# ASSESSMENT OF HEAVY METALS CONCENTRATION IN HAND DUG WELLS IN GERO COMMUNITY, JOS SOUTH LOCAL GOVERNMENT OF PLATEAU STATE.

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**ABSTRACT**

*The heavy metal assessment of water from in Jos South Local Government of Plateau State was studied for the purpose of ascertaining the water quality of the hand dug wells. Six hand dug wells were sampled. The location of the wells were these samples were collected were denoted as P1, P2, P3, P4, P5, P6. The concentrations of the following heavy metals were assessed; Iron (Fe), Copper (Cu), Chromium (Cr) and Cadmium (Cd) using the Atomic Absorption Spectrometer method of analysis. The results from the chemical analysis has shown that there was considerable amount of heavy metals in the hand dug wells though the levels were low when compared to the World Health Organisation (WHO) and Standard Organisation of Nigeria (SON) maximum permissible levels for Copper (Cu), Iron (Fe) and Zinc (Zn). Cadmium (Cd) was detected at location P5. Cadmium (Cd) concentration exceeded the WHO maximum permissible level of 0.003mg/l. High concentration of Cadmium (Cd) could be attributed to leaching of Cd metal into the water from the surroundings. This shows that the water at P5 was polluted by Cadmium (Cd) metal. Artisan miners should be educated and enlightened on safe mining practices and there is a need to educate the general public through the media (TV, Radio, Pamphlets, Newspapers, Drama) on ways to avoid contamination of the environment and water bodies.*

**Key words:** *Hand dug wells, Heavy metals, Tin mining*

## INTRODUCTION

Water is life and is known to be next to oxygen in the order of importance in the sustenance of life. In fact, about two-thirds of human body is made of water. This colourless, odourless and tasteless liquid is essential for all forms of growth and development and is the basic need for sustaining human economic activities. Not only does water support a wide range of activities, it also plays a central symbolic role in rituals throughout the world and is considered a divine gift by many religions. It is indeed one of the earth's most precious resources (Ayoade and Akintola, 1999; Yisa and Onoyima, 2011).

Clean water is such scarce resource in the world that only a tiny fraction of the planet's abundant water is available as fresh water. Of the total water on earth only about 97% of it is available as saltwater. More than 2% is locked up in ice cap or glaciers. Only less than 1% of the earth's total volume of water is available as drinking water. The fresh water we use comes from two sources; surface and groundwater. Precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration is surface water. The subsurface area where all available soil or rock is filled by water is groundwater (Yisa and Onoyima, 2011).

Although water is essential for human survival, many are denied access to sufficient potable drinking water supply.

Globally, about 1.1billion people rely on unsafe drinking water resources from lakes, rivers and open wells. The majority of these are in Asia (20%) and sub-Sahara Africa (42%). Furthermore, 2.4 billion people lack adequate sanitation worldwide (WHO/UNICEF, 2008). Nevertheless, the key to increase human productivity and long life is good quality drinking water. The provision of good quality water is often regarded as an important means of improving health. In recent time, some parts of the world have been making encouraging progress in meeting the Millennium Development Goals (MDG) on water, but serious disparities remain. Lack of access to improved drinking water is still a serious problem in large portion of Asia and Sub-Sahara Africa (WHO/UNICEF, 2008).

In many African countries, including Ghana (Ediin and Brown, 2010), not only is rising population increasing demand for safe drinking water supplies, but also most natural sources of drinking water are unprotected from pollution due to human activities. In West Africa, unsafe solid wastes from domestic activities are an important source of water pollution in many capitals, such as Yaoundé (Cameroun), Lagos (Nigeria), Abidjan (Ivory Coast) and Dakar (Senegal) due to overcrowding, poverty and low sanitation in precarious neighbourhood areas. Rural to urban migration has led to rapid development in African towns in relatively small areas under poor conditions of sanitation. The impact is that the municipalities cannot provide water supply and sanitation. For example, in 2000, urban areas of Ghana generated about 763 698 $m^3$ of wastewater each day, resulting in approx. $280 \times 10^6$ $m^3$ over the entire year. In addition, during the rainy season, wastewaters and non-disposed wastes were washed and drained to surface water in place with a favourable topological context (Agodzo & Huibers, 2011).

In Nigeria today, research indicates that, majority of the common fresh water sources are polluted, resulting to serious outbreak of these and other diseases. A study by Wogu (2011) showed that 48% of the people in Katsina-Ala Local Government area of Benue state are affected by urinary *schistosomiasis*, due to increase in water pollution index. Some previous investigations indicate that 19% of the whole Nigerian population is affected, with some communities having up to 50% incidence. This has raised serious concerns to World Health Organisation, in an attempt to improve cultural and socio-economic standards of people in the tropical region. Recently, Wokunmi and Asaolu (2011) have documented varying levels of microbial contaminations in drinking water from western parts of the country. Total bacteria and coliform counts were found to be between 2.86 -4.45 and ≤ 1.62 log cfu/ml respectively. In addition to microbial infections, heavy metals poisoning through drinking water have also been documented. The elevated levels were linearly correlated with water and air contaminations by lead emissions. Garba et al. (2010) reported a mean arsenic concentration of 0.34 mg/l in drinking water from hand dug wells, boreholes and taps of Karaye Logal Government area, Kano state. The arsenic levels are of serious concerns to regulatory agencies because they by far exceed the upper band (0.01 mg/l) recommended by WHO.

**STATEMENT OF THE PROBLEM**

The most common environmental pollutants in the world are heavy metals (Papatilippaki *et al.,* 2008). The presence of heavy metals at trace level and essential elements at elevated concentration causes toxic effects if exposed to human population (Fong *et al*., 2008).



In Zamfara for instance, lead poisoning was recorded as result of Pb-Zn mining and gold ore processing. Although farming is the major livelihood in Zamfara State, gold-ore–processing increasingly constitutes an important income source among selected areas. During routine meningitis surveillance in Zamfara State conducted during February–April 2010, Medecins sans Frontieres (MSF) and local public health officials identified more than 200 children aged <5 years with convulsions during the previous 3 months among 4 villages. About 40 of these children were reported to have died (Raji and Ehinmindu, 2010). Environmental causes were suspected because of a recent increase in gold-ore– processing activities in the region. Over 400 children were reported to have died as a result of lead poisoning outbreak in Zamfara State, Nigeria and about 2000 children are currently on treatment (WHO,2009). Efforts have been made by government to regulate illegal mining activities in Zamfara State in other to minimize the problem but the problem still persists.

The major source of drinking water for the inhabitants of Gero area in recent time is the untreated groundwater obtained from hand dug wells and abandoned mining wells that are drilled across the entire study area mostly by the individuals and miners respectively. Most of these wells are newly constructed and there is no existing information on their water quality. Meanwhile, the area is known for its intensive agricultural and tin mining activities. Most of these wells are located within the vicinities of farm lands and tin mining sites, therefore could be contaminated. Also, the area is characterized by massive underlying rocks which could contain minerals capable of impacting on the groundwater. No efforts were made to mitigate the existing problem. It is on this background that the water quality assessment of these hand dug wells became necessary so as to ascertain their suitability for drinking purposes.



## AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess the concentration of heavy metals in hand dug wells in Gero community.

### OBJECTIVES

i. To compare the levels of heavy metals with permissible standards of WHO (World Health Organisation) and other regulating agencies like SON (Standard Organisation of Nigeria) for water to ascertain the suitability of the water for drinking and domestic purposes.

ii. To ascertain the health implications associated with the consumption of water from this wells.

**THE STUDY AREA**

The study area "Gero" is located in Jos South Local Government Area of Plateau State, North-central Nigeria. It lies within latitudes $9^0$48'4''N and $9^0$49'15''N and longitudes $8^0$48'20''E and $8^0$49'15''E (Figure.1). It encompasses the Ward A (Anguwan Turawa), Ward B (Anguwan Chiyawa) and Ward C (Anguwan Kwano) communities.

The study area is generally accessible through the Bukuru express road with some tarred feeder roads and footpaths linking the various communities. Gero area has about 300 inhabitants including men, women and children. The inhabitants of Gero area are either farmers, miners or some of the inhabitants are cattle rearers.

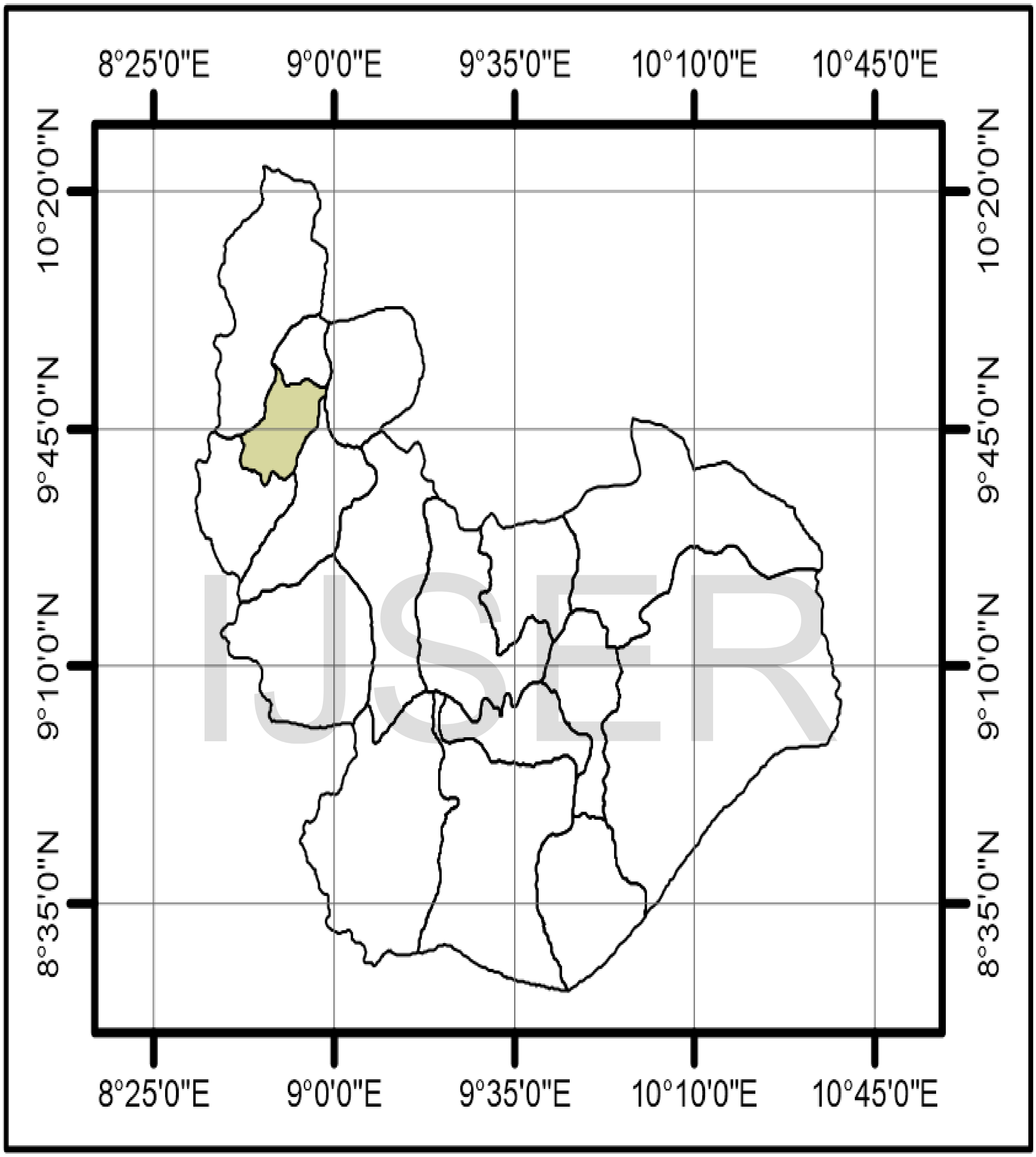


Figure 1. Map of Plateau State showing Jos South Local Government Area

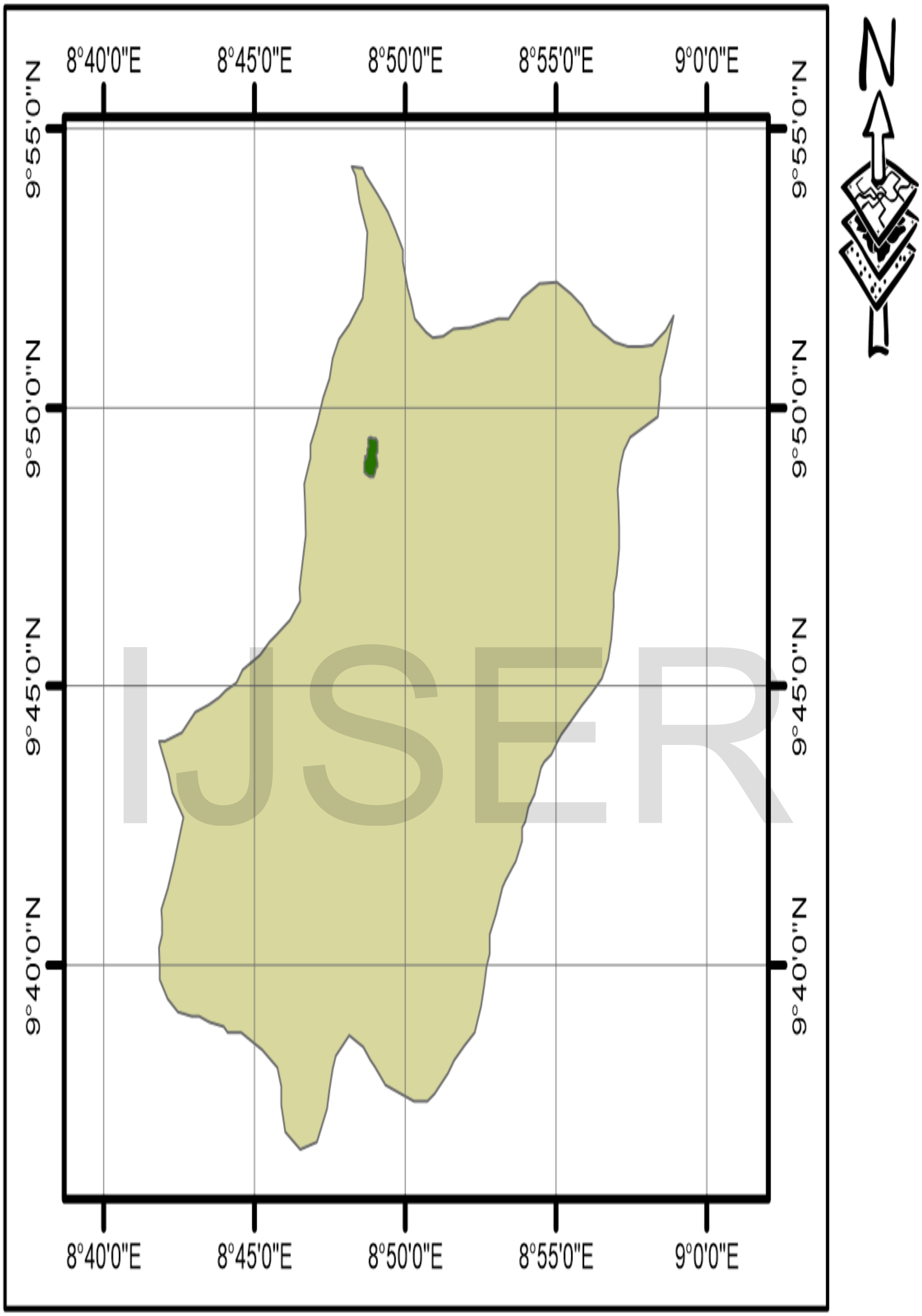


Figure 2 Map of Jos South Local Government Area Showing the study area

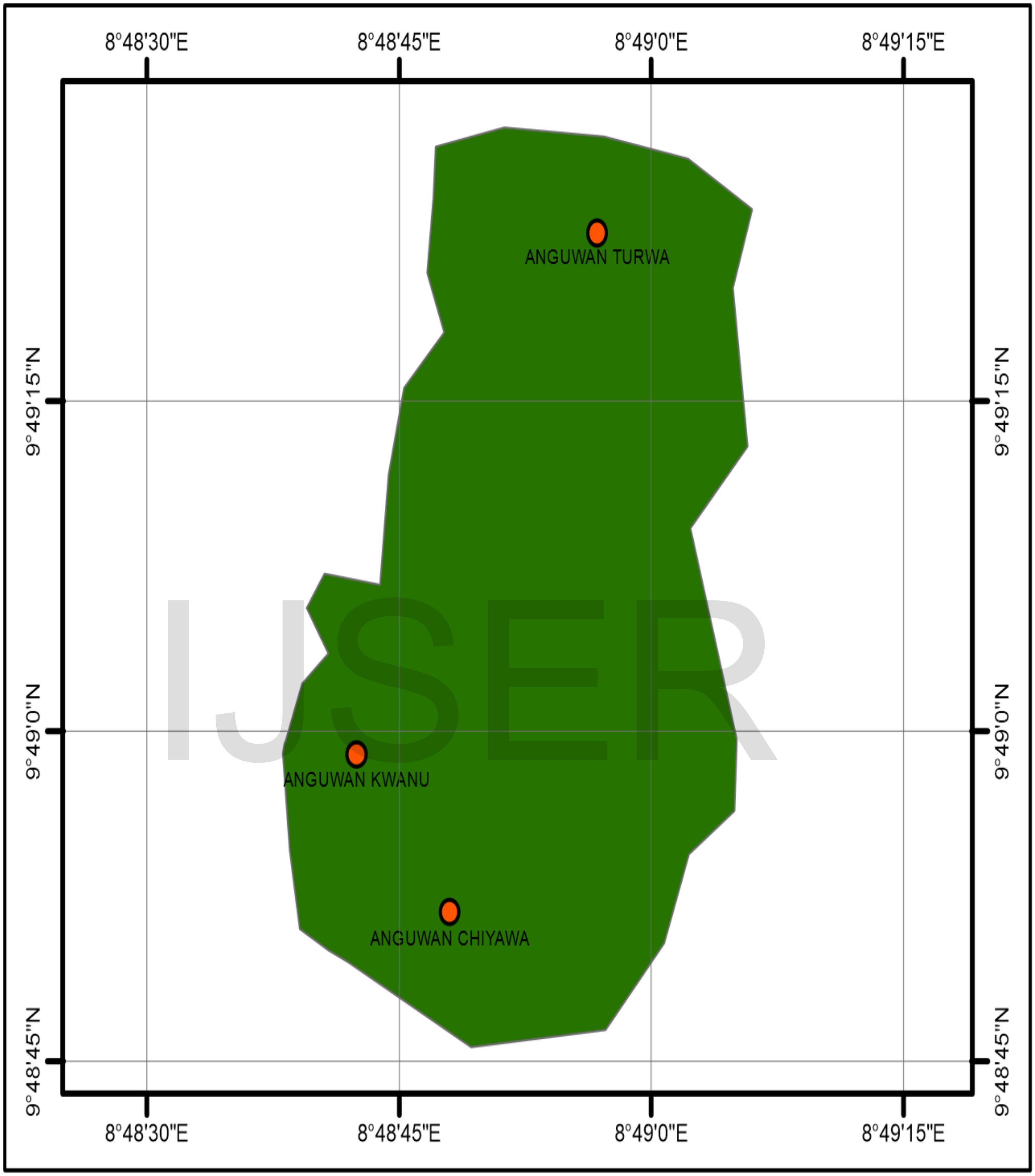


Figure 3: Map of the study area showing the three wards

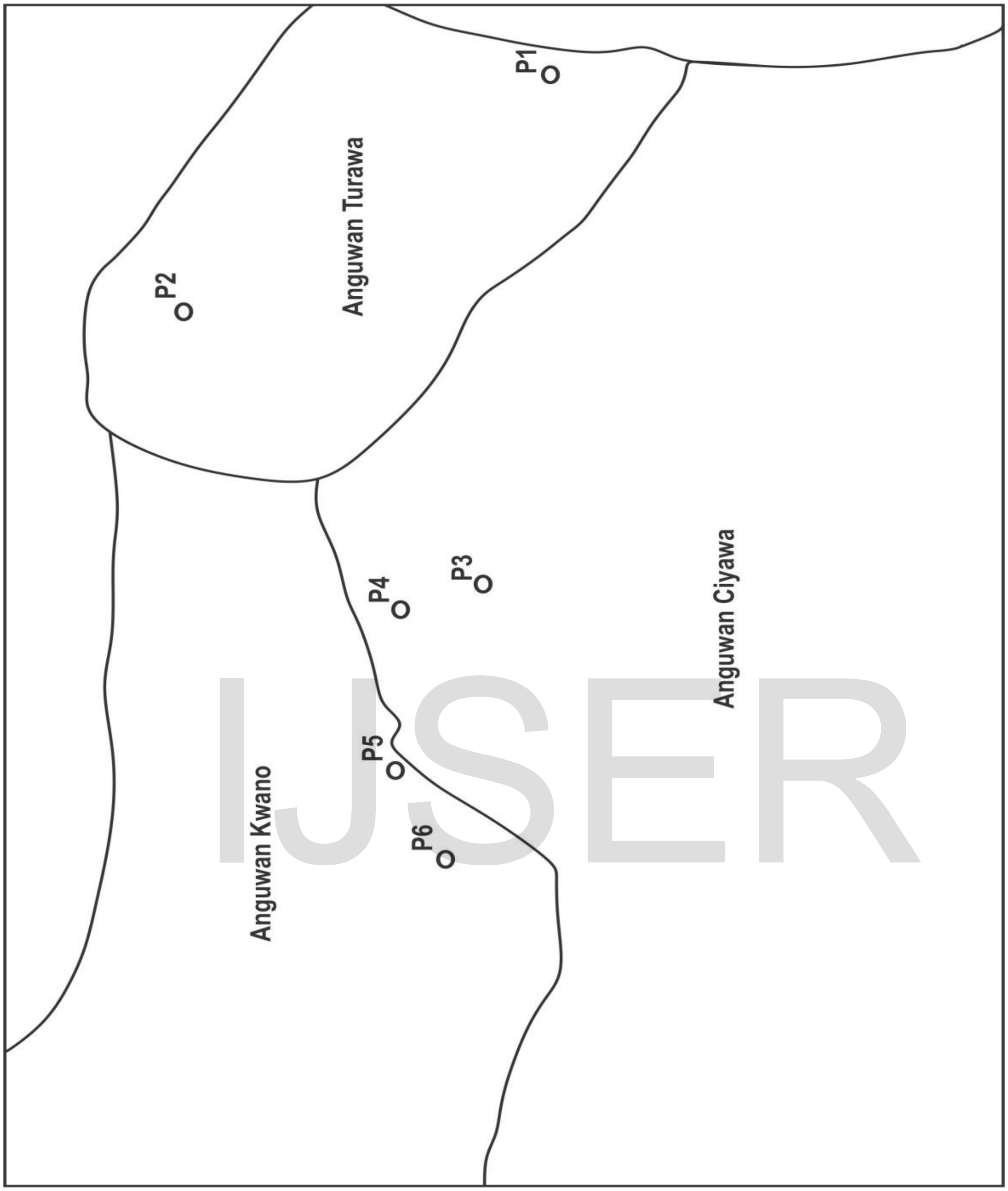


Figure 4. A Sketch Map of the study Area

