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Assessment of Heavy Metal levels in Lake Geriyo, Yola, Adamawa State, Nigeria

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Abstract:
The assessment the levels of heavy metals in water samples from Lake Geriyo, Yola, Adamawa State, Nigeria. Water samples were collected from three sites from January, 2013 to June, 2014 for the determination of Iron (Fe), Manganese (Mn), Nickel (Ni), Cadmium (Cd), Lead (Pb), Zinc (Zn), Copper (Cu) and Cobalt (Co). The levels of heavy metals in the water samples were determined using atomic absorption spectrophotometer (AAS). The concentrations of Fe, Mn, Cu, Cd, Ni,Cu, Pband Co in the water samples were higher than the WHO guideline limits while Zn was within WHO guideline limits, indicating that the pollution level of Lake Geriyo is eminent. Concentrations of heavy metal was higher in dry than rainy season.. All values of the parameter studied were not within permissible limits of WHO except Zn in both the seasons. This high level of some heavy metals in the dry season is as a result of farming activities taking place around the lake. The presence of heavy metals in the water samples from Lake Geriyo give cause for concern with time. The results of the study implies that continuous monitoring of these heavy metals in these study area has to be carried outto ascertain the long-term impact of anthropogenic inputs to take remedial measures so as to ensure the good health of aquatic life.

Keyword: *Heavy metals, water, Season, Lake Geriyo*

1. Introduction

The aquatic environment with its water quality is considered the main factor controlling the state of health and disease in both cultured and wild fishes. Pollution of the aquatic environment by inorganic and organic chemicals is a major factors posing serious threat to the survival of aquatic organisms including fish (Samir, et al, 2008**)**. The agricultural drainage water containing pesticides and fertilizers and effluents of industrial activities and runoffs in addition to sewage effluents supply the water bodies and sediment with huge quantities of inorganic anions and heavy metals (ECDG, 2002). The most anthropogenic sources of metals are industrial, petroleum contamination and sewage disposal (Santos et al., 2005).

Many researches have worked on heavy metals. These include the works of (Ghorade*et al.*, 2014,Matkar, 2008, Ghorade, 2013, Lohar, 2000, Banat *et al.*,1998 , Mason, 2002, Abbasi, 1998, Turnland, 1998, WHO, 2004, Gomez *et al*., 2000, and Anglin-Brown *et al*., 1995)and so many others.The present work is aimed at investigating the pollution levels of some heavy metals (Iron, Zinc, Copper, Nickel, Cobalt, Manganese, Cadmium and Lead) in Lake Geriyo, Yola, Adamawa State, Nigeria.

2. Materials and Methods

2.1. Study Area

Lake Geriyo is located at the outskirts of Jimeta- Yola metropolis on the north-west region (Longitude 12^{o} 25$^{'}$E and between latitude 9^{o} 81$^{'}$N and 9^{o} 17'). It has a high level of 750ha and low level of 200ha. Storage at level about 7,500,000cm$^{2.}$The area available to fisheries development is about 250ha; consequently, most of the settlers around the lake are fishermen (fig.1), (UBRBDA, 1985).

Lake Geriyo is a natural lake that started as a small gulley, but later filled with water from rains and some influx from River Benue. The lake came into recognizable existence in 1950. Initially, the lake was not used for fishing. It has now become a major fishery, with fishing activities taking place all year round. It is also a major source of water for irrigation, during the dry season farming that takes place around the lake. The water level of the lake is reasonably constant with regards to the movement of water in and out. This has given rise to a stable growth of water plants that give the basin the appearance of a typical lake.

The lake experiences two seasonal period: the rainy and dry seasons. The rainy season starts in the months of May and last till October and is characterized by heavy downpour which may sometimes result in extensive floods. The dry season on the other hand is from late October to April and is characterized by the cold, dusty dry winds of December and January (Harmattan) and intense heat of

February, March through April. Atmospheric temperature can be as low as 20^0 C in December and January and as high as 40^o C in March and April.

