

Analysis of Heavy Metal Contents in Pindiga Dams, Akko LGA, Gombe State, Nigeria: Implications for Human Consumption

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Abstract

The study assessed the concentration of some heavy metals in the two dams in Pindiga Community of Akko LGA, Gombe State. Water samples were collected randomly at the major entry point of each dam giving 2 water samples for rainy season only. The water samples collected were fed into 2 liters plastic containers and labeled for laboratory analysis. 3ml nitric acid were added into each collected water sample to avoid biochemical reaction. Handheld Geographically Positioning System (GPS) was employed during samples collection. The Laboratory analysis was conducted at the Federal Ministry of Water Resources, Department of Water Quality Control and Sanitation, National Water Quality Reference Laboratory Gombe, Gombe State. The following metals (Al, Ca, Mg, Mn, As, Cu, Fe, Cd, Pb, Zn, Na, Cl) were analyzed in the water samples and the concentration of each metal was determined and the values were compared with the permissible limit provided by Nigerian Standard for Drinking Water Quality (NSDWQ). The results showed that Aluminum (Al) was detected in both dams, Madagasca (15.50mg/l) and Earth dam (0.70mg/l) and were both above the permissible limit (0.20mg/l). Calcium. (Ca) was detected at both dams, Madagasca (8.50mg/l) and Earth dam (9.00mg/l). Both were below the permissible limit (180mg/l). Magnesium (Mg) was detected at both dams, Madagasca (3.02mg/l) and Earth dam (6.55mg/l), and both were below permissible limit. Manganese (Mn) was detected at Madagasca (4.60mg/l) which was above the permissible limit. Arsenic (As) was only detected at Madagasca dam (0.03mg/l), it was below the permissible limit of (10.00mg/l). Copper was only detected at Madagasca dam (10.00mg/l), the concentration here is below permissible limit of 1000mg/l. Iron (Fe) was detected at both dams, Madagasca (6.00mg/l) and Earth dam (0.03mg/l). The result at Madagasca was above the permissible limit and objectionable for drinking while the concentration at the Earth dam was permissible since it is within the safety limit (0.03mg/l). Cadmium (Cd) was only detected at the Madagasca dam (3.60mg/l) and it was above the permissible limit. Lead (Pb) was only detected at Madagasca dam (1.09mg/l) which is below permissible limit (10.00mg/l). Zinc (Zn) was only detected at Madagasca dam (0.07mg/l) which is below permissible limit. Fluoride (F) was detected at both dams, Madagasca has a value of 8.80mg/l which is above permissible and it is objectionable for human consumption while Earth dam has a value of 0.03mg/l which is below permissible (1.50mg/l). Sodium (Na) was only detected at the Earth dam (8.00mg/l), both values were below permissible limit (200mg/l). Chromium (Cr) was detected at the Earth dam (0.03mg/l), both were within the permissible limits (0.03mg/l). However, Aluminum, manganese, Iron, Cadmium and Fluoride were above permissible limit and can cause several diseases like kidney failure, spinal cord and nervous system diseases etc. All other elements were either not detected, far below or within the expected permissible limit. The study recommends provision of tap water and boreholes, boiling and filtration of water before consumption and proper hospital wastes disposal.

Keywords: Dams, Effects, Heavy Metals, Human Consumption, Surface Water

INTRODUCTION

Generally, heavy metal simply means any metal which has relatively high density or which has high relative atomic weight (Hendryx, 2015), and if that metal exceeds the permissible safety limits established by World Health Organization (WHO) and or Nigeria Standard for Drinking Water Quality (NSDWQ) among others is said to be objectionable for human consumption and very dangerous to human health (FGN, 2004).

Water is a very useful and necessary resource for all biotic organisms to survive. Without water there would be no life because it is the back bone of all forms of life. Rain water greatly help in the formation of surface and ground water. About 97.5% of water on the earth is salt water, only 2.5% as fresh water out of which over two-third is frozen in glaciers and polar ice caps. The remaining unfrozen water (fresh) is mainly found as ground water, with only a fraction present on the ground and in the air in form of vapor (Asthana, 2009).

