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Research paper

Assessment of seasonal variations of some heavy metals in water samples collected from Gwaigwaye, Maska and Zobe dams

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Abstract

Water pollution can Damage Aquatic Ecosystems, leading to Death of Fish, plants and other Aquatic organism, which in turn can Disrupt the Entire Food chains. This study was conducted to Determine the Concentrations of Some Heavy metals in water samples obtained from Gwaigwaye, Maska and Zobe Dams in Dry and wet Seasons. The Dams provides water for Drinking, Fishing, Farming and other Agricultural Activities to the Neighbouring Communities. In this study water samples collected from Gwaigwaye, Maska and Zobe Dams in Dry and wet Seasons were Analyzed for Some Heavy metals namely, Cadmium, Cobalt, Copper, Nickel, lead and zinc. After Samples Digestion, microwave plasma atomic emission spectroscopy(MPAES) was used for the Determination of the Metal concentrations and their Levels were compared with permissible limits set by local and international standard regulatory Authorities. From the result of the Analysis, the Concentrations of the Heavy metals in Dry season in mg/L ranged as follows. 0.00±0.00 to 0.03±0.00 mg/L for Cd, 0.02±0.00 to 0.084±0.002 mg/L for Co, 0.057±0.003to 0.186±0.003 mg/L for Cu, 0.03±0.00 to 0.19±0.005 mg/L for Ni, 0.00±0.00 to 0.01±0.00 mg/L for Pb and 0.06±0.02-0.193±0.003 mg/L for Zinc. Similarly, the Concentrations of metals in wet season in(mg/L) ranged as follows, 0.00±0.00 to 0.027±0.002 for Cd, 0.02±0.002 to 0.071±0.002 for Co, 0.051±0.003 to 0.103±0.014 for Cu, 0.029±0.003 to 0.12±0.013 for Ni, 0.00±0.00 to 0.00±0.00 for pb and 0.057±0.002 to 0.160±0.003 for Zinc. The Concentrations level of Cd, Co and Ni in water samples from Maska, Gwaigwaye and Zobe Dams in dry season were above the permissible set by WHO/SON. However, Cu, Pb and Zn were within the permissible limit of WHO and SON in all the Dams in dry and wet seasons. The Result of Statistical Analysis indicated no Significant Difference between the Metals in all the Dams in both Dry and Wet seasons as p values were greater than 0.05(p >0.05).

Keywords: *Dam; Heavy Metals; Water and Assesment.*

1. Introduction

Pollution refers to Introduction of Harmful Substances, such as Toxic chemicals or Excessive Amounts of Nutrients, into the Environment, resuiting in Negative Impacts on the Quality of life for both Humans and other living organism, Including plants and Animals[1] pollution of surface and Ground water is often Caused by a variety of Human Activities such as Industrialisation, Urbanisation and Agriculture, which Release pollutants into these Sources of water[2]. In many Developing Countries, Dam water bodies are often used as Dumping ground for Industrial Effluents, which contain Harmful pollutants such as Heavy metals, toxic chemicals and other waste products. This result in Degradation of water quality in these Areas affecting both the Environment and Human health[3]. water Bodies like Rivers, Lakes and Ground water Aquifers serve as a critical source of water for both Human consumption and Agricultural Activities in many parts of the world. However, as a result of pollution of these water Sources by Human Activities, their water quality can be compromised, leading to Negative Impacts on public health and Food Security[4]. Even at trace levels, Heavy metals can be highly toxic and cause severe Health problems in Humans and other organisms. The toxicity of Heavy metals depends on several factors, such as the Type and the Amount of metals present, Species of organisms exposed, the Biological role of the metal in the organism's body and the length of time of exposure[5]. As the Heavy metal pollutants have the potential of eventually being transmitted to Humans and other Advanced organisms through the Food chain, they also cause Serious threats to Human health. These Heavy metals are not easily eliminated after entering the Human body and tend to continuously accumulate over time. Once they exceed the physiological limit of the human body, they tend to cause physiological and structural changes. These changes may lead to Acute, chronic, or long-term Hazardous effects. Under Environmental conditions with high Concentrations of Heavy metals, the Ingestion of Excessive Amounts of Heavy metals will lead to poisoning effects with possible Serious consequences [5]. Heavy metals have the potential to act as free radicals, causing oxidative stress and leading to Damage to DNA, Cells and Tissues. This Damage may manifest in various ways, including premature aging, Cardiovascular Disorders, Fatique and rare Autoimmune Disorders, such as Arthritis and Calcification. Additionally, Chronic exposure to

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Heavy metals can lead to Degenerative problems and Arterial rupture contributing to an overall decline in Health and wellbeign [6]. Gwaigwaye, Maska and Zobe Dams play a Significant role to the Neighbouring Local communities supplying water for Consumption, Irrigation, Farming and other Agricultural Activities [7]. Previous Studies on the Contamination Status of these Dams have been relatively Scarce making the need for further Research on levels of Heavy metals Necessary. In the light of this Knowledge Gap, this study was conducted to assess the extent of Heavy metal Contamination in the Dams and to provide a valuable insight into Health and Environmental Implications of such Contaminations.