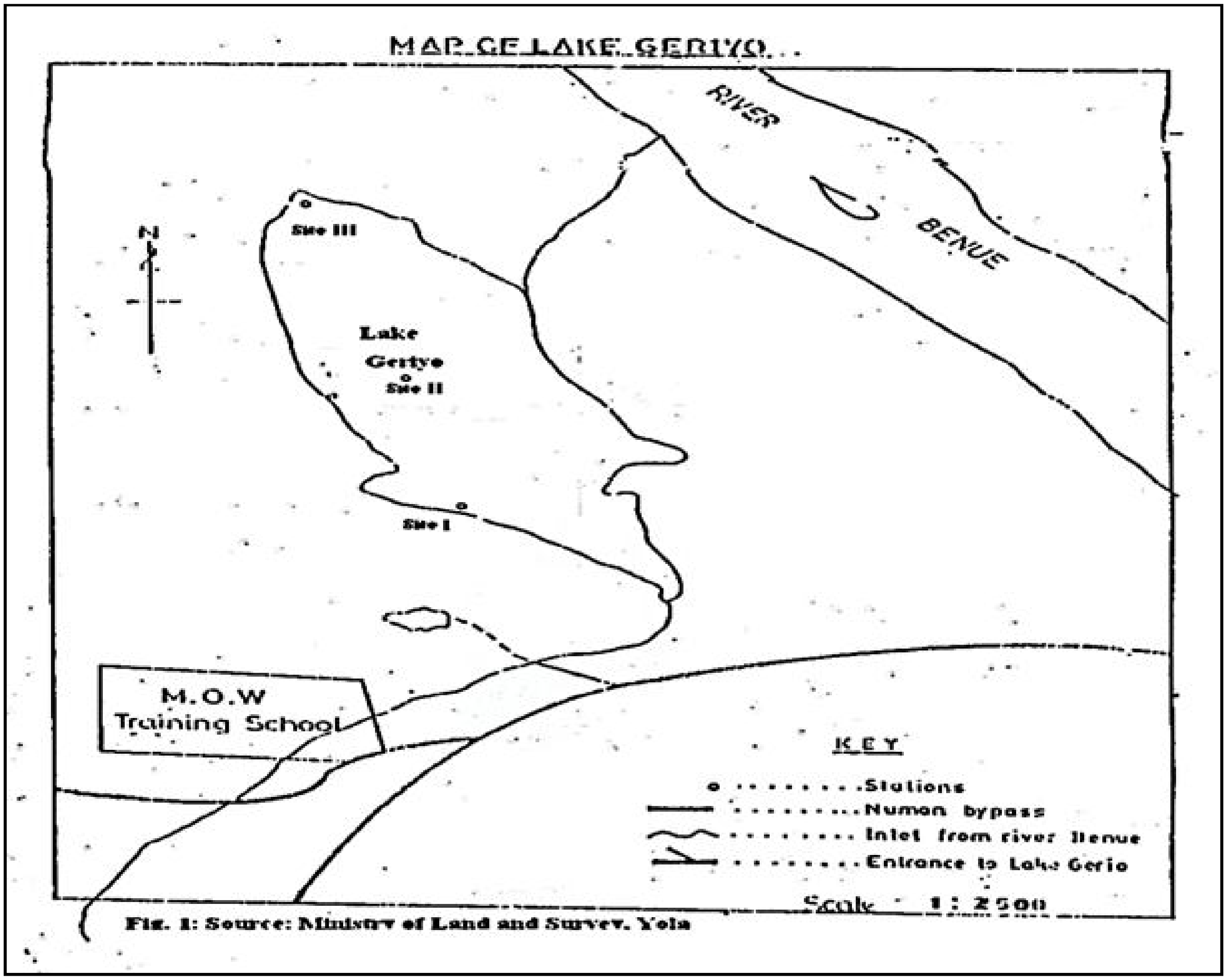

Figure 1

2.2. Sample Collection

Water samples were collected in plastic containers previously cleaned by washing with non-ionic detergent, rinsed with tap water and later soaked in 10% HNO_3 for 24 hours and finally rinsed with deionised water prior to usage. Samples of the water were taken fortnightly from Lake Geriyo at three sites(Fig.1) over a period of 18 months (January, 2013 to June, 2014) at a 6am local time. During sampling, sample bottles were rinsed with sampled water three times and then filled to the brim at a depth of one meter below the water from each of the sampling sites. At each sampling site, water samples were collected in triplicate from three sites. The samples were labeled and transported to the laboratory, stored in the refrigerator at 4°C prior to analysis.

2.3. Analysis of Samples

Determination of Cu, Zn, Co, Mn, Fe, Cd, Ni and Pb was made using Atomic Absorption Spectroscopy (AAS) (VGP 210) as described by (Radojevic and Bashkin 1999).

