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Determination of Some Heavy Metals in Water and Sediment Samples from Maska Dam, Katsina State, Nigeria

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Abstract

Water and sediment samples collected from Maska dam in dry and wet seasons were analysed for some heavy metals namely, Cd, Cu, Ni and Zn. After sample digestion, micro-wave Plasma atomic absorption spectroscopy (MPAES) was used to determine the concentrations of the metals. The concentrations were analysed statistically using one way analysis of variance (Anova). The levels of metals in water and sediment were compared with local and international regulatory authorities. From the result of analysis, the concentrations of the metals in (mg/L) were as follows: 0.03±0.01 for Cd, 0.186±0.003 for Cu, 0.19±0.005 for Ni and 0.193±0.003 for Zn, 0.027±0.002 for Cd, 0.057±0.002 for Cu, 0.114±0.002 for Ni and 0.141±0.001 for Zn in water samples in dry and wet seasons. Likewise, the concentration of the metals in sediment in dry and wet seasons were, 0.0196±0.002 for Cd, 0.143±0.003 for Cu, 0.166±0.044 for Ni and 0.766±0.044mg/kg for Zn in dry season. Similarly, 0.019±0.001 for Cd, 0.143±0.004 for Cu, 0.160±0.09 for Ni and 0.451±0.003mg/kg for Zn were obtained in wet season.

The concentrations of Cu and Zn were below the permissible limits of WHO/SON while Cd and Ni were above the permissible limit of WHO/SON in water samples. However, the concentrations of all the metals were below the permissible limits of NOAA and USEPA. The result of statistical analysis indicated no significant difference at P greater than 0.05 (P>0.05).

Keywords: Water, Sediment, Heavy metals and Maska Dam.

INTRODUCTION

The growth of agriculture, industry and urban areas has increased the amount of metals in the environment (Chen et al.,2015). Presence of heavy metals in aquatic environment is critical concern, as these metals are toxic and can accumulate in the ecosystem (Ahmed et al; 2010). Heavy metals are not broken down by natural processes and therefore accumulate in the food chain causing health effect in organism that are far removed from the sources of pollution (Ahmed et al.,2010). In aquatic system, trace metals often bind to the sediment particles through chemical and physical processes such as adsorption and coagulation and settle to the bottom (Mazrui et al., 2017).

Fish and other aquatic organism are exposed to higher levels of these metals since they live and feed on sediments that contain them, hence bioaccumulate in the tissues of fish and

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biomagnify along the food chain, causing toxic health effect to fish, peoples and animals that eat it.

The aim of this study was to determine the concentrations of cadmium, copper, Nickel and Zinc in both water and sediment at Maska dam, to compare these concentrations between dry and wet seasons and to understand how much of these metals are polluting the dam. Based on the findings of this study it is possible to draw conclusion on the level of contamination of these metals that would help in taking step to prevent further pollution, because there is no much existing research about heavy metals contamination in Maska dam.