## MATERIALS AND METHODS

A Multi staged sampling technique was applied to this study. Gero area consist of a heterogenous population and so it was stratified into the three Wards, namely; Ward A (Anguwan Turawa), Ward B (Anguwan Chiyawa) and Ward C (Anguwan Kwano) to get a homogenous population, then the systematic sampling technique was also applied to get a total of six water samples. Out of every three wells, one sample was selected at to get the required sample size of six with two each from the three wards. There are twenty-one hand dug wells in the study area; six at Ward A (Anguwan Turawa), seven at Ward B (Anguwan Kwano) and eight at Ward C (Anguwan Chiyawa).

The study involved field work. Water samples were collected from some hand dug wells. Six water samples were collected in sterilized plastic containers and acidified by adding few drops of $HNO_3$ acid; this was to prevent loss of metals. With the aid of a pH meter, the pH and Temperature of the water samples were measured on the spot of the collection. The locations (GPS readings) of every sample point was recorded using a GPS and recorded.



Table 1. Sample point locations

| Sample Points | LOCATIONS(GPS READINGS) |
|---|---|
| P1 | 9˚48’ 10” |
| | 9˚49’ 04” |
| P2 | 8˚48’ 17” |
| | 9˚49’ 8” |
| P3 | 8˚48’ 39” |
| | 9˚49’ 12” |

| | |
|---|---|
| P4 | 8˚48' 57" |
| | 9˚49' 33" |
| P5 | 8˚48' 40" |
| | 9 ˚48' 60" |
| P6 | 8˚48'35" |
| | 9˚48' 37" |

The six water samples were taken to the laboratory of the Department of Chemistry, Faculty of Sciences, Abubakar Tafawa Balewa University Bauchi for analysis to determine the concentration of the following heavy metals; Cadmium (Cd), Iron (Fe), Copper (Cu), and Chromium (Cr).