Water pollution is the contamination of water bodies (lakes, rivers, oceans, aquifers, dams and ground water) by unwanted pollutants that are discharge into water bodies directly or indirectly by human activities or natural causes. Hence, water is typically referred to as polluted when it is impaired by anthropogenic contaminants and does not support human use, e.g., drinking (Din, 2013).

According to Buba (2019), clean water simply means any water that is free from microbial, chemical and physical contaminants. This includes contaminants that present a health risk (e.g. diseases causing bacteria, toxic metal) and those that have no health risk but can make the water unpleasant to drink (e.g. poor taste resulting from iron level) the study examined the impact of heavy metals on human consumption in Pindiga dams. Water to be safe for human consumption, the concentration of heavy metals should not exceed the safety limit approved by Nigeria Standard for Drinking Water Quality (NSDWQ, FGN,2004).

For many years Pindiga Village in Akko LGA, Gombe State suffered in clean water supply for human consumption. The people of Pindiga have for many years depended on dam's surface water for human consumption undermining its health implications. Only in the recent past the village provided few boreholes to supplement the consumption of the unhealthy dams' surface water. However, many people still drink from the unhealthy dams. Pindiga has two popular dams: Madagasca which is located in the heart of the

Village and Pindiga Earth dam which is located alone near Pindiga Cottage hospital, Gombe road. The study assessed the concentration of some heavy metals in the two dams and their impact on human health if consumed by man. The water samples collected were fed into a 2liters plastic containers and labeled for analysis in a standard Laboratory in Gombe Metropolis. Based on the Laboratory analysis, the study addressed the following research questions: What are the concentrations of heavy metals in both Dams? What is the variation in the concentration of heavy metals in both dams? What are the suitability of both water samples for human consumption?

The aim of the study is to assess the impact of heavy metals on human consumption in Pindiga dams, Akko LGA, Gombe State. The aim will be achieved through the following objectives: to determine the concentration of heavy metals in both Dams, to ascertain if there are any significant difference in the concentration of heavy metals in both Dams, to evaluate the suitable of both dam's water for human consumption in the study area.

MATERIALS AND METHODS

Study Area

The study area is Pindiga Akko Local Government Area, Gombe State. with headquarters in Kumo. Kumo is on the A345 highway south of Gombe State Capital The major tribes are: Jukun, Fulani, Tangale, Tula, Hausa, among others. Most of the people practice Christianity and Islam. It is located between longitude E10⁰59 E and latitudes N9⁰ 50N and it is about 12km drive from Tumu junction (popularly called kwanar Pindiga, off Yola Road). It covers a land area of about 50km². It lies within the tropical continental climate (Oruonye, 2016). It has two seasons, both rainy and dry, rainfall ranges from 850mm to 1000mm, temperature is around 37⁰C, it is relatively cold from December to January with a low temperature of about 25⁰C and high temperature from March to April, with dry season from October to April (Amusa, 2008). The vegetation comprises of a light canopy with spangling of under shrubs and sparse growth of grasses to a more open grass of lesser height. Some of the trees include butyrospermum, mumparadoxum, Tamarin indica, Parkiabiglobosa among others (Kati and Abdul, 2009). The people of Pindiga are predominantly farmers, cultivating crops like maize, beans, millets, guinea corn among others. They also produce cash crops like soya beans, groundnut and beans.