METHODOLOGY

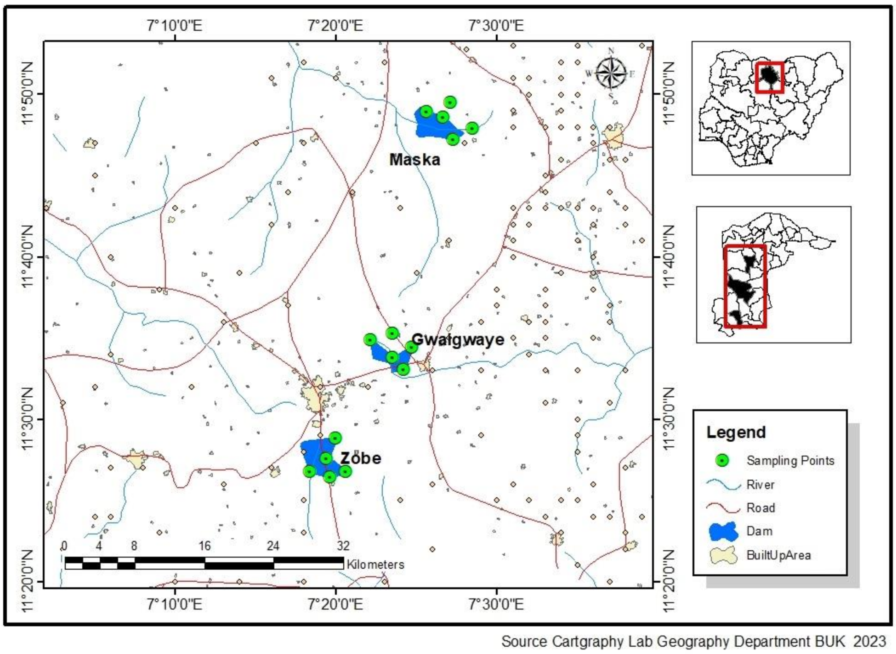
Materials

Analytical grade reagents were used throughout the study. Distilled water was used for all solutions preparations.

All the glass wares were washed thoroughly with detergent, rinsed with tap water and finally with deionized water before drying. All the plastic containers were cleaned by washing with detergent rinsed with tap water, soaked in 10% HNO_3 for 24hours and finally rinsed with deionized water prior to usage (Salihu et al.,2019).

Study Area

Maska dam is located on geographical co-ordinate of latitude $11^{0}19^{1}0^{11}$ North of the equator and longitude $7^{0}20^{1}0^{11}$ East of Greenwich meridian. Maska dam was built in the year 1996 during the administration of former military head of state Gen. Sani Abacha in Funtua, Katsina State, with aim of providing water for irrigation to the surrounding communities and drinking water for local government areas namely: Funtua, Sabua and Dandume Local Government.



Source Cartgraphy Lab Geography Department BUK 2023

Fig. 1: Maska Dam showing Sampling Points

Samples Collection

Water samples were collected from five designated sampling points in Maska dam in dry and wet seasons. A water sampler polythene plastic containers of were used to collect surface water from the sampling points. All the sample bottles were cleaned before use with detergent and rinsed with deionized water for sampling purpose. During sampling, the bottles were rinsed with dam water three times then used for collecting the samples. Finally freshly collected water samples were mixed together and taken as representative sample for digestion process. The collected water samples were placed in an iced box and transported to the laboratory for further treatment (Gerenfes and Teju, 2018).

Sediment samples were collected from five sampling points in Maska dam in dry and wet seasons, about 50m apart for each points, 5 bottomed sediment samples were taken using soil auger. The composite sample was prepared by mixing the samples thoroughly and allowed to dry in the laboratory. The sediment samples were ground into powder using porcelain pestle and mortar, then sieved through 2mm brass sieve and stored till ready for the analysis (Muhammad et al., 2014).

Digestion of Water

The sample (100cm^3) of representative water sample from Maska dam was transferred into a beaker and 10cm^3 of concentrated HNO_3 was added. The beaker with content were placed on a sand bath and evaporated down to 20cm^3. The beaker was cooled and another 5cm^3 of HNO_3 was added to the beaker. The beaker was covered with watch glass and returned to the sand bath. The heating continued and then small portion of HNO_3 was added to beaker until the solution appear light colour and clear. The beakers wall and watch glass were washed with deionized water and the sample was filtered to remove any insoluble materials that could clog the atomizer. The sample volume was made up to 100cm^3 with deionized water (Salihu et al., 2019).

Digestion of Sediment Sample

The sample (3g) of dried ground and sieved sediment sample from Maska dam was placed in a cleaned 250cm^3 beaker. 20cm^3 of Aqua regia was added to the beaker. The beaker was left for the reaction to subside, the beaker was covered with watch glass placed on a hot plate and hooted at 120^{o}c until yellow-brown colouration formed. The solution was allowed to cool before filtering using whatman 1 filter paper. It was transferred into a pre-cleaned sample bottle and made up to the mark with distilled water (Sulaiman and Audu, 2014). The sample was taken to CDA BUK for analysis.

