Journal of Radiation and Nuclear Applications
An International Journal

http://dx.doi.org/10.18576/jrna/080210

Carcinogenic and Non-Carcinogenic Health Risk Assessment of Water Sources Due to Heavy Metal across Toto Town, Nasarawa State, Nigeria.

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Received: 31 Mar. 2023, Revised: 20 Apr. 2023, Accepted: 27 Apr. 2023.
Published online: 1 May 2023.

Abstract: It is evidently clear that water is one of the prime elements responsible for life on earth. Regrettably, even this small portion of fresh water is under pressure due to anthropogenic sources that results from rapid growth in population and industrial activities. Heavy metals are the main pollutants and elements of risk in drinking water. The results of the Assessment of Heavy Metals Concentration in some Selected Water Sources across Toto Local Government Area of Nasarawa State, Nigeria using Micro Plasma Atomic Emission Spectrometer have been presented. Four heavy metals along with their respective concentrations in mg/l (Zn (0.35), Cu (0.02), Pd (0.04) and Ni (0.003) were found in the water samples. One of the major points of concern in this research is the concentration of Lead (Pb) in all the water samples under investigation which was found to be higher than the World recommended limit of 0.01 mg/l. However, finding of this study have revealed that the mean Concentration of the analyzed heavy metals in all the water samples arranged in decreasing order is Zn > Pb > Cu > Ni. It was also found that the Mean Daily Intake in mg/l/day, carcinogenic risk assessments (Risk Pathway and Total Risk) and the non-carcinogenic risk assessments (Hazard Quotient and Hazard Index) were found to be lower than the WHO's recommended value of unity in all the heavy metals for all locations under investigation. This implies that the mean concentration level of most of heavy metals like Zn, Cu and Ni in those areas is not significant and may not cause radiological hazard to the populace unless when accumulated over a long period of time. However, high concentration of lead was recorded which could be attributed to both natural and man-made activities such as geological formation of the study Area, fertilizer, herbiside, pestiside application by farmers, artisenanl mining activities, activities of metal scrap businesses taking place in the area and so on. Hence, it can be concluded that the mean concentration level of heavy metals in those areas may cause health hazard to the populace as a result of accumulation of Pb in the body over time.

Keywords: Hazard Index; Hazard Quotient; Cancer Risk; Total Risk; Mean Daily Intake; Heavy Metal Concentration; Carcinogenic; Non-Carcinogenic; Herbiside; Artisenanl; Pestiside.

1 Introduction

Water is an essential component of life, fresh water constitutes about 3% of the total water on the earth surface, and only 0.01% of this fresh water is available [1], with two thirds of the earth's surface covered by water and the human body consisting of 75% of it. It is evidently clear that water is one of the prime elements responsible for life on earth. Regrettably, even this small portion of fresh water is under pressure due to anthropogenic sources that results from rapid growth in population and industrial activities [2]. Heavy metals are the main pollutants and elements of risk in drinking water [3].

Investigation on water contamination by heavy metals has become the prime focus of environmental scientists in recent years [4]. More attention should be given to toxic heavy elements because of bio accumulation and bio magnification potential, and their persistence in the environment. Some metals like copper (Cu), and zinc (Zn) are essential for normal body growth and functions of living organisms and are referred to as essential elements. Other elements are referred to as non-essential, high

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concentrations of these metals like cadmium (Cd), iron (Fe), chromium (Cr), manganese (Mn), nickel (Ni) and lead (Pb) are considered highly toxic to human and aquatic life [5]. A certain amount of Cr for instance is needed for normal body functions; but at the same time high concentrations may cause toxic effect such as liver, kidney problems and genotoxic carcinogen [6]. Like Cr, Co is also one of the required metals needed for normal body functions as a metal component of vitamin B12 [7]. However, high intake of Co via consumption of contaminated food and water can cause abnormal thyroid artery, polycythemia, over-production of red blood cells (RBCs) and right coronary artery problems [8].