2. Material and methods

All the Chemicals used were of Analytical grade purity, Distilled water was used for solution preparation. Analytical grade reagent and Deionized water were used throughout the study.
All the Glass wares and plastic Containers used were washed cleaned and dried in an oven at 105°C. All weighing was carried out on Analytical weighing Balance[8].
Gwaigwaye Dam was constructed in the year 2003 by the Former president Chief Olusegun Obasanjo in Funtua Katsina state, with the aim of providing water for irrigation to the surrounding communities and Drinking water for the Local government areas namely Funtua Faskari and Bakori Local Government. The reservoir is formed by an Embankment over Gwaigwaye River on Latitude (11° 58`N) and longitude (7° 20` E) Funtua, Katsina state. The size of th Reservoir is above 450 m while the Depth is about 130m. It has a Storage Capacity of 130 million cubic meters. The climate of the Area is typical savannah type with wet season (May- October) and dry season (November-April)[9] .
Maska Dam Was Built in the year 1996, during the administration of Former military Head of State late Gen Sani Abacha in Maska Village, Funtua local Government Katsina State, with the aim of providing water for irrigation to the sorrounding Communities and Drinking water for some Local governments areas, namely, Funtua, Dandume and Sabua. It is located on a Geographical Coordinate of Latitude 11^0 19' 0" North of the Equator and Longitude 7^0 20' 0"East of Greenwich meridian[10].
Zobe Dam was established in the late 1970s during the Administration of Former Military Head of State General Olusegun Obasanjo. It was planned to supply 50% of drinking water for Katsina state while also supporting the irrigation Farming in Dutsinma Area. The Dam was completed and commissioned in 1983 by then President Alhaji Shehu Shagari. It is located on a Geographical coordinate of latitude 12°23'18" North of the equator and longitude 7°28'29"E East of the Greenwich Meridian. It has the Height of 19m and a length of 2750m. The Dam has storage capacity of 170 Million cubic meters covering 800 Hectares of the Land. The climate of the Area is typical savannah type with Wet season (May-October) and Dry season (November- April) [11].

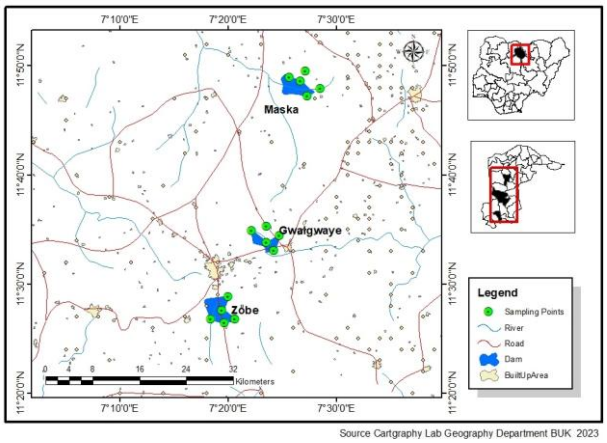


Fig. 2.1: Map Showing Maska, Gwaigwaye and Zobe Dams.

3. Samples collection

3.1. Water

Water samples from Gwaigwaye, Maska and Zobe Dams were obtained from five Different sampling points between two seasons; Dry and Wet seasons. Water samples collected from five Different sampling points were mixed together to get the representative samples in a polyethylene plastic Containers that were previously cleaned by washing with Detergent and then rinsed with tap water and soaked in 10% HNO_3 for 24 hours and finally rinsed with Deionized water prior to usage[12]. During sampling, sample bottles used were rinsed with sampled water three times and then filled to the brim at a depth of 0.5m of the surface water from each of the five designated sampling points. The water samples were preserved by adding 5 cm^3 of Concentrated HNO_3 to 5 liters to reduce microbial Activities. The water sample Bottles were labelled, stored in an Iced-blocked coolers and transported to the Laboratory. while in the Laboratory; they were stored in the Refrigerator at about 4°C prior to the Analysis ([13].

3.2. Digestion

3.3. Digestion of water samples

The water samples (100 cm^3) of each representative samples were transferred into beakers and 10 cm^3 concentrated HNO_3 were added. The Beakers with the content were placed on a sand bath and evaporated down to about 20 cm^3 at a Temperature of 100°C. The beakers were cooled and another 5 cm^3 Concentrated of HNO_3 were added to each beaker. The beakers were covered with watch glasses and returned to the sand bath. The heating continued and then small portion of HNO_3 was added onto each beaker until the solutions ap-

peared light colour and clear. The samples were then filtered while hot to remove insoluble materials that could clog the atomizer, the filtrate was allowed to cool and then diluted to mark in 100 cm^3 Flask with Distilled water[14].