RESULTS AND DISCUSSION

Results

Tables 1 and 2 show the Mean Concentrations (mg/L) of some heavy metals in water and sediment samples respectively.

Table 1: Mean Concentrations (mg/L) of some heavy metals in water samples

	Cd	Cu	Ni	Zn
Dry Season	0.03±0.000	0.186±0.003	0.19±0.005	0.193±0.003
Wet Season	0.027±0.002	0.057±0.002	0.114±0.002	0.141±0.001
Permissible Limit (WHO, 2011; SON,2007)	0.003	2.000	0.010	3.000

Table 2: Mean Concentrations (mg/L) of some heavy metals in sediment samples

	Cd	Cu	Ni	Zn
Dry Season	0.0196±0.002	0.143±0.004	0.166±0.044	0.766±0.044
Wet Season	0.019±0.001	0.143±0.004	0.160±0.09	0.451±0.003
Permissible Limit (**USEPA/NOAA, 2009**)	4.9	31.6	35.8	120

DISCUSSION

Table 1 revealed the concentrations of some heavy metals in the analysed water samples from Maska dam in dry and wet seasons.The level of cadmium concentration in Maska dam was found to be 0.03±0.00 mg/L in dry season which slightly decreased to 0.027±0.002 mg/L in wet season. These values were lower than 0.24±0.09 mg/L for Cd in Jibia dam reported by Shamsuddin et al. (2018) and 0.21 mg/L for Cd from Azuabie Greek Portharcourt, River State by Ekweozor et al. (2017). This could be attributed to effluent discharge from industries and sewages from domestic sources. The level of cadmium in Maska dam in both dry and wet seasons was above 0.003 mg/L permissible limit by WHO/SON. This might come from agricultural source with fertilizer & pesticide containing Cd washed into the dam. This could have serious implication for aquatic life and for human health.

Copper concentration in Maska dam decreased from 0.186±0.00 mg/L in dry season to 0.057±0.002 mg/L in wet season. These results were below the permissible limit of 2.0 mg/L proposed by SON/WHO. The level of copper below the permissible limit is not a cause for concern. However, it is still important to monitor its level since too much of its can be toxic to aquatic life.

A value of 0.06 – 0.3 mg/L for Cu reported by Oiganji et al. (2023) from Kuru dam, Jos was within the findings of the present study. However, 0.010 mg/L for Cu from Chamo Lake, Botswana obtained by (Gerenfes and Teju 2018) was below the findings of the current research.

The highest concentration of 0.19±0.005 mg/L for Nickel was found in Maska dam in dry season, while the least concentration of 0.114±0.002 mg/L for nickel was detected in wet season. The levels of nickel in both dry and wet seasons were above 0.01 mg/L set by SON/WHO. This signified negative implications for both the environment and for humans. It can affect the health of aquatic life in the dam and impact human health if people drink water or eat the fish from the dam.

In a similar research by Shamsuddin et al. (2018) a slightly higher value of 0.24±0.09 mg/L was obtained for nickel from Jibia dam, Katsina. However, 0.01±0.01 mg/L of nickel obtained by Raji et al. (2016) from Sokoto river was below the findings of the present study.

The concentration level of zinc in Maska dam slightly decreased from 0.193±0.003 mg/L in dry season to 0.141±0.001 mg/L in wet season. The results obtained in both dry and wet seasons were below 3.00mg/l recommended by SON/WHO. Zinc level below the permissible limit means there is no significant risk of toxicity for aquatic life.

On comparison with some previously reported work Ogoyi *etal*. (2014) reported a lower value of 0.05 mg/L for Zn from Victoria east lake, central Africa. However, 0.42 mg/L obtained by Oluwa et al. (2010) for Zinc from Epe badagry Lagos was above the finding the present study. This could be attributed to accumulation of the metals bodies through anthropogenic and or agricultural activities.