2.4. Data Analysis

One-way analysis of variance (ANOVA) was used to evaluate the significant difference in the concentration of different studied heavy metals.

3. Results

The result of heavy metals in the Lake Geriyoare shown in table 1.

3.1. Iron (Fe)

The monthly mean concentration of Iron in mg/L during the year 2013-2014 varied from 0.968±0.476 to 12.243±2.517 in September and April respectively. There was a significant difference at $P<0.05$ within the months..

3.2. Manganese (Mn)

The monthly mean concentration of Manganese in mg/L during the year 2013-2014 varied from 0.238±0.041 to 1.217±0.087 in September and May respectively. There was a significant difference in at $P<0.05$ within the months.

3.3. Nickel (Ni)

The montly mean concentration of Nickel in mg/L during the period of the study varied from 0.018±0.003 to 0.101±0.001 in February and June respectively. There was significant difference at $P<0.05$within the months.

3.4. Cadmium (Cd)

The monthly mean concentration of Cadmium in mg/L level during the year 2013-2014 varied from 0.013±0.003 to 0.051±0.004 in March and June respectively. The difference was significant at $P<0.05$.

3.5. Cupper (Cu)

The monthly mean concentration of copper in mg/L varied from 0.179±0.083 to 0.417±0.020 in January and August respectively. There was significant difference in variation within the months ($P<0.05$).

3.6. Lead (Pb)

The monthly mean concentration of copper in mg/L level during the year 2013-2014 varied from 0.011±0.002 to 0.037±0.006 in January and April respectively. The difference was significant at $P<0.05$.

3.7. Zinc (Zn)

The monthly mean concentration of copper in mg/L during the study period varied from 0.020±0.003 to 0.057±0.014 in January and May respectively. There was a significant difference in variation within the months ($P<0.05$).

3.8. Cobalt (Co)

The monthly mean concentration of cobalt in mg/L during the year 2013-2014 varied from 0.020±0.005 to 0.095±0.004 in February and April respectively. There was a significant difference at $P<0.05$ within the months.

Seasonal variations of heavy metal concentration in Lake Geriyo are presented in Fig.2. Fe was the highest followed by Mn and Cu in both dry and rainy seasons. There was a significant difference at $P<0.05$ in the seasonal variation of heavy metals concentration in Lake Geriyo. In general, there was a high value of heavy metals in the drying season than the rainy season.

Months	Fe	Mn	Ni	Cd	Cu	Pb	Zn	Co
January	7.410±1.303	0.450±0.206	0.021±0.016	0.014±0.006	0.179±0.083	0.011±0.002	0.020±0.003	0.027±0.007
February	6.813±1.172	0.504±0.217	0.018±0.003	0.017±0.005	0.300±0.114	0.014±0.005	0.023±0.009	0.020±0.005
March	8.588±2.188	0.457±0.104	0.027±0.040	0.013±0.003	0.292±0.045	0.015±0.005	0.029±0.001	0.022±0.007
April	12.243±2.517	0.872±0.144	0.031±0.003	0.022±0.010	0.403±0.034	0.026±0.011	0.052±0.010	0.043±0.005
May	3.898±0.286	1.217±0.087	0.035±0.010	0.046±0.012	0.321±0.022	0.023±0.005	0.050±0.043	0.063±0.016
June	1.435±0.363	0.598±0.128	0.044±0.009	0.037±0.004	0.263±0.022	0.027±0.007	0.055±0.014	0.056±0.016
July	1.884±0.106	0.379±0.198	0.037±0.007	0.020±0.009	0.236±0.017	0.019±0.001	0.026±0.005	0.047±0.006
August	1.035±0.175	0.325±0.104	0.028±0.008	0.018±0.002	0.417±0.020	0.012±0.004	0.026±0.004	0.039±0.007
September	0.968±0.476	0.238±0.041	0.031±0.004	0.023±0.004	0.355±0.021	0.018±0.007	0.028±0.007	0.034±0.004
October	1.035±0.203	0.367±0.097	0.028±0.003	0.016±0.004	0.344±0.022	0.024±0.006	0.037±0.004	0.030±0.001
November	1.034±0.117	0.433±0.026	0.029±0.005	0.031±0.008	0.317±0.032	0.023±0.006	0.033±0.005	0.030±0.003
December	1.218±0.229	0.396±0.063	0.031±0.008	0.027±0.013	0.257±0.033	0.015±0.005	0.028±0.003	0.037±0.005
January	6.306±0.639	0.477±0.076	0.032±0.003	0.016±0.006	0.254±0.054	0.022±0.004	0.028±0.004	0.035±0.004
February	4.139±0.525	0.549±0.059	0.038±0.001	0.023±0.008	0.313±0.042	0.028±0.007	0.032±0.005	0.047±0.028
March	6.040±0.937	0.588±0.052	0.042±0.006	0.037±0.013	0.315±0.048	0.024±0.005	0.038±0.003	0.077±0.023
April	7.493±1.047	0.652±0.045	0.052±0.016	0.037±0.007	0.307±0.004	0.035±0.005	0.040±0.004	0.095±0.004
May	3.451±0.577	0.814±0.095	0.078±0.015	0.047±0.014	0.316±0.032	0.037±0.006	0.057±0.014	0.089±0.011
June	2.731±0.845	0.505±0.140	0.101±0.001	0.051±0.004	0.282±0.002	0.033±0.005	0.048±0.009	0.082±0.012