3.4. Analysis of water samples using mpaes

After sample Digestion process, water samples were carefully transferred into sample Cups and sealed. These sample Cups were then placed in the Microwave plasma atomic emission spectrometry instrument which was subsequently turned on and allowed to warm up for a short period of time. This process was necessary to ensure that the instrument was operating at Optimal Conditions for Accurate Analysis of the Heavy metal Concentrations in the samples. The sample solution was injected into the plasma torch, where High Energy of the microwave Radiation atomized and excited the Heavy metal atoms present in the sample. This allow for the Detection and Ouantification of Cadmium, Cobalt, Copper, Nickel, Lead and Zinc Concentrations, as the Emission of light from the excited atoms were measured by the Spectrometre.

3.5. Results

Table 1: Presents the Mean Concentrations of Some Heavy Metals in Water Samples from Gwaigwaye, Maska and Zobe Dams in Dry season(mg/L)

Metals	Cd	Co	Cu	Ni	Pb	Zn
Maska Dam	0.03±0.00	0.084±0.002	0.186±0.03	0.19±0.005	ND	0.193±0.003
Gwaigwaye Dam	0.03±0.00	0.0733±0.003	0.057±0.03	0.166±0.03	0.01±0.00	0.19±0.008
Zobe Dam	ND	0.02±0.00	0.19±0.00	0.03±0.00	ND	0.06±0.015

Table 2: Presents the Mean Concentrations of Some Heavy Metals in Water Samples from Gwaigwaye; Maska and Zobe Dams in wet season(mg/L)

Metals	Cd	Co	Cu	Ni	Pb	Zn
Maska Dam	0.027±0.002	0.071±0.002	0.057±0.002	0.12±0.013	ND	0.141±0.001
Gwaigwaye Dam	0.025±0.001	0.07±0.09	0.051±0.003	0.114±0.002	ND	0.160±0.003
Zobe Dam	ND	0.020±0.002	0.103±0.014	0.029±0.003	ND	0.057±0.002

3.6. Statistical analysis

The Data obtained from the Analysis of some Heavy metals in water samples from Maska, Gwaigwaye and Zobe Dams were presented as Mean±Standard deviations and were subjected to one way Analysis of variance(anova) to asses whether the Heavy metals differed significantly between the Dams or not. The result of the Analysis of variance did not show Significant Differences in the Concentrations of the Metals in the Analyzed water samples from Maska, Gwaigwaye and Zobe Dams in both Dry and Wet seasons.

4. Discussion

From the results presented in Tables(1 and 2), the levels for Cadmium (Cd) in water samples for dry season were found to be the same for Maska and Gwaigwaye (0.03±0.00 mg/L) dams and it was not detected in Zobe Dam. Lower concentrations of Cadmium in wet seasons were observed in Maska and Gwaigwaye dams respectively. The level of cadmium detected in Zobe Dam was 0.019 ± 0.003 mg/L the result obtained shows that the concentrations of Cadmium in all the water samples were above the permissible limit of 0.003 mg/L recommended by (WHO, 2011; SON, 2007). This could be due to the accumulation of Cadmium metals in the water bodies as a result of some Anthropogenic activities taking place around the Dams. [15] reported almost similar value of 0.01±0.00 mg/L for Cd in water from Challawa Gorge dam, Kano. In another research conducted by [16] from river Benue, 4.01 ± 0.01 mg/L which is extremely higher compared to the value obtained in the current research was obtained for Cadmium. Similar value of 0.03±0.010 mg/L was obtained by [17] from Jibia Dam Katsina State.

Cobalt Concentrations were found to varied across the three Dams, with concentrations measured in mg/L beign 0.084 ± 0.002, 0.073 ± 0.003 and 0.020 ± 0.00 during the dry season for Maska, Gwaigwaye and Zobe Dams respectively . In the wet season concentrations decreased to 0.071±0.002 mg/L and 0.070±0.009 mg/L for Maska and Gwaigwaye Dams but increased significantly to 0.036±0.00 mg/L in Zobe Dam during the wet season. The concentrations of cobalt were above the permissible limit of 0.05 mg/L for Maska and Gwaigwaye Dams in both seasons but within the permissible limit for Zobe dam. (WHO, 2011; SON, 2007). The increase in metal concentration during the rainy season could be due to high precipitation which subsequently led to higher run off Cobalt containing material from Agricultural activities around the Dam.[18] In another study conducted by [19], 0.05 mg/L was obtained for Cobalt in water around refuse dumpsite in Ibadan Metropolis which agreed with the finding of the present work. Likewise, 0.122 ± 0.08 mg/L for Cobalt in water sampled from Wudil in Kano as reported by [20] and a concentration range of 0.017±0.001 – 0.1178±0.022 mg/L obtained for Co in Mairuwa Dam Katsina State by [21] were slightly above the findings of the present study.