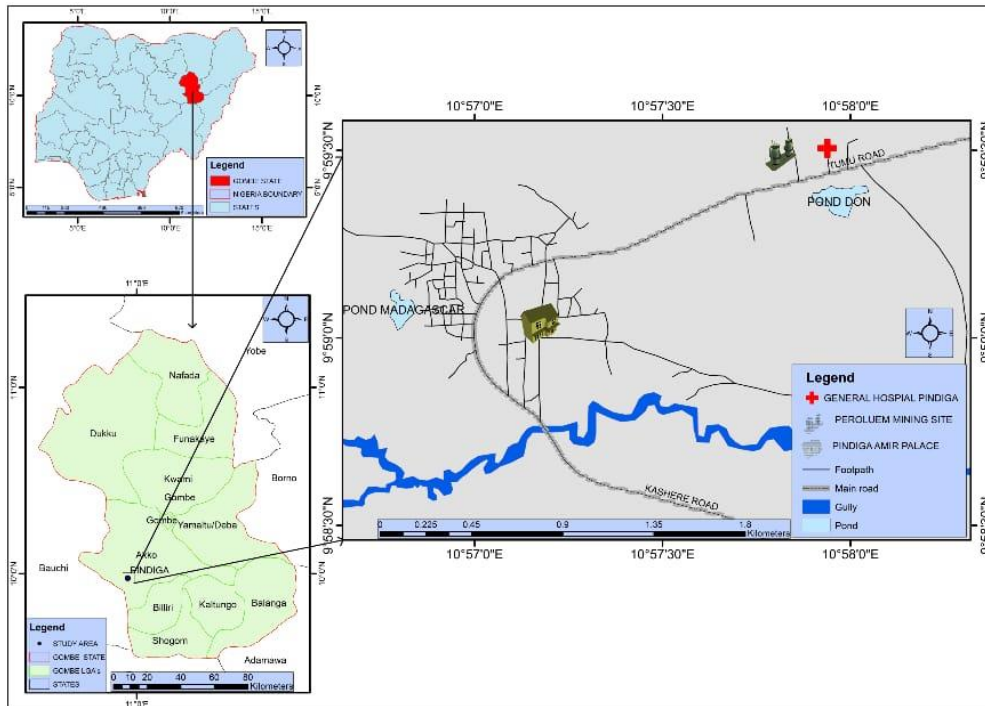


Figure 1 Pindiga in Gombe State, Gombe State Nigeria
 Source: Google Earth/ArcGIS Analysis 2022

Water Sampling and Laboratory Procedures

The water samples were collected in two locations (Madagascar and Pindiga Earth Dams). Sample was taken from each Da a total of 2 water samples for rainy season only. The water samples collected were fed into a 2liters plastic containers and labeled so as to have adequate water samples for laboratory analysis covered by the study. Before samples were taken, the plastic containers were thoroughly washed and distilled to avoid contamination, 3ml nitric acid were added into each collected water sample to avoid biochemical reaction that may likely occurred before laboratory analysis.

The water samples were taken to the Laboratory for the determination of heavy metals only. The analyzed metals were: Residual Chloride, Aluminum, Calcium, Magnesium, Manganese, Arsenic, Iron, Cadmium, Lead, Zinc, Sodium and Chloride using standard analytical procedures. The Laboratory analysis was conducted at the Federal Ministry of Water Resources, Department of Water Quality Control and Sanitation, National Water Quality Reference

Laboratory Gombe, Gombe State. Heavy metals like Lead (Pb), Aluminium (Al), Sodium (Na), Iron (Fe), Manganese (Mn), Chromium (Cr), Calcium (Ca), Magnesium (Mg) were determined by using Atomic Absorption Spectrophotometer (AAS) (Jackson,1958). Copper (Cu), Total Arsenic (TAs), Cadmium (Cd) and Zinc (Zn) were determined by using Metalyser method (AOAC1950). At the point of collecting the water samples, field sheet was used to record all information such as coordinates, sampling points, handheld Geographically Positioning System (GPS) and so on. The collected data were analyzed using statistics presented in t-test, tables, figures and chats.

RESULTS AND DISCUSSION

Concentration of Heavy Metals Examined in the Two Reservoirs in Pindiga

The section below present the analyzed values of heavy metals considered for the study at the two locations in Pindiga Community compared with NSDWQ permissible/safety standard.