Table 1: Monthly mean ±SD variations of Heavy Metals concentration (mg/L) of the Lake Geriyo Water from January 2013 to June 2014

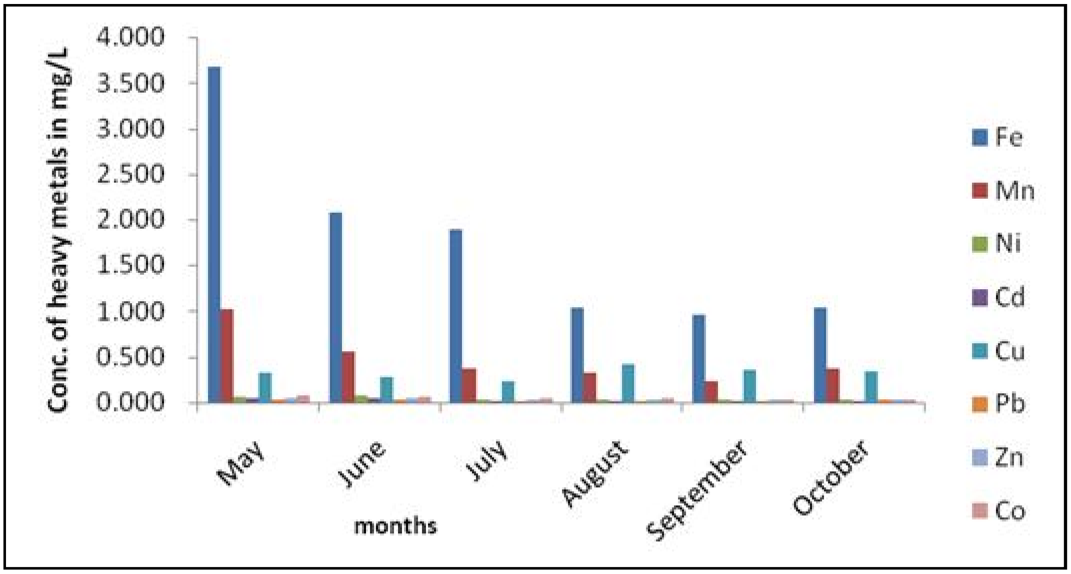

Figure 2: Monthly mean variation of heavy metal in rainy season

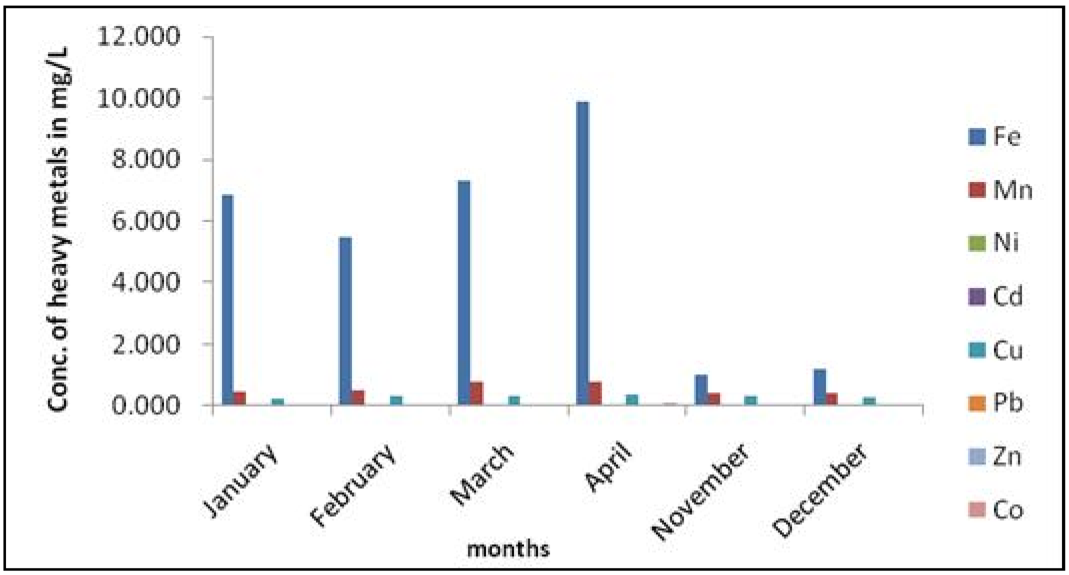

Figure 3: Monthly mean variation of heavy metal in dry season

4. Discussion

The monthly mean concentration of Iron in mg/L level was varied from 0.968±0.476 to 12.243±2.517 during the period of the study. This result is less than the observed range between 16.43 ± 1.87 and 20.92 ± 1.55 mg/L as reported by [Joseph*et al.*, 2012]in Lake Chad, Baga. This result contrast WHO guideline value of 0.3 mg/l and maximum contaminant levels of 0.30 mg/L (water) for Fe. This might be as a result of waste dumped around the Lake which could be washed into the Lake. Iron concentration was generally high in the entire sample analyzed. There was a significant variation at $p<0.05$ in the levels of Fe within the months.

The monthly mean concentration of Manganese in mg/L level during the year 2013-2014 varied from 0.238±0.041 to 1.217±0.087. The observed values were in agreement with 0.311 to 1.034 mg/L reported by (Maitera*et al.*, 2011) in River Benue. Manganese compounds are used in fertilizers, varnish and fungicides and as livestock feeding supplements which are washed into the Lake.The concentrations of Mn within the months in Lake Geriyo exceeded the permissible limit of 0.05 mg/L (water) set by (USEPA, 2002, WHO, 2004) .

Nickel concentrations in the water samples ranged between 0.018±0.003 and 0.101±0.001 mg/L. The concentration of Ni in the water samples in Lake Geriyo exceeded the permissible limit of 0.01 mg/L set by (WHO, 2004). Green (1986) reported high concentration of nickel in Lake Vanadawater and attributed as result to industrial and urban