Generally, high concentrations of Mn and Cu in drinking water can cause mental diseases such as Alzheimer's and Manganism [9]. High Mn contamination in drinking water also affects the intellectual functions of 10-year-old children [10]. Similarly, the Ni-sulfate and Ni-chloride ingestion can cause severe health problems, including fatal cardiac arrest [11]. Pb is also a highly toxic and carcinogenic metal and may cause chronic health risks, including headache, irritability, abdominal pain, nerve damages, kidney damage, blood pressure, lung cancer, stomach cancer and gliomas. As the children are most susceptible to Pb toxicity, their exposure to high levels of Pb cause severe health complexities such as behavioral disturbances, memory deterioration and reduced ability to understand, while long-term Pb exposure may lead to anemia [12].

Like other heavy metals, sufficient amount of Zn is also very significant for normal body functions. Its deficiency can lead to poor wound healing, reduced work capacity of respiratory muscles, immune dysfunction, anorexia, diarrhea, hair loss [13]. Cd exposure can cause both chronic and acute health effects in living organisms [14]. The chronic effects include kidney damage, skeletal damage and itai-itai (ouch-ouch) diseases [15]. Experimental data in humans and animals showed that Cd may cause cancer in humans, diarrhea, hair loss, dermatitis (Acrodermatitis enteropathica) and depression. Cd exposure can cause both chronic and acute health effects in living organisms [16].

Heavy metals concentration in water is a global and serious issue that call for great attention and concern, their presence in water e.g. Lead (Pb), Zinc (Zn), Copper (Cu), Nickel (Ni), etc., could emanate from fertilizers application, Animal manures, atmospheric disposition etc., these are capable of posing health challenges as a result of buildup in different part of the body including blood, kidney, liver, heart etc. [17].

Various waste including waste oil, metal scraps, used batteries and effluents among others, which often contain heavy metals are indiscriminately discarded by the artisans and end up in the general environment. Alarmingly, many semi-rural holdings exist within Toto Local Government Areas which serve as both residence and metallurgical shop for most artisans and other individuals in such polluted environment. Due to the metropolitan authority's inability to extend potable water supply to the entire area owing to lack of maintenance or increased population, ground water consumption has become a common practice with many homes having resorted to the use of hand-dug and hand-pump wells for domestic purposes all over Toto Local Government Areas. Considering the high-water table and the depth of hand- dug wells (approximately 3 to 15meters), the suitability of groundwater for drinking in the Toto Local Government Area has raised some concerns due to the possibility of concentration of the underlying ground water by heavy metals.

2 MATERIALS AND METHOD

2.1 Materials

The instruments/materials that were used for the carcinogenic and non-carcinogenic risk assessment of heavy metals in some selected water sources across Toto Local Government Area in Nasarawa State are shown in Table 1

Table 1: Materials and their specifications.

Materials	**Quantity**	**Specifications**
500 ml plastic bottles	1	Used for collection of water samples.
Plastic Funnel	1	Used for easy passage of water samples into the sample bottles.
Plastic Cup	1	Used for easy transfer of water sample through the funnel to bottles.
Hand Glove	5 sets	Used to protect the hand from direct contact to the chemicals.
pH Metre	1	Used for measuring the acidity and basicity of the water samples.
Concentrated Nitric Acid (HNO_3)	500 ml	Used for rinsing the sample bottles before sample collection.
Drawer	1	Used for drawing water from the well.
Masking Adhesive Tapes	1	Used for labeling the water samples as well as sealing the mouth of the bottles.
Global Positioning System	1	Used for taking the coordinates of each sample points.
Sack	1	Used for packaging of collected water samples for easy transportation.
Micro Plasma Atomic Emission Spectrometer.		Used for analyzing the water samples in the laboratory.

2.2 Methods

On the basis of geologic setting, in Toto towns, three (3) sites were randomly selected for water sampling. The representative water samples (1 L each) were therefore, collected from Borehole (1 sample), well (1 sample) and stream (1 sample). The pH was measured on the spot, using a pH meter (Hanna instrument). From each sampling point, the water samples were collected in cleaned plastic bottles pre-washed with 20% dilute nitric acid (HNO_3) and double distilled water. The water samples were filtered and a few drops of HNO_3 was then added before transporting the sample to the laboratory for analysis.

