 3 MATERIALS AND METHODS

#### 3.1 Water Sampling Sites

The selected sampling sites were chosen from the eleven wards namely: Ajiya, Alkalawa, Yelwa, Luggere, Rumde, Doubeli, Jambutu, Gwadabawa, Nasarawa, Karewa and Limawa (Fig. 2). The busiest boreholes and wells which serves as the main water supply for drinking in each of the above mentioned wards was identified and selected for water sampling.

#### 3.2 Water Sampling Equipment's

The sampling equipment used are: labeling tape, 100ml capacity sampling bottles which were pre cleaned with nitric acid and then rinsed with distilled water, and then fitted with cap cover, high density polyethylene containers were selected and used because of the fact that they are less adsorptive to arsenic [11].

#### 3.3 Water Sampling method, time and frequency

The random sampling method was adopted and sampling time was early morning hours where the boreholes were open to run for ten minutes as suggested by [12]. The sampling container was also washed with the ground water samples and then filled with the water samples and closed tight with the container cap. Triplicate samples were collected from boreholes and wells in all the eleven wards listed above. The sampling time was in the months of September, October and November 2018 in the early morning hours on fortnight basis. The samples were preserved under a temperature of less the 5°C in a cooler and immediately taken to Federal Ministry of Water Resources, Department of Water Quality Control and Sanitation, National Water Quality Reference Laboratory Gombe, Gombe State. Plate 1 shows the raw water samples from wells and boreholes for laboratory analysis.



Plate 1. Raw water samples from wells and boreholes for laboratory analysis

### 3.4 Water Sample analysis

The preserved collected samples were analyzed using the graphite furnace system GA3202 HGA (Plate 2), with absolute sensitivity of  $10^{-10} - 10^{-12}$  grams fitted with 5cm long life titanium burner and nitrous oxide- acetylene flame analysis in the Department of Water Quality Control and Sanitation, National Water Quality Reference Laboratory in Gombe.



Plate 2. GA3202 HGA Graphite Furnace System

### 3.5 Data Analysis

The data obtained from the analysis of the arsenic concentration levels in groundwater samples was analyzed using simple descriptive statistical analysis and the results were compared with the World Health Organization [5] and Standard Organization of Nigeria Standard [13] permissible limits of arsenic in drinking water. The results are discussed below:

## 4 RESULTS AND DISCUSSIONS

The results obtained as shown in the Table 1 below indicated that Limawa ward has the highest mean arsenic concentration of 0.92 mg/L and is far above the maximum permissible limit, this could be attributed to the fact that there is improper waste disposal almost everywhere in the ward, a lot of industrial activities like the presence of old abattoir, dyeing centers, laundries, car wash centers, aluminum company, polythene bags company among others and agricultural activities like fishing and the presence of irrigation farms in the

wards (Figure 3). Gwadabawa ward has a mean arsenic concentration of 0.7096mg/L followed by Nassarawo ward with a concentration of 0.602mg/L, Doubeli ward with a concentration of 0.218mg/L, Rumde ward with a concentration of 0.18mg/L, Yelwa ward with 0.176mg/L, followed by Luggere with 0.144mg/L, then Jambutu with 0.405mg/L.

Table 1. Concentration Levels of Arsenic in Ground Water Source in Yola North

Sampling Sites	As (mg/L)	WHO (2017)	NDWQS (2015)	Pollution	Remark
Ajiya	0.052	0.01	0.01	High	Potential Health Risk
Alkalawa	0.092	0.01	0.01	High	Potential Health Risk
Yelwa	0.176	0.01	0.01	Very high	Potential Health Risk
Luggere	0.144	0.01	0.01	Very high	Potential Health Risk
Rumde	0.18	0.01	0.01	Very high	Potential Health Risk
Doubeli	0.218	0.01	0.01	Very high	Potential Health Risk
Jambutu	0.1405	0.01	0.01	Very high	Potential Health Risk
Gwadabawa	0.7096	0.01	0.01	Very high	Potential Health Risk
Nasarawo	0.602	0.01	0.01	Very high	Potential Health Risk
Karewa	0.02	0.01	0.01	High	Potential Health Risk
Limawa	0.92	0.01	0.01	Very high	Potential Health Risk