Table 1 Concentration of heavy metals at Madagasca and Pindiga Earth Dams compared with NSDWQ permissible standards for drinking water quality

Parameter (Mg/l)	Pindiga Madagasca Dam		Pindiga Earth Dam		NSDWQ
	Results	Remark	Results	Remark	
Aluminium	15.50	AP	0.70	AP	0.20
Calcium	8.50	AP	9.00	AP	0.05
Magnesium	3.02	BP	6.55	BP	20
Manganese	4.60	AP	0.00	BP	0.20
Arsenic	0.0030	BP	0.00	BP	0.01
Copper	10.00	AP	0.00	BP	2.00
Iron	6.00	AP	0.30	P	0.30
Cadmium	3.60	AP	0.00	BP	0.003
Lead	1.09	AP	0.00	BP	0.01
Zinc	0.07	BP	0.00	BP	5.00
Flouride	8.80	AP	0.03	BP	1.50
Sodium	0.00	BP	8.00	BP	200
Chromium	0.00	BP	0.03	BP	0.05

Source: Field Survey and Laboratory Analysis (2022)

NB: (AP=Above Permissible, BP= Below Permissible and P= Permissible)

NSDWQ= Nigeria Standard for Drinking Water Quality

Al (III) (mg/l)

Findings of the study shown that Pindiga Madagasca Dam has a concentration of 15.50 mg/l while the Earth Dam recorded a concentration of 0.70mg/l. The result indicated that both Madagasca and Earth dams has concentrations above the NSDWQ safety limit of 0.2mg/l. By implication, since both results showed higher concentrations above the safety limit, the results signified both dams water is objectionable for human consumption and could cause different diseases in man like liver and kidney failure. According to Ahmed (2003), the consumption of Aluminum above the safety limit is dangerous to human health and can cause several diseases.

Calcium (mg/l)

The concentration of calcium at Pindiga Earth Dam is 9.00mg/l while Madagasca Dam is 8.50mg/l. The result of the study indicated that water from both dams were above the NSDWQ standard of 0.005mg/l. This implies that the concentration of Calcium in both dams' water were above the safety limit and are objectionable for human consumption. The result shows that consuming water from both dams can affect human health. Metals like Calcium and Iron, if

consumed above the NSDWQ safety limit can cause ill-health (Adelana, 2006).

Magnesium (mg/l)

The result of the study shown that the concentration of Magnesium was 6.55mg/l at Pindiga Earth Dam while the concentration at Madagasca Dam is 3.02mg/l. The result indicates that the concentration of Magnesium at both dams were below the permissible safety limit as approved by NSDWQ standards (20mg/l). The result shows that both water from the two Dams are below permissible limit and are not objectionable for human consumption.

Manganese (mg/l)

Manganese has a concentration of 4.60mg/l at Madagasca dam while non was detected at Pindiga Earth dam. The safety limit as recommended by NSWDQ standard is 0.2mg/l. The result of the study shown that the concentration of Manganese at Madagasca dam was above the safety limit, hence indication that the water is polluted and objectionable for human consumption because it could cause diseases like vomiting, spinal cord injury among others. This is supported by Ristovic (2011), who stated that excess of such dissolved metals can cause ill health in human if consumed by man.

Arsenic (mg/l)

The concentration of Arsenic was recorded 0.03mg/l at Madagasca Dam while non was detected at Pindiga Earth Dam (0.00mg/l). The approved safety limit approved by NSDWQ is 0.01mg/l. The result of the study shown that the concentration of Arsenic is above the permissible safety limit at Madagasca dam, making the water unsuitable and objectionable for human consumption. Excess of Arsenic in drinking water is dangerous to human health as pointed out by Deshpande S.M. and Ather K.R. (2012).