2.2.1 Study Area

Toto falls within the western senatorial district of Nasarawa State otherwise known as Nasarawa West Senatorial District alongside Nasarawa, Keffi, Karu and Kokona Local Government Areas. Toto local government area also forms a federal constituency alongside Nasarawa local government area, and Toto covers an area of 2,903 km^2. The local government area is bounded to the north by the Federal Capital Territory, to the east by Nasarawa local government area, and to the south and west by Kogi State, and a population of 119,077 at the 2006 census. Toto Local Government has three districts namely Gadabuke, Toto and Umaisha. Settlements within the area include Ohizi Ogabo. The postal code of the area is 962. [18].

2.2.2 Sampling/Sampling Technique

For the sampling, the study adopts the simple random sampling technique to select 10 points. For the sample type, the study also adopts the simple random sampling technique to select 3 water sources from each of the 10 points making a total of 30 samples for the entire study. Sample point and their GPS location are shown in Table 2. And the map of the study area is presented in Figure 1.

Table 2: Sample Codes with their Respective GPS Coordinates.

Sample Code	GPS Coordinate	
	North	**East**
W	$8^0 30'1.566''$	$7^0 31'19.166''$
B	$8^0 29^1 22.302''$	$7^0 20^1 40.788''$
S	$8^0 24^1 11.826''$	$7^0 45^1 29.298''$

Where W = well, B = Borehole and S = Stream.

Fig. 1: Map of Toto LGA.

2.2.3 Method of Sample Collection

Thirty (30) water samples were randomly collected from different points across Toto Local Government Area. Two (2) drops of nitric acid ($HNO_{3)}$ was added to each water sample before analyzed to maintain the constant pH and minimize loss of sample because of variation in pH, evaporation, precipitation and other relevant physical and chemical properties. Samples were collected from different water sources such as streams, wells and boreholes located in Toto Local Government Area. The samples were collected randomly using acidified plastic bottles and mixed. The bottles were filled and then sealed tightly to avoid head space that might cause loss of samples because of oxidation.

2.2.4 Method of Sample Preparation

The samples for analysis were digested by measuring 250ml of the water sample in a conical flask and 5ml of concentrated nitric acid was added to the measured sample and then heated on microwave machine until the total volume was reduced to about one third of the initial volume to break the complex bond and release the sample into solution. The solution was then filtered using a filter paper into another beaker, made up of 50ml with distilled water and mixed thoroughly. The sample was packaged into samples bottles before taking to MP AES machine for analysis at Centre for Dryland Agriculture Bayero University, Kano.

2.2.5 Method of Sample Analysis

All filtered and acidified water samples were analyzed for all the heavy metals by using Micro Plasma Atomic Emission Spectrometer under standard operating conditions. In view of data quality assurance, each sample is analyzed in triplicate and after every 10 samples two standards (one blank and another of 2.5 mg/l) of respective metal was analyzed on atomic emission. The reproducibility was found to be at 95%confidence level. Therefore, the average value of each water sample was used for further interpretation. Standard solutions of all elements were prepared by dilution of 1000 mg/l certified standard solutions of corresponding metal ions with double distilled water. All the acids and reagents used were of analytical grade. All these analyses were performed in the Micro Plasma Atomic Emission Spectrometer (MP AES), at Centre for Dryland Agriculture Bayero University, Kano, Kano State, Nigeria.

2.2.6 Method of Data Analysis

The equations were coded in an excel software package. Concentrations of elements as analyzed by the X-Ray Florescence Spectrometric Analysis are as follows; the unit of the raw data were in weight percent (w.t. %) and parts per million (ppm). Conversions were made to uniform unit of mg/l which is the same as parts per million (ppm) as the world standard acceptable unit for water analysis (WHO, 2017).

2.2.7 The Estimated Mean Daily Intake (MDI)

The exposure assessment is to measure or estimate the intensity, frequency, and duration of human exposures to an environmental contaminant in a study area, it is carried out by measuring the Mean daily intake (MDI) of heavy metals identified through ingestion, inhalation and dermal contact by adults and children from a study area. Adults and children are separated because of their behavioral and physiological differences [19]. According to [20] the (MDI) are calculated using the following equations.