NDWQS= National Department of Water Quality Control and Sanitation

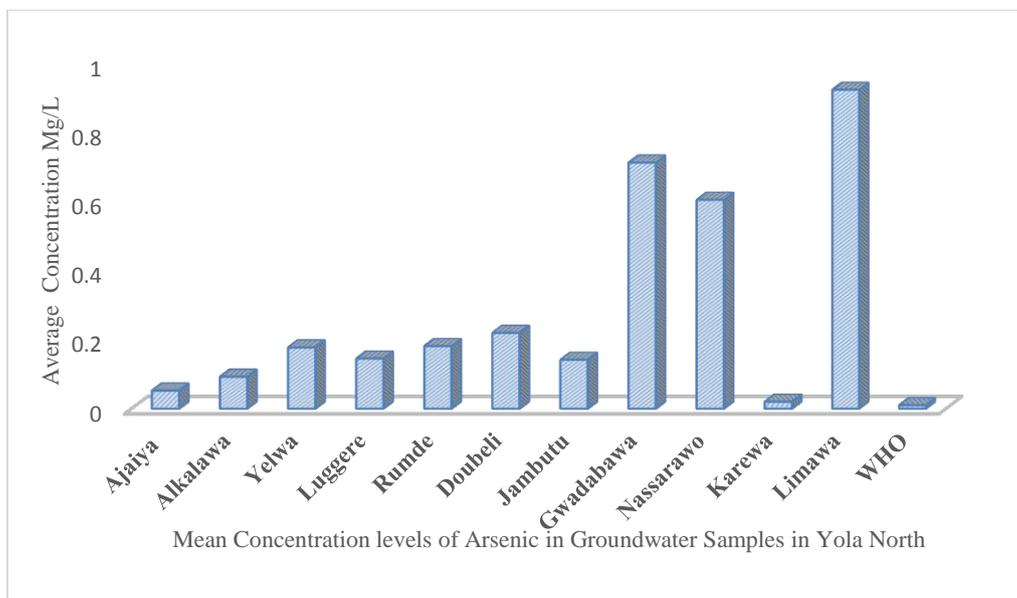


Figure 3. Mean concentration levels of Arsenic in Groundwater of Yola North

Karewa ward has the least Arsenic concentration in the study area with a mean Arsenic concentration of 0.02 mg/L but it is slightly above the Maximum Permissible Limit of 0.01 mg/L this could be attributed to the fact that improper waste disposal is less, absence or minimum industrial and agricultural activities. Ajiya ward has a mean Arsenic concentration of 0.052 mg/L and Alkalawa ward with a mean Arsenic concentration of 0.092 mg/L. In this study, an analysis of the arsenic concentration in Yola North local Government Area of Adamawa State has shown that the highest concentration level of arsenic in groundwater was found in Limawa ward with a value of 0.9200 mg/l and the lowest concentration value was found in Karewa ward having a concentration value of with 0.02 mg/l respectively as shown in the table 1 above. This trend of the results could be attributed to leachates of different arsenic containing substances dumped in refuse dump sites and the use of agrochemicals (fertilizers, herbicide and insecticides) that infiltrates in to ground water

sources around these areas. All the observed concentration values were above the World Health Organization (WHO) and also the values adopted and agreed by Nigerian Industrial standard [13], Nigerian Directorate for Drinking Water Quality (NDWQS, 2015) and Standard Organization of Nigeria, [13]. The arsenic concentration level tested in groundwater sources were found to be contaminated with abnormal concentration of arsenic in the water source. The presence of high concentration of arsenic in ground water sources in Yola could be risky to consumers and also long-time cumulative effect of drinking water from these sources without proper treatment could expose consumers to severe health hazards. The high arsenic concentrations level present in these water sources could be attributed to both natural and anthropogenic processes such, as erosion, under surface weathering, toxic chemicals, improper waste and sewage disposal, wastes from industries, agricultural activities and vehicular emissions [14], The contaminants in ground water take more time to be cleaned because it moves slowly and is not exposed to the natural cleansing benefits of air, sunlight and micro-organism [15]. Different works have been reported by many researchers on arsenic concentrations in wells and boreholes water. [16] Reported a mean arsenic concentration of 0.02 to 0.51 mg/L in Zaria city. [17] From their research findings, reported high level of arsenic concentration of 0.81mg/L in Kutama and 0.77 mg/L in Getso, Gwarzo Local Government area, Kano State, both of which are above the Maximum Concentration Limit (MCL) of 0.01 mg/L. They attributed these high concentrations to likely be due to disposal of arsenic containing materials, burning of solid wastes, natural processes and human activities [16]. High concentration of arsenic was recorded in wells from the sampled areas because most of them are open and the areas where they are located have high human, agricultural activities and natural processes. In our current study in Yola north local government area, much lower concentration level of arsenic of 0.2958 mg/L was recorded. This could be attributed to the fact that Kano and Zaria have much higher industrial areas than Yola, therefore justifying our recorded results. The level of arsenic in natural waters varies between land area to another mostly 2 mg/L [18]. Concentrations may be elevated however, in areas containing natural sources value as high as 12 mg/L have been reported [17]. The high concentration level of arsenic in groundwater sources as evidence from our study calls for urgent sensitization and education of consumer's, by government, public health officers and stakeholders on the long-time effect of drinking such water without proper treatment particularly during dry season where water demand and consumption is on the higher side due to high extreme temperature experienced in Yola.

## 5 CONCLUSIONS

The concentration levels of arsenic in groundwater sources (Boreholes) in Yola North area were determined. The result showed that all the eleven wards had their water sources contaminated and tainted with arsenic concentrations above the maximum concentration limit (MCL) of 0.01 mg/L set by World Health Organization and adopted by Nigerian Industrial Standard, Standard Organization of Nigeria and Nigerian Standard for Drinking Water Quality (NSDWQ 2015). Limawa and Gwadabawa recorded the higher concentration of arsenic above the world Health Organization Standard (WHO). People living in Yola North local Government are at a risk of contracting human body organs disorder like lungs, kidney and skin diseases as the people does not treat their water before drinking. The high concentration level of arsenic in groundwater sources as evidence from our study calls for urgent sensitization and education of consumers, by government, public health officers and stakeholders on the long-time effect of drinking of such water particularly during dry season where water demand and consumption is on the higher side due to high extreme temperature experienced in Yola. Further studies are to be carried out to characterize the type of Arsenic in the water samples. Analysis of the solid waste also be carried out in order to detect the content of Arsenic in the Dumpsites.

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