Copper (mg/l)

Copper has a concentration of 10.00mg/l at Madagasca Dam while non (0.00mg/l) was detected at Pindiga Earth Dam. The approved safety limit as approved by NSDWQ is 2.00mg/l. The results of the study revealed that the water at Madagasca is above the safety limit and objectionable for human consumption, whereas, the water at Pindiga Earth dam safe and not objectionable for human consumption at the moment.

Iron (mg/l)

The concentration of Iron was recorded 6.00mg/l at Madagasca Dam while the concentration of Iron at Pindiga Earth dam was 0.30mg/l. The approved permissible limit by NSDWQ is 0.30 mg/l. The result indicated that the concentration of Iron at Madagasca Dam is above the permissible limit and so it is objectionable for human consumption because it can cause several diseases in man if consumed. Whereas, the concentration at the Earth Dam is within the permissible standard, this implies that the water is safe for human consumption. According to Umara (2007), Iron is a common element found in many rocks and soils, it is also an essential and important element for animal growth if consumed within the safety limit NSDWQ. However, Alex (2008) observed that if Iron, Copper, Cadmium among others metals are consumed above the NSDWQ safety limit is dangerous to man and can cause different diseases like kidney failure, spinal cord disease and nervous system diseases.

Cadmium (mg/l)

The concentration of Cadmium at Madagasca Dam is 3.60mg/l while the concentration of Cadmium was not detected (0.00mg/l) at Pindiga Earth dam. The NSDWQ safety limit is 0.003mg/l. The result of the study shown that the concentration of Cadmium at Madagasca is above the permissible

safety limit and is it dangerous to human health. Whereas, the concentration at Pindiga Earth dam was zero, hence the water is suitable for human consumption. Cadmium occurs naturally in rocks and soils and can enters water when there is contact with soft groundwater or surface water. Moreover, it may be introduced by paints, pigments, plastic stabilizers, mining and smelting operations, and other industrial operations such as electroplating and fossil fuel, fertilizer, and sewage sludge disposal (Goel,2000). However, Agarawal (2000), observed that excess Cadmium in drinking water is dangerous to human health and can cause different diseases in man if consumed.

Lead (mg/l)

Lead has a concentration of 1.09mg/l at Madagasca dam, while non was detected at Pindiga Earth dam (0.00mg/). The NSDWQ approved safety limit of Lead is 0.01mg/l. From the result of the study, the concentration of Lead at Madagasca is above the permissible limit and it is dangerous for human consumption, whereas the water at the Earth dam is very safe for human consumption since no trace of Lead was detected in the water analysed. Lead is believed to be essential for human beings especially for body systems including the neurologic, hematologic, gastrointestinal, cardiovascular and renal system if consumed below the safety limit of NSDWQ. However, it was observed by (Buba, Ishaya and Marcus, 2019), that the consumption of high concentration of Lead in drinking water is dangerous to human health and cause different diseases in man like kidney failure, nerves disorder, vomiting among others.

Zinc (mg/l)

Zinc has a recorded concentration of 0.07mg/l at Madagasca dam, while Pindiga Earth dam has a concentration of 0.05mg/l. The approved safety standard recommended by NSDWQ is 5.00mg/l. Based on the result of the findings, the Zinc concentration at both dams are below the permissible safety limit, this means both dams water is safe and not objectionable for human consumption. Therefore, no health implication in water consumption at both dams because they are below the expected values.

According to Din (2013), any quantity of Zinc consumed above the NSDWQ recommended safety limit is dangerous to human health because it could cause stomach cramps, nausea and vomiting.

Fluoride (mg/l)

The concentration of Fluoride is 8.80mg/l at Pindiga Madagasca Dam, while the concentration at Pindiga Earth Dam is 0.03mg/l. The recommended safety limit approved by NSDWQ standard is 1.50mg/l. The result of the study shown that the concentration of Fluoride at Pindiga Madagasca Dam is above the safety limits and hence the water is objectionable and not suitable for human consumption. Whereas the concentration at Pindiga Earth Dam is below the safety limits, making the water suitable for human consumption at the moment.