2.2.8 Ingestion of Heavy Metals through Water

$$MDI_{ing} = \frac{C_s * IR * EF * ED * CF}{BW * AT} \quad 1$$

Where MDI_{ing} is the Mean Daily Intake of heavy metals ingested from the soil in mg/l/day, C_s is the concentration of heavy metal in mg/l for water [21].

2.2.9 Inhalation of Heavy Metals through Water

$$MDI_{inh} = \frac{C_s * IR_{air} * EF * ED}{BW * AT * PEF} \quad 2$$

Where MDI_{inh} is the Mean Daily Intake of heavy metals inhaled from water in mg/l/day, C_s is the concentration of heavy metal in water in mg/l [22].

2.2.10 Dermal Contact of Heavy Metals with Water

$$MDI_{derm} = \frac{C_s \times SA \times FE \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \quad 3$$

Where MDI_{derm} is the Exposure Dose via dermal contact in mg/l/day. C_s is the concentration of heavy metal in soil in mg/l [23]. The abbreviated parameters in equation 1, 2 and 3 are explain in Table 3 as reported by [24,25].

Table 3: Exposure Parameters Used for the Health Risk Assessment Through Different Exposure Pathways for Water.

Parameter	Unit	Children	Adults
Body Weight (BW)	Kg	15	70
Exposure Frequency (EF)	Days	350	350
Exposure Duration (ED)	Years	6	30
Ingestion Rate (IR)	mg/day	200	100
Inhalation Rate (IR air)	m^3/day	10	20
Skin Surface Area (SA)	cm^2	2100	5800
Soil Adherence Factor (AF)	mg/cm^2	0.2	0.07
Dermal Absorption Factor (ABS)	None	0.1	0.1
Dermal Exposure Ratio (FE)	None	0.61	0.61
Particulate Emission Factor (PEF)	m^3/kg	1.3×10^9	1.3×10^9
Conversion Factor (CF)	mg/kg	10^{-6}	10^{-6}
Average Time (AT) For Carcinogens For Non- Carcinogens	 Days Days	 365 x 70 365 x ED	 365 x 70 365 x ED

2.2.11 The Non-Carcinogenic Health Risks Assessments

According to [26,27], the non-carcinogenic health risks (Hazard Quotient and Hazard Index) were computed using the following equations.

$$HQ = \frac{MDI}{RfD} \quad 4$$

Where (MDI) is the mean daily intake of heavy metals from different pathways and (RfD) is the reference dose derived from Table 4 as reported by [26,27].

Table 4: Reference Doses (RfD) and Cancer Slope Factors (CSF) for different Heavy Metals.

Heavy Metal	Pb	Ni	Cu	Zn
Oral RfD	3.6×10^{-3}	3.7×10^{-2}	2.0×10^{-2}	3.0×10^{-1}
Dermal RfD	NA	5.6×10^{-3}	2.4×10^{-2}	7.5×10^{-2}
Inhalation RfD	NA	NA	NA	NA
Oral CSF	8.3×10^{-3}	NA	NA	NA
Dermal CSF	NA	NA	NA	NA
Inhalation CSF	4.2×10^{-2}	NA	NA	NA

NA = Not Available.

$$HI = \sum_{k=1}^{n} HQ_k = \sum_{k=1}^{n} \frac{MDI_k}{RfD_k} \quad 5$$

The summation of hazard quotients (HQ) resulted to hazard index (HI) [28,29].

2.2.12 The Carcinogenic Health Risks Assessments.

For carcinogens, the risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. Equation 6 shows the mathematical representation of excess lifetime cancer risk as expressed by [30,31] as:

$$Risk\ Pathway = \sum_{k=1}^{n} MDI_K CSK_K \qquad 6$$

The summation of the (MDI) and the (CSF) resulted to the risks pathway. The Cancer Slope Factor converts the estimated daily intake of the heavy metal averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer [32,33].
The total excess life time cancer risk for an individual is finally calculated from the average contributions of the individual heavy metals for all the pathways. Equation 7 shows the mathematical representation of this parameter as expressed by [34,35] as:

$$Risk_{(total)} = Risk_{(inj)} + Risk_{(inh)} + Risk_{(derm)} \qquad 7$$

Where, $Risk_{(ing)}$, $Risk_{(inh)}$, and $Risk_{(derm)}$ are risks contributions through ingestion, inhalation [36].