Copper concentrations during the dry season were 0.186 ± 0.003, 0.057 ± 0,003 and 0.19 ± 0.00 mg/L for Maska, Gwaigwaye and Zobe Dams respectively. However during the wet season copper concentrations decreased significantly to 0.057±0.002, 0.051±0.003 and 0.16± 0.01 mg/L. The concentrations of Copper in all the analyzed water samples were below the permissible limits of 2.0 and 1.0 mg/L proposed by WHO (2011, SON (2017). [17] reported a slightly lower value than that of the present work 0.03 ± 0.001 mg/L Cu for water from Ajiwa Dam Katsina state. In another different research conducted by [22] a concentration range of 0.06 -0.12 mg/L was obtained for Cu from Koramar wanke Dam, Gusau Zamfara state. 0.077 mg/L for Copper in Chamo lake Addis Ababa Ethiopia by [23] is in excellent agreement with current research.

The concentrations of Nickel were decreased from 0.190±0.005 and 0.167±0.00 mg/L in dry season to 0.120±0.001 and 0.114±0.00 mg/L in wet season for Maska and Gwaigwaye respectively but increased from 0.030±0.00 to 1.037±0.00 mg/L in Zobe Dam. Nickel concentrations in the analyzed water samples were above the recommended values of 0.05 and 0.02 mg/L by WHO/SON. This might be as a result of high surface run off from Agricultural land and soil rich in Nickel around Zobe Dam. In comparison with previously reported work, a value of (0.001 mg/L) lower than that of the present work was reported by [24] for Nickel in Gubi dam in Bauchi State Nigeria. [25] also reported 0.056±0.01mg/L for Nickel from the pollution prone irrigation areas around Kano Metropolis. This also closely agreed the finding of the current research.[26] obtained 0.11±0.56 mg/L for Nickel in Jibia Dam which agreed with the present study.

Lead was only detected in Gwaigwaye, (0.010±0.00 mg/L) in dry season but not detected in all the Dams in wet season. This could be due to dilution effect as suggested by [15]. The result is within the permissible limit of 0.01 mg/L by WHO/SON. [27] reported a slight-

ly higher values than that of the present study (0.02 mg/L) for Pb in water from Azuabie Creek Port Harcourt and 0.096 ± 0.03 mg/L for lead in water from Ajiwa Dam by [26]. Likewise, 0.00-0.736 mg/L for Pb in water sampled from fish farm cluster in Niger delter region by [28] agreed with the present study. The concentrations ranged from 0.001 – 0.005 mg/L for lead from Nguru River was also reported by [29].
Zinc concentrations decreased from 0.190±0.008 and 0.060±0.002 in dry to 0.160±0.003 and 0.023±0.003 mg/L in wet season for Gwaigwaye and Zobe dams, while it increased from 0.0193±0.003 in dry season to 0.141±0.00 mg/L in wet season for Maska. This could be attributed to Agricultural and Anthropogenic activities taking place around Maska Dam. The results were below the permissible limit of 3.0mg/L by WHO/SON. [30] reported 0.42 mg/L for Zn in water from Epe Badagry Lagos which is slightly higher compared to the values in the current research. These higher values could be attributed to Geographical distribution of metals which varies from one location to another as suggested by [24]. [31] reported 0.050 mg/L for Zinc in water from Lake Victoria East Africa which also agreed with the present work. A slightly lower value of 0.035 ± 0.002 mg/L was obtained by [32] from saki Dam oyo state. 0.44±0.19 mg/L reported for Zn by [33] from concrete water storage reservoir in Bakalori irrigation project, Zamfara state was above the finding of the current research.

4.1. Conclusion

The Concentrations of Cadmium, Cobalt and Nickel in the Dams have exceeded the recommended Permissible limits by WHO/SON, thereby making the Dams partly unsafe for various purposes, sush as consumption, irrigation and other Agricultural Activities. The high levels of these metals poses potential risks to Both Human and Environmental health, and hence the need to be Addressed to prevent further Contamination and Degradation of the Dams' Ecosystem. However, the Concentrations of Copper, lead and Zinc in the Dams are within the safe limits, indicating that they are not currently posing significant risks to the environment and Human health. This suggests that the levels of these heavy metals are currently beign effectively managed.

4.2. Acknowledgement

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4.3. Conflict of interest

The Authors have declared that no conflict of interest exist.

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