Sodium (mg/l)

Sodium has a concentration of 8.00mg/l at Pindiga

Earth Dam, while non (0.00mg/l) was detected at Madagasca Dam. NSDWQ has recommended 200mg/l as an approved safety limit for human consumption. The results indicated that the water at both dams are not unobjectionable and suitable for human consumption at the moment.

Chromium (mg/l)

Chromium recorded a concentration of 0.03mg/l at the Earth Dam (0.03mg/l) while non (0.00mg/l) was detected at Madagasca Dam. The permissible limits for NSDWQ is 0.05mg/l. The results indicated that both Dams water are suitable and permissible for human consumption at the moment because their concentrations are below the recommended safety limit.

Table 1 Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 Pindiga Madagas Dam & Pindiga Earth Dam	29	0.02	0.887

Table 2 Paired Samples t Test

	Paired Differences							Sig. (2-tailed)
	Mean	Std. Dev	Std. Error Mean	95% CI of the Difference		T	df	
Pindiga Madagasca Dam - Pindiga Earth Dam	2.05	118.63	22.02995	-43.06699	47.18561	0.09	28	0.92

Source: Author’s data analysis, 2021

The results in Tables 1 and 2 shows that the mean difference in physiochemical parameters of water samples from Pindiga Madagasca dam and Pindiga Earth dam is 2.05, with a standard deviation of 118.63. Also, it is observed from Table 2 that there is no significant difference or variation in concentration of physiochemical parameters of water samples from Pindiga Madagasca dam and Pindiga Earth dam in Pindiga town (t = 0.09, df = 28, p = 0.92). This decision was based on the fact that the probability value of the t test statistics (p = 0.09) is greater than the level of significance (0.05). This finding implies that, the level of physiochemical parameter concentration in water samples from the study area share similar characteristics, as well as, a common water quality status, with little or no variations. Moreover, there is a positive but weak correlation between the physio-chemical parameters of water samples from the Madagasca

dam and the Earth dam (r = 0.02) (Table 1). This implies that as the physiochemical parameters concentration in madagasca dam increases that of the Earth dam also increases.

CONCLUSION

The study was about Laboratory analysis of water quality in the two dams’ available at Pindiga area for human consumption. For many years, the people of Pindiga have depended on these two dams as their major sources of water supply because the dams provide them with water for drinking throughout the year. Moreover, the study area is not connected to Gombe State Water Board, hence, they lack clean water supply for human consumption. In all, two water samples were collected for the study at rainy season, one sample from each dam. The samples were collected at the major entry point for each dam. The coordinates of the sampling locations were

recorded. The water samples were collected in a 2 liters distilled plastic containers and 3mls of Nitric acid was added to each sample to avoid biochemical reaction before standard Laboratory analysis was done for trace metals. The Laboratory analysis was done at the Federal Ministry of Water Resources, Department of Water Quality Control and Sanitation, National Water Quality Reference Laboratory Gombe, Gombe State.

The result of the study shown that Aluminum and Calcium were above permissible limit and were objectionable for human consumption at both dams. Manganese, Copper, Cadmium, Lead and Fluoride were above the permissible limit at Madagasca dam only whereas, the result shown that the same metals analyzed were found to be below the permissible limit and suitable for human consumption at the Earth dam. This implies that the water at Madagasca dam is objectionable and dangerous for human consumption, therefore, it is likely to cause different diseases in man if consumed, such as low blood pressure, urine retention, jaundice, seizures, joint pain, fever and so on.

Recommendations

Based on the findings of the study, it is recommended that:

Both State and LGA should ensure increase access to safe and potable water supply by embarking on quality water development project such as digging of boreholes and connecting the study area with Gombe State Water Board for the provision of clean and well treated water for human consumption. And also to ensure increase sanitation and sanitary condition in the dam area to avoid contamination or water pollution.