Table 5: Mean Concentration of Heavy Metals in Well, Borehole and Stream Water Samples from Toto in mg/l

Code	**pH**	**Zn**	**Cu**	**Pb**	**Ni**
W	0.8	0.35	0.03	0.03	0.005
B	0.9	0.50	0.02	0.06	0.001
S	0.4	0.19	0.01	0.03	0.002
Mean		**0.35**	**0.02**	**0.04**	**0.003**
WHO, (2017)		**3.00**	**2.00**	**0.01**	**0.100**

It was observed from Table 5 that the mean concentration level of Zinc (Zn) in Ara is 0.35 mg/l. The Zinc (Zn) concentration level analyzed in Ara ranged from 0.5 mg/l (highest to lowest) in water sample point B to 0.19 mg/l (lowest to lowest) in water sample point S. The Mean concentration level of Copper (Cu) in Ara is 0.02 mg/l. Concentration of copper (Cu) in Ara ranged from 0.03 mg/l (highest to lowest) in water sample point W to 0.01 mg/l (highest to lowest) in water sample point S. Mean concentration of Lead (Pb) in Ara is 0.04 mg/l. The concentration of lead (Pb) in Ara ranged from 0.06 mg/l (highest to lowest) in water sample point B to 0.03 mg/l (lowest to lowest) in water sample point W and S. Finally, mean concentration of Nickel (Ni) in Ara is 0.003 mg/l. The nickel (Ni) concentration in Ara ranged from 0.005 mg/l (highest to lowest) in water sample point W to 0.001 mg/l (lowest to lowest) in water sample point B.

Table 6: Carcinogenic Mean Daily Intake of Heavy Metals in Well, Borehole and Stream Water Samples from Toto in mg/l/day.

Rec.	**Path**	**Zn**	**Cu**	**Pb**	**Ni**	**Total**
Ing.	Child	3.9x10-7	2.2x10-8	4.4x10-8	1.3x10-8	1.2x10-7
Ing.	Adult	2.1x10-7	1.2x10-8	2.4x10-8	7.1x10-9	2.6x10-7
Inh.	Child	1.5x10-11	8.4x10-13	1.7x10-12	5.0x10-13	1.8x10-11
Inh.	Adult	3.2x10-11	1.8x10-12	3.6x10-12	1.1x10-12	1.3x10-12
Derm	Child	4.9x10-8	2.8x10-9	5.6×10-9	1.7x10-9	5.9x10-8
Derm	Adult	5.3x10-8	3.0x10-9	6.0×10-9	1.8x10-9	6.4x10-8
Mean		**1.2x10-7**	**6.6x10-9**	**1.3x10-8**	**3.0x10-8**	**8.0x10-7**
WHO, (2017)		**1.1x10-6**	**6.6x10-7**	**2.3x10-9**	**3.3x10-8**	**1.8x10-6**

It was observed from Table 6 that the estimated carcinogenic mean daily intake results of heavy metals for both adults and children because of their behavioral and physiological differences in terms of ingestion, inhalation and dermal contact pathway for carcinogenic risk from Ara is in descending order trend with ingestion in adults ($2.6x10^{-7}$) mg/l/day > ingestion in children ($1.2x10^{-7}$) mg/l/day > dermal contact in adults ($6.4x10^{-8}$) mg/l/day > dermal contact in children ($5.9x10^{-8}$) mg/l/day > inhalation in children ($1.8x10^{-11}$) mg/l/day > inhalation in adults ($1.3x10^{-12}$) mg/l/day.