**RESULTS AND DISCUSSION**



The concentration of the heavy metals in the water analysis were directly compared with World Health Organisation (WHO) standards and other health regulating bodies such as SON (Standard Organisation of Nigeria). Table 2, shows these values. The World Health Organisation (WHO) has therefore recommended permissible concentration levels for these elements in drinking water, while some natural health regulatory agencies like SON have their standard which for some elements tally with that of WHO. Table 3 shows the comparism of water standards with those of WHO standards. For this study, 6 water samples were collected from hand dug wells. The pH of this samples were taken at the spot. The table (2) shows the results and chemical analysis of the water samples and their pH.

Table 2. Results for Chemical Analysis of water samples and pH values

| SAMPLE POINT | HEAVY METALS | | | | pH |
|---|---|---|---|---|---|
| | Zinc(Zn) mg/l | Cadmium(Cd) Mg/l | IRON(Fe) Mg/l | Copper(Cu) Mg/l | |
| P1 | 0.01 | ND | 0.008 | 0.27 | 8.4 |
| P2 | ND | ND | 0.103 | 0.21 | 8.2 |
| P3 | 0.001 | ND | 0.059 | 0.37 | 7.8 |
| P4 | 0.004 | ND | 0.013 | 0.10 | 8.3 |
| P5 | 0.001 | 0.0142 | 0.212 | ND | 7.3 |
| P6 | 0.001 | ND | 0.081 | 0.17 | 8.4 |

KEY: ND-Not Detected

Table 3. Water Standards for WHO, SON and NESREA

| Parameters | SON<br><br>Standard(mg/l) | WHO<br><br>Standard(mg/l) | NESREA<br><br>Standard(mg/l) |
|---|---|---|---|
| Zinc | 5.0 | 3.0 | 5.0 |
| Cadmium | 0.003 | 0.003 | 0.003 |
| Iron(Fe) | 0.3 | 0.3 | 0.3 |
| Copper(Cu) | 1.2 | 1.2 | 1.2 |
| Ph | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 |