Table 2 revealed the concentrations of some heavy metals in sediment samples of Maska dam. A slight decrease in the concentration of cadmium from 0.0196±0.002 mg/kg in dry season to 0.019±0.001 mg/kg in wet season was observed in Maska dam sediment. The concentration level of cadmium was below 4.9 mg/kg NOAA permissible limit. Cd below the permissible limit in sediment indicated less risk of harm to aquatic organism that live in or on the sediment. There is less risk of Cd entering the food chain through organism that live in or on the sediment. The result disgraced with the report of Uba et al. (2020) that obtained a lower value of 0.009 mg/kg for Cd in sediment of Shika dam. Similarly, 4.13±0.01 mg/kg obtained for Cd from Challawa Gorge dam sediment in Kano State by Zakaria et al. (2014) was very far above the values obtained in the current research. This could be due to direct discharge of untreated industrial effluent into the dam.

The level of copper in Maska dam sediment was found to be 0.143±0.004 mg/kg for both dry and wet seasons. This might be as a result of sedimentation process which balanced out any changes in the copper input from the dam. The level of copper in Maska sediment was below 31.6 mg/kg by NOAA. Copper below the permissible limit means there is less risk of toxicity for organism that live in or on the sediment. The result was lower than the report of Bubu et al. (2017) that obtained 1.3 mg/kg for copper in bonny river sediment.

In another research by (Edward and Zira, 2021) a concentration range of 0.57±0.08 to 1.18±0.99 mg/kg was reported for copper from Kiri reservoir, Adamawa State. These higher values might be as a result of discharge of pollutant from industrial and domestic sources into the dam.

Nickel concentrations were found to be 0.166±0.044 mg/kg and 0.160±0.09 mg/kg for both dry and wet seasons. These are below the permissible limit of 35.8 mg/kg by NOAA. There is less risk of toxicity to aquatic organism that live in or on the sediment. Low level of Nickel can have both negative and positive implication. Almost similar value of 0.15±0.01 mg/kg for Nickel in sediment of Bunsuru river was obtained by (Muhammad et al., 2014). However, 0.02 mg/kg of nickel reported by (Gav et al; 2008) in sediment of Awe dam was below the findings of the present study.

Zinc was significantly higher with a concentration of 0.766±0.044 mg/kg in Maska dam sediment in dry season which dropped to 0.451±0.003 mg/kg in wet season. These values were below 120 mg/kg permissible limit by NOAA. Zinc below the permissible limit means that the sediment is not posing a toxic risk the aquatic life. Additionally, it means zinc is available for uptake by organism that live in or on the sediment. The result closely agreed with the report of Yar'adua et al. (2018) that obtained 0.736±0.00 mg/kg for Zinc in sediment of Ajiwa dam, Katsina State.

Ekweozor et al. (2018) obtained 27.70 mg/kg for zinc in Azuabie Greek Portharcourt. This is extremely higher than the findings of the present study. This higher value could be attributed to the discharge from many industries residential building and main Portharcourt abattoir. The mean concentrations of the metals were higher in dry season than wet season, this could be attributed reduction in the volume of water during the dry season as suggested by (Zakaria et al., 2014) when they analysed some heavy metals in water and sediment of Nassarawa Gorge dam, Kano State.

CONCLUSION

In conclusion, the concentrations of copper and zinc were below the permissible limit of SON/WHO, while Cadmium and Nickel were above the permissible limits of SON/WHO in water samples in dry & wet seasons. However, the concentrations of Cadmium, Copper, Nickel and Zinc were all below the permissible limits of NOAA and USEPA in sediment samples of Maska dam in dry and wet seasons Maska dam is therefore moderately polluted and might not be completely safe for drinking and other domestic and agricultural activities.

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