Table 7: Non-Carcinogenic Mean Daily Intake of Heavy Metals in Well, Borehole and Stream Water Samples from Toto in mg/l/day

Rec.	Path	Zn	Cu	Pb	Ni	Total
Ing.	Child	4.6×10^{-5}	2.6×10^{-6}	5.2×10^{-6}	1.6×10^{-6}	5.5×10^{-5}
Ing.	Adult	4.9×10^{-7}	2.8×10^{-8}	5.6×10^{-8}	1.7×10^{-8}	5.9×10^{-7}
Inh.	Child	1.7×10^{-10}	9.8×10^{-12}	2.0×10^{-13}	5.9×10^{-12}	1.8×10^{-10}
Inh.	Adult	7.4×10^{-11}	4.2×10^{-12}	8.4×10^{-12}	2.5×10^{-12}	9.1×10^{-11}
Der	Child	5.6×10^{-7}	3.2×10^{-8}	6.4×10^{-8}	1.9×10^{-8}	6.8×10^{-7}
Der	Adult	1.2×10^{-7}	6.8×10^{-9}	1.4×10^{-8}	4.1×10^{-9}	1.4×10^{-7}
Mean		$9.7x10^{-6}$	$4.4x10^{-7}$	$8.9x10^{-7}$	$2.7x10^{-7}$	$1.1x10^{-5}$
WHO, (2017)		$6.7x10^{-5}$	$4.4x10^{-5}$	$2.2x10^{-7}$	$2.2x10^{-6}$	$1.1x10^{-4}$

It was observed from Table 7 that the estimated non-carcinogenic mean daily intake results of heavy metals for both adults and children because of their behavioral and physiological differences in terms of ingestion, inhalation and dermal contact pathway for non-carcinogenic risk from Ara is in descending order trend with ingestion in children ($5.5x10^{-5}$) mg/l/day > dermal contact in children (6.8×10^{-7}) mg/l/day > ingestion in adults (5.9×10^{-7}) mg/l/day > dermal contact in adults (1.4×10^{-7}) mg/l/day > inhalation in children ($1.8x10^{-10}$) mg/l/day > inhalation in adults ($9.1x10^{-11}$) mg/l/day

Table 8: Carcinogenic Risk Assessments in Toto.

Pathway	Cancer Risk	Total Risk
Ingestion	$8.2x10^{-6}$	
Inhalation	$4.3x10^{-10}$	$4.4x10^{-5}$
Dermal	$3.3x10^{-5}$	
WHO, (2017)	1	1

It was observed from Table 8 that the cancer risk from Ara followed the decreasing trend with dermal contact pathway ($3.3x10^{-5}$) > ingestion ($8.2x10^{-6}$) > inhalation ($4.3x10^{-10}$) and the total cancer risk was found to be ($4.4x10^{-5}$).

Table 9: Non-Carcinogenic Risk Assessments

Pathway	Hazard Quotient	Hazard Index
Ingestion	$1.9x10^{-4}$	
Inhalation	$5.6x10^{-6}$	$2.0x10^{-4}$
Dermal	$9.8x10^{-6}$	
WHO, (2017)	1	1

It was observed from Table 9 that the hazard quotient from Ara followed the decreasing trend with ingestion pathway ($1.8x10^{-4}$) > dermal contact ($9.8x10^{-6}$) > inhalation ($5.6x10^{-6}$) and the hazard index was found to be ($2.0x10^{-4}$).

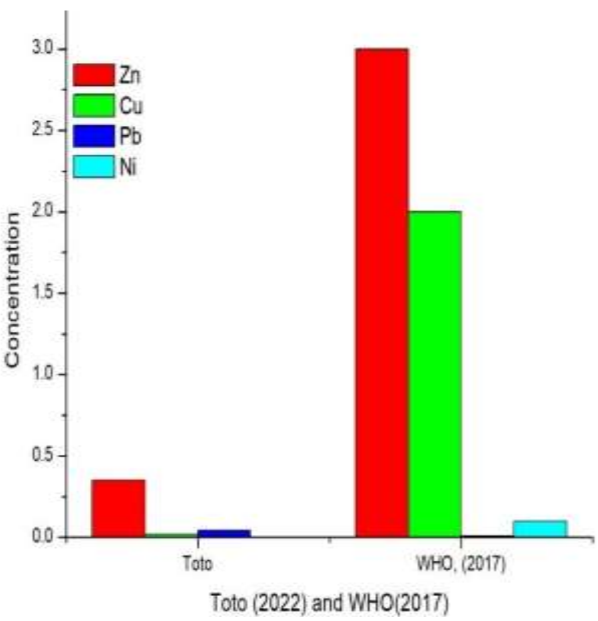

Fig. 2: Comparison of Mean Concentration Level with World Health Organization.