**ZINC (Zn)**

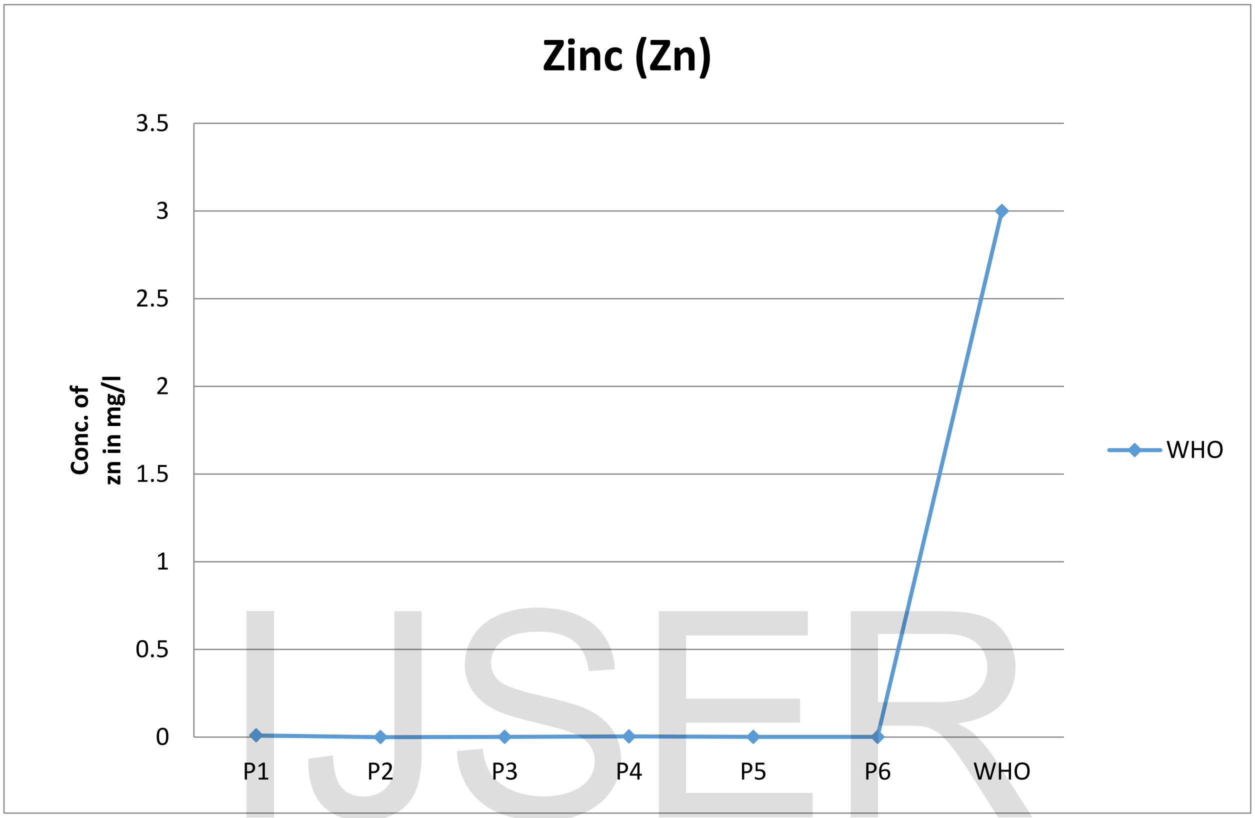


Figure 4a. A Graph showing Zinc (Zn) concentrations in water samples of the study area in comparism with WHO standard for zinc in water.

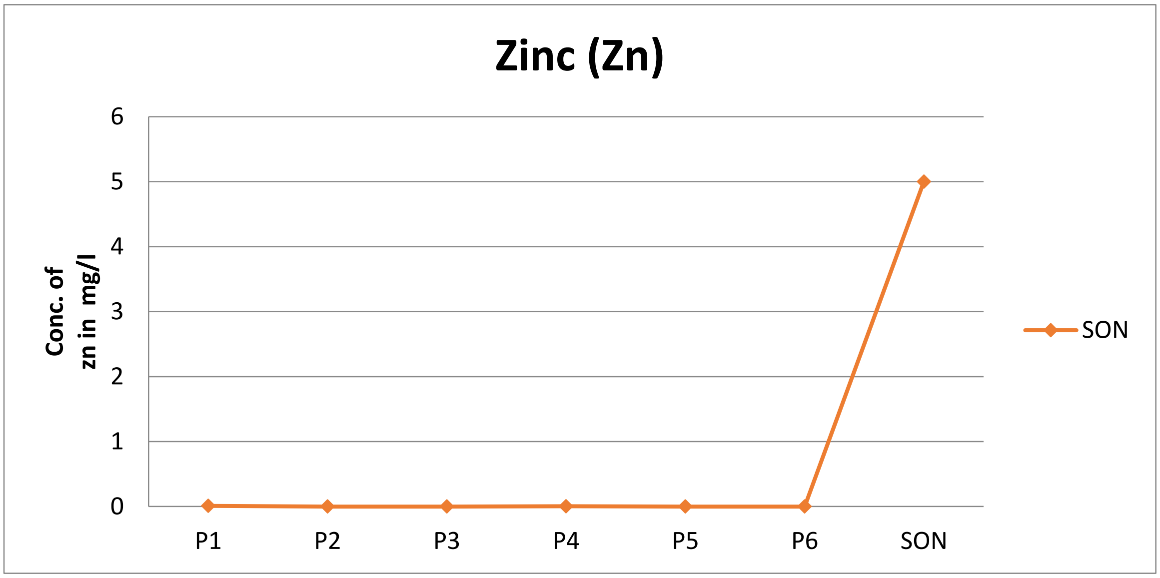


Figure 4b. A Graph showing Zinc (Zn) concentrations in water samples of the study area in comparism with SON standard for zinc in water.

The result of the water sample analysis in Table 2 shows the concentration of zinc in the water samples ranging from 0-0.004mg/l.

The graphs in Figureures 4a and 4b show these zinc concentrations in the water samples in comparism with World Health Organisation (WHO) and Standard Organisation of Nigeria (SON) standards for zinc in public water supply. The water samples of the study area shows all the samples have Zn concentration that are below the WHO recommended permissible limit of 3.0ppm and SON standards of 5.0mg/l for Zinc in water. This implies that there is deficiency of zinc in the water bodies of the study area.

Zinc is an essential element required in the body and deficiency of zinc leads to problems like bone disorders, delayed healing wounds and extreme cases of lung cancer (WHO, 2009)

**CADMIUM (Cd)**

The results in Table2 shows that in the water samples, cadmium was only detected in P6 with a concentration of 0.0142mg/l. Figure 4b shows that the concentration of cadmium in P5 is 0.0142 mg/l in comparism with WHO standard for cadmium in drinking water is high. The cadmium value in P5 exceeds WHO maximum permissible limit of 0.003mg/l for cadmium in water. This may cause adverse effects like diarrhea, kidney and lung damages and also damage to the nervous system (WHO, 2009)