It advocates for the adoption of local water treatment measures by the people in the study area such as boiling and filtration of water which would help to kill most microbial parasite that may likely be present in the water, hence it would reduce the rate of water borne diseases. It recommends the need for public awareness on regulations for safe drinking water by government agencies which would help to reduce the incidence of water pollution by the populace especially the unnecessary and improper dumping of household wastes.

More so, Pindiga cottage hospital is located not too far from the Earth dam (just directly opposite), therefore to avoid contamination or pollution from the hospital

wastes, the study recommends for proper disposal of wastes within the hospital premises.

REFERENCES

Adelana, S. (2006). Nitrate Pollution in Nigeria. Y X u, B. Usher, eds. Ground water pollution in Africa. Taylor and Francis, Leiden, Netherlands

Agarawal, P.K. (2000) Water Quality Survey of Rohtas District of Bihar 61(3), 387-398

Ahmaad, Q. R. (2003) Towards Poverty Alleviation: The water sector perspectives. *Int. J. Water Resource Development*, 19(2), 263-277.

Alex, G. (2008). "Coal combustion: Nuclear Resource or Danger" Oak Ridge National Laboratory.

Amusa, T. S. (2008). Physicochemical and Bacteriological Analysis of Water used for Drinking and swimming purposes in Abeokuta, Nigeria. *Afr. J. Biomed Res.* 1 (1), 285-290

Asthana and Asthana (2009) physiochemical characteristics of rain water quality of Warri, Nigeria, 346-355

Buba, S., Essoka, P.A. and Musa Iliya (2019) Assessment of heavy metals concentration in Soils around Maiganga Coal mines, Akko LGA, Gombe State, Nigeria. *Gombe Journal of Geography and Environmental Studies (GOJGES)* 1(1), 163-168.

Buba, S., Samaila, K. and Marcus N.D (2019) Impact of coal mining on water Quality in Maiganga, Akko LGA, Gombe State, *Jalingo Journal of Social and Management Science*, 1(4), 274-286.

Deshpande S.M. and Ather K.R. (2012). Evaluation of groundwater quality and its suitability for drinking and agriculture use in parts of Vaijapur District Aurangabad MS India. *Research Journal of Chemical Sciences*, 2, 25-31.

Din, S.A.M., Yahaya, N.N.N and Abdullahi, A. (2013). Fine Particulates Matter (PM_{2.5} from Coal – fired Power Plant in Manjung and its Health Impacts", *Procedia- socio and Behavioral Science*, 85, 92-99.

Federal Republic of Nigeria (2004) National water policy Abuja, available at Federal Republic

- of Nigeria, 2004, at 5, available at [http// www. Wsssrp. Org](http://www.Wsssrp.Org)
- Goel, P.K, (2000) Water pollution causes, effects and control, New Delhi, New Age Ltd.
- Hendryx, M. (2015) The Public Health Impacts of Surface Coal Mining, the Extractive Industry. Society, 2, 820-826.
- Kati T.G..and Abdul Q. (2009) Assessment of Water Quality of Polluted Lake using statistical techniques: a case study of Pakistan
- Oruonye, E.D., Illiya, M.,and Ahamed, Y.M.(2016). Sustainable mining practices in Nigeria: A case study of Maiganga coal mining in Gombe. *International Journal of Plain and Soil* 11 (5), 1-9,
- Ristović, I. (2011) Environmental Risks to Air, Water and Soil Due to the Coal Mining Process, in G. Meško et al. (eds.) Understanding and Managing Threats to the Environment in South Eastern Europe, NATO Science for Peace and Security Series C: Environmental Security, (New York: Springer Science Business Media B.V. 251-264.
- Umara, J. Dibal, M. Isa, A.K. (2007). Quality Analysis of Water from River Kuamadungu for human consumption and irrigation suitability *Journal of Liberal and Environmental science* 9, 521-526