It can be seen clearly from Figure 2 that the mean concentration of zinc (Zn) for the present study is lower than that of World Health Organization. It also possible to note that the mean concentration of copper (Cu) for the present study is lower than that of World Health Organization. The mean concentration of lead (Pb) for the present study is higher than that of World Health Organization. It is also observed that the mean concentration of nickel (Ni) in for the present study is lower than that of World Health Organization.

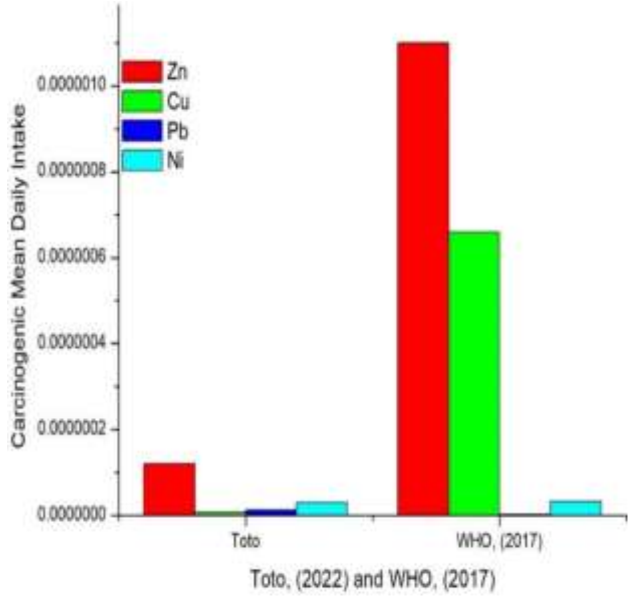

Fig. 3: Comparison of Carcinogenic Mean Daily Intake with World Health Organization

It can be seen clearly from Figure 3 that the average carcinogenic mean daily intake of zinc (Zn) for the present study is lower than that of World Health Organization. It can also be seen that the total mean carcinogenic daily intake of copper (Cu) for the present study is lower than that of World Health Organization. The total mean carcinogenic daily intake of lead (Pb) for the present study is higher than that of World Health Organization. It is also possible to see that the total mean carcinogenic daily intake of nickel (Ni) for the present study is lower than that of World Health Organization.

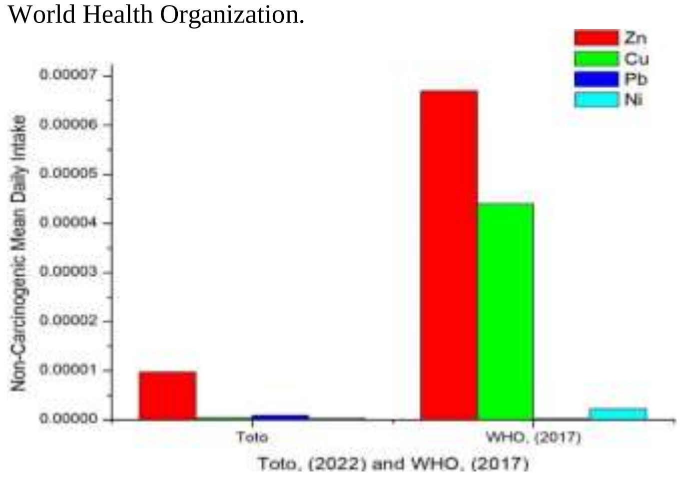

Fig. 4: Comparison of Non-Carcinogenic Mean Daily Intake with World Health Organization.

It can be seen clearly from Figure 4 that the total mean non-carcinogenic daily intake of zinc (Zn) for the present study is lower than that of World Health Organization. It can similarly be seen that the total mean non-carcinogenic daily intake of copper (Cu) for the present study is lower than that of World Health Organization. The total mean non-carcinogenic daily intake of lead (Pb) for the present study is higher than that of World Health Organization. It can also be noted that the total mean non-carcinogenic daily intake of nickel (Ni) for the present study is lower than that of World Health Organization.