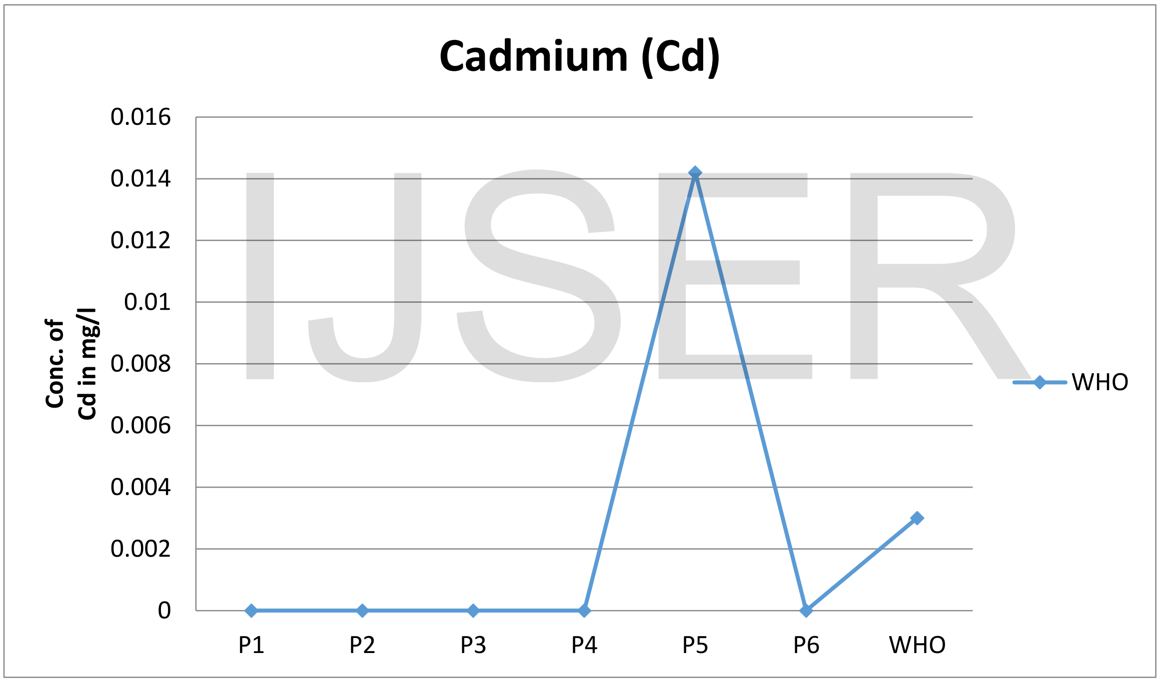


Figure 5a. A Graph showing Cadmium (Cd) concentrations in water samples of the study area in comparism with WHO standard for Cadmium in water.

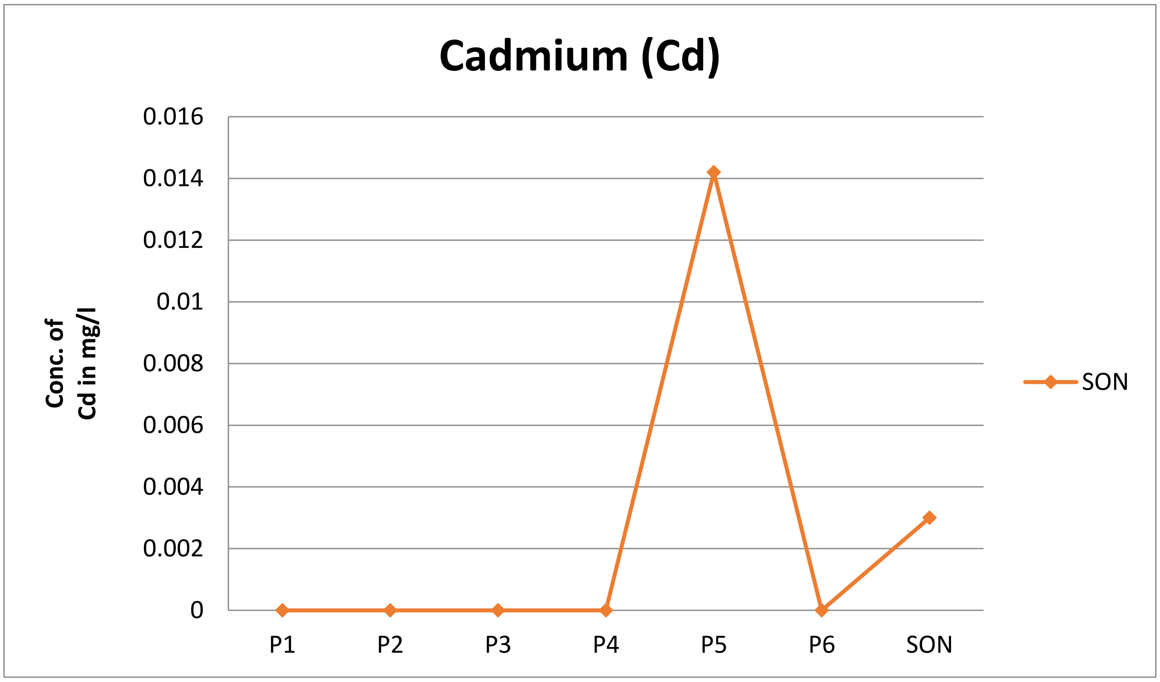


Figure 5b. A Graph showing Cadmium (Cd) concentrations in water samples of the study area in comparism with SON standard for Cadmium in water.

**IRON (Fe)**

The results in table 2, shows that the concentration of iron in the water sample ranging from 0.008-0.212mg/l. The graph in Figure (4c) shows these concentration values in comparism with WHO standards. This range of values is below the WHO recommended permissible limits of 0.3ppm for (Fe) in drinking water. This implies that there is a deficiency of iron (Fe) in the water bodies of the study area especially the locations from which P1 (0.008 mg/l), P3 (0.059mg/l) and P4 (0.013mg/l) were sampled. Deficiency in iron can result in Anaemic conditions for humans (WHO, 2009)

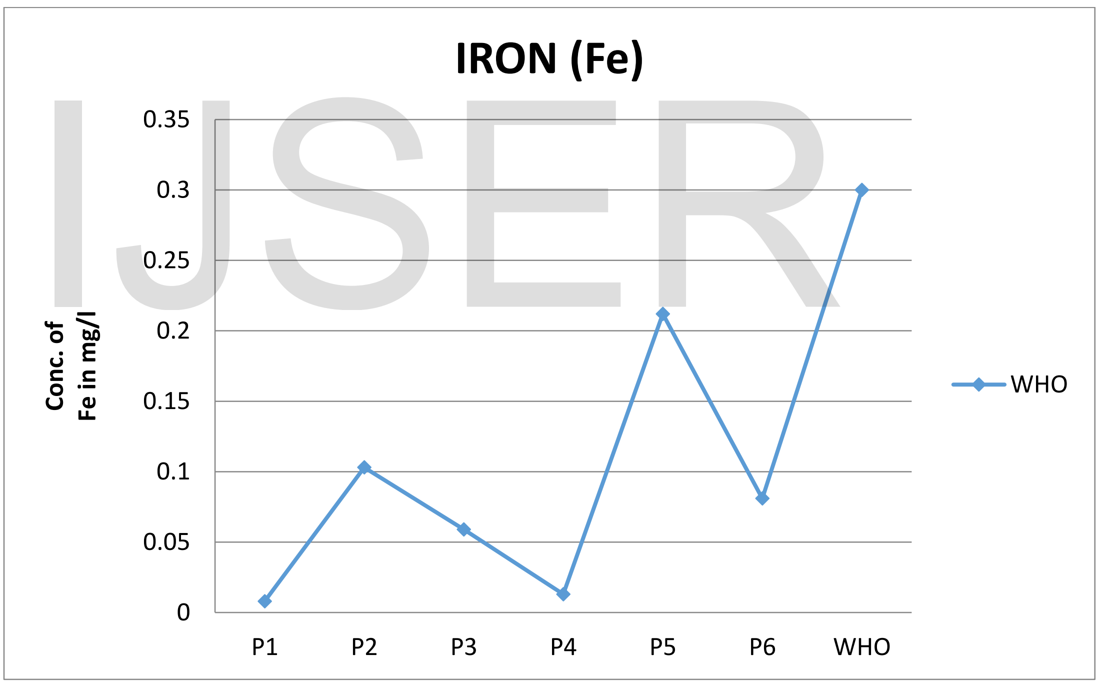


Figure 6a. A Graph showing Iron (Fe) concentrations in water samples of the study area in comparism with WHO standard for Iron (Fe) in water.

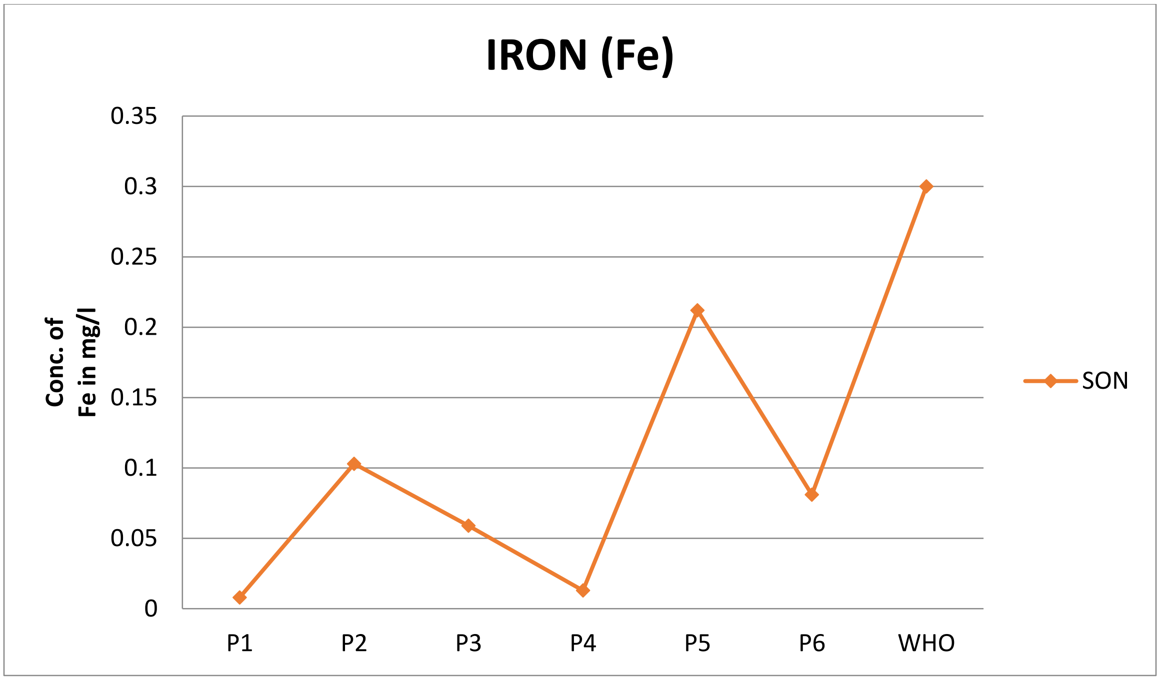


Figure 6b. A Graph showing Iron (Fe) concentrations in water samples of the study area in comparism with SON standard for Iron in water.



**COPPER (Cu)**

Results of the water sample analysis Table 2 shows the concentrations of copper ranging from 0.037 mg/l. This range of values is below the WHO recommended permissible limits of 3.0 mg/l for copper in drinking water Table 3 shows the sample points and their corresponding copper concentrations . Deficiency of copper in the human body can result in nervous disorders, heart diseases and anaemia (WHO, 2009).

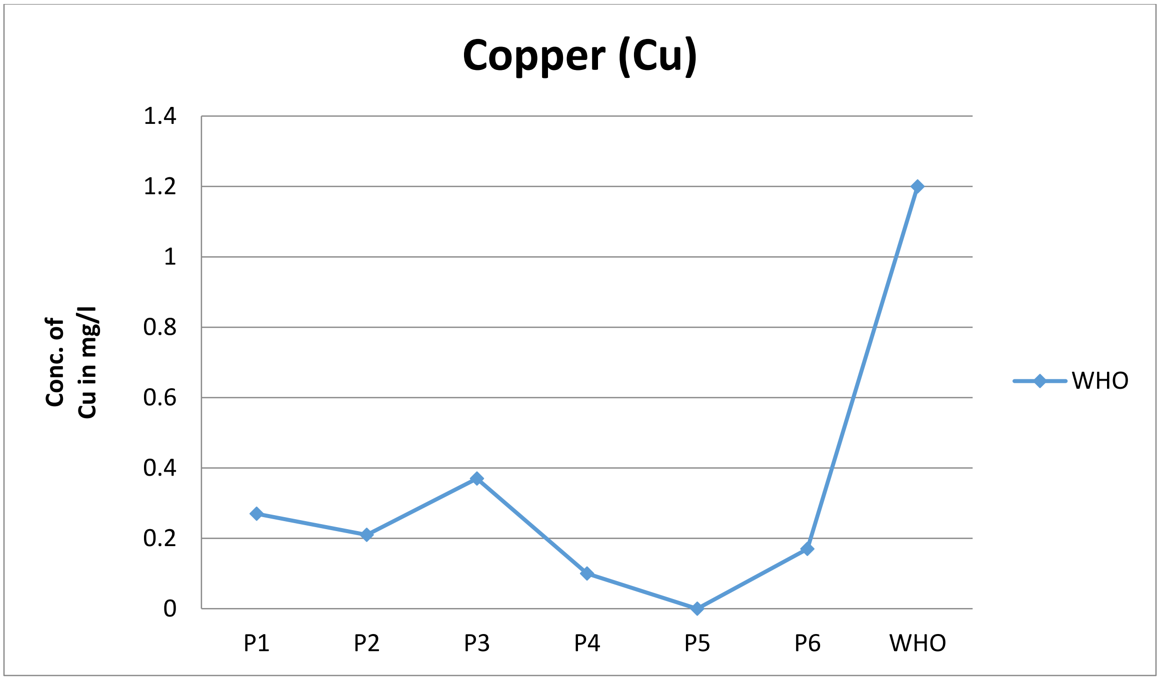




Figure 7a A Graph showing Copper (Cu) concentrations in water samples of the study area in comparism with WHO standard for Copper in water.