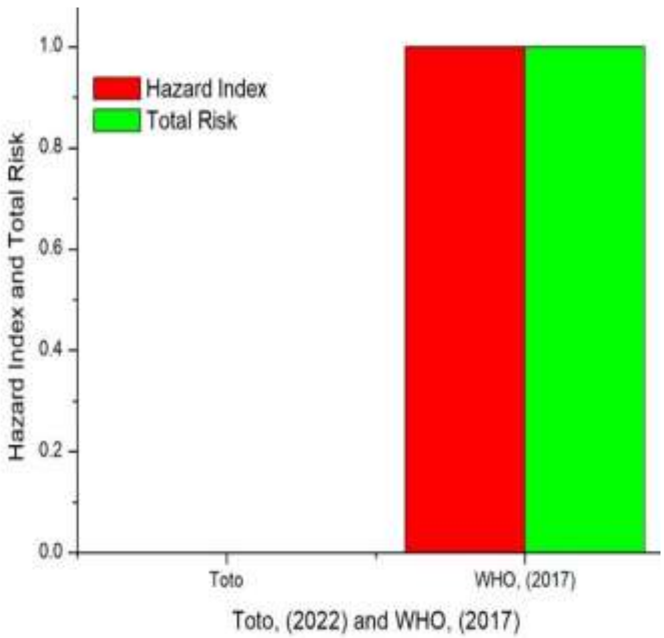

Fig. 5: Comparison of Carcinogenic Hazard Index and Total Risk with World Health Organization.

It can be seen clearly from Figure 5 that the carcinogenic health risk assessments (Hazard Index) and non-carcinogenic health risk assessments (Total Risk) for the present study are lower than that of World Health Organization.

3 Discussion

The results of the Assessment of Heavy Metals Concentration in some Selected Water Sources across Toto Local Government Area of Nasarawa State, Nigeria using Micro Plasma Atomic Emission Spectrometer have been presented. The mean concentration of various heavy metals found in the water samples are presented in Table 3. Four heavy metals along with their respective concentrations in mg/l (Zn (0.35), Cu (0.02), Pd (0.04) and Ni (0.003) were found in the water samples.

One of the major points of concern in this research is the concentration of Lead (Pb) in all the water samples under investigation which was found to be higher than the World recommended limit of 0.01 mg/l. This high concentration might be attributed to both natural and man-made activities such as geological formation of the study Area, fertilizer, herbiside, pestiside application by farmers, artisenanl mining activities, activities of metal scrap businesses taking place in the area and so on.

However, finding of this study have revealed that the mean Concentration of the analyzed heavy metals in all the water samples arranged in decreasing order is Zn > Pb > Cu > Ni. It was also found that the Mean Daily Intake in mg/l/day, carcinogenic risk assessments (Risk Pathway and Total Risk) and the non-carcinogenic risk assessments (Hazard Quotient and Hazard Index) were found to be lower than the WHO's recommended value of unity in all the heavy metals for all locations under investigation. This implies that the mean concentration level of most of heavy metals like Zn, Cu and Ni in those areas is not significant and may not cause radiological hazard to the populace unless when accumulated over a long period of time. However, high concentration of lead was recorded which could be attributed to both natural and man-made activities such as geological formation of the study Area, fertilizer, herbiside, pestiside application by farmers, artisenanl mining activities, activities of metal scrap businesses taking place in the area and so on.

4 Conclusions

All water samples collected from the study Area shows that, the concentration of Pb is above the WHO recommended safety standard. Other heavy elements investigated such as Zn, Cu and Ni are below the WHO recommended limit. High lead concentration could be attributed to both natural and man-made activities such as geological formation of the study Area, fertilizer, herbiside, pestiside application by farmers, artisenanl mining activities, activities of metal scrap businesses taking place in the area and so on.

Hence, it can be concluded that the mean concentration level of heavy metals in those areas may cause health hazard to the populace as a result of accumulation of Pb in the body over time.

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