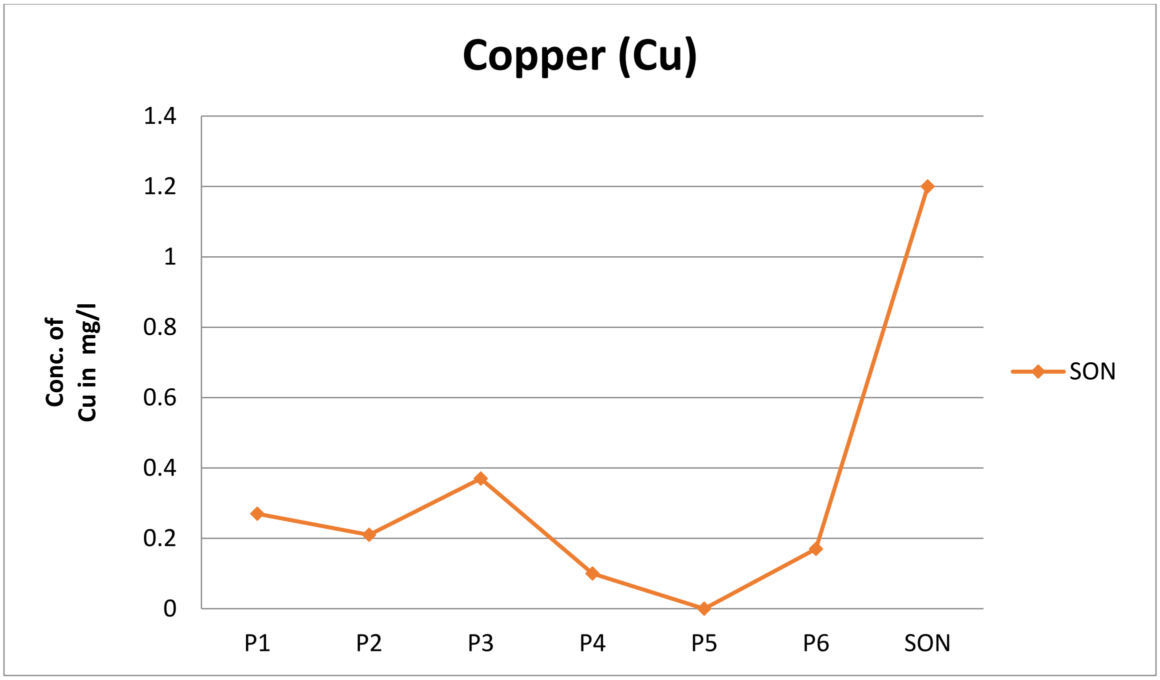




Figure 7b A Graph showing Copper (Cu) concentrations in water samples of the study area in comparism with SON standard for Copper in water.

**SUMMARY**

From the study it is obvious that all the six water samples collected from all the six wells were deficient in zinc concentration when compared to WHO standard for zinc in drinking water. This may be due to the fact that the wells are far from the source of this zinc metal. Deficiency in zinc metal may lead to lung cancer (WHO, 2009)

Cadmium metal was found in well P5 and the concentration was high when compared to WHO standard for cadmium in drinking water. This could be that well P5 is close to cadmium metal source or there is high leaching of water in well P5. High concentration of cadmium in the body could lead to diseases such as diarrhea, kidney disease and lung damage.

Iron metal was found to be low when compared to WHO standard for iron in drinking water to be low at location P1, P3 and P4. This may be attributed to the fact that these wells a quite far from iron metal source. Deficiency of iron in the body could lead to anaemia (WHO, 2009).

Copper metal was found to be deficient in all the water samples collected from the six well when compared to WHO standard for copper in drinking water. This could be that all the six well sampled are far from the source of copper metal. Deficiency of copper in the body could lead to diseases such as anaemia and heart disease

**CONCLUSION**

This research therefore concludes that there is considerable amount of heavy metals in the hand dug wells though the levels were below WHO maximum permissible levels for Copper (Cu), Iron (Fe) and Zinc (Zn). Cadmium (Cd) was detected at location P5. Cadmium (Cd) concentration exceeded the WHO maximum permissible level of

0.003mg/l. High concentration of Cadmium (Cd) could be attributed to leaching of Cd metal into the water from the surrounding. This shows that the water at P5 was polluted by Cadmium (Cd) metal.

## RECOMMENDATION

From the results discussed, there should be proper education and enlightenment to the public on the danger of high Cadmium concentration in their hand dug wells**.**

Artisan miners should be educated and enlightened on safe mining practices. A further study should be done to include metals like manganese, arsenic and others to determine their concentration in other water bodies. This is because serious tin- mining activities are going on in the study area.



## REFERENCES

Agodzo, S.K. & Huibers, F.P. (2011) Wastewater generation and use in urban Ghana: past, present and the future. *International Conference on Sustainable Development of Natural Resources in Africa* 2011, 5–8 December 2011, Accra, Ghana.

Ayoade, Y. O. and Akintola, F. O. (1999). *Water and Man, a Handbook of Geography*

Ediin, G.; Golantu, E. and Brown, M. (2000). Essentials for health and wellness. Toronto, Canada: Bartlett Publishers. Pp 368.

Fong, F.; Seng, C.; Azan, A. and Tahir, M. (2008). Possible source and pattern distribution of heavy metals content in urban soil at Kuala Terengganu Town Centre. *The Malasian Journal of Analytical Sciences; **12**: 458-467.*

Garba, Z.N., Hamza, S.A and Galadima, A. (2010) Arsenic level speciation in fresh water from Karaye Local Government Area, Kano State, Nigeria. International Journal of Chemistry, India. Vol. 20, No. 2: 113-117.

Goel, P. (2009). Water pollution. New Delhi, India: New Age International. Pp 1-2.

Papafilippaki, A.; Kotti, M. and Stavroulakis, G. (2008). Seasonal variations in dissolved heavy metals in the Keritis River Chania, Greece. *Global Nest Journal*; **3**:320-325.

Raji, M.; Ibrahim, Y. and Ehinmidu, J. (2010). Physiochemical characteristics and heavy metal levels in drinking water resources in Sokoto Metropolis in North-western Nigeria. *Journal of Applied Science Environment and Management*; **14**: 81-85.

WHO/UNICEF. (2008). *Joint Monitoring Programme for Water Supply and Sanitation*. New York: WHO/UNICEF

Wogu, D. and Okaka, E. (2011). Pollution studies on Nigerian rivers: Heavy metals in surface water of warri River, Delta state. *Journal of Biodiversity and Environmental Sciences*; **1**: 7-12.

Wokunmi, A.; Asaolu, S. and Ipinmoroti, K. (2011). Effect of leaching on heavy metals concentration in some dumpsites. *African Journal of Environmental Science and Technology*; **4**: 495-499.

Yahoya, M.; Ezeh, G.; Musa, F. and Mohammad, Y. (2010). Analysis of heavy metals concentration in roadside soils of Yauri, Nigeria. *African Journal of Pure and Applied Chemistry*; **4**: 22-30.

Yisa, J.; Jacob, J. and Onoyima, C. (2011). Identification of sources of heavy metal pollution in road deposited sediments using multivariate statistical analysis. *Journal of Emerging Trends in Engineering and Applied Sciences*; **2**: 658-663.