activities. The high concentration of Ni in the water samples from this portion of Lake Geriyo could be from agricultural runoff, which may carry higher concentrations of this metal, which arise from anthropogenic activities such as use of chemical fertilizers and pesticides in agriculture land (Rajmohan and Elango, 2005).

The concentrations of Cd in the water samples fluctuate between 0.013±0.003 and 0.051±0.004 mg/L. Higher concentration of cadmium is extremely toxic to fish population. Its effects on the growth rate have been observed even for concentrations between

0.005 and 0.01 mg/L (Green, *et al*.,1986).The highest levels of Cd obtained in water samples might be due to agricultural runoff, where fertilizers, pesticides and other agro-chemical are used in addition to possible release of sediment bound metal. Apart from natural sources, other probable sources of this metal in surface water include leaching from Ni-Cd based batteries [Hutton ,1999], runoff from agricultural soils where phosphate fertilizers are used (Stoeppler, 1991) and other metal wastes. The levels of cadmium in the water samples during the period of the research were above the (WHO, 2004) standard values of 0.01 mg/L for the survival of aquatic organism.

The levels of Cu in the water samples fluctuate between 0.179±0.083 to 0.417±0.020 mg/L. This could be as a result of Copper compounds used as Cu based fungicides, algicides, insecticides and wood preservatives. Run off from the waste around the Lake could have also contributed to the high level of Cu. The copper concentrations in the water samples in Lake Geriyo were found to be higher than the permissible limit of 0.05 mg/L set by WHO (2004) for the survivor of aquatic organism.

The concentrations of Pb in the water samples ranged between 0.011±0.002 and 0.037±0.006 mg/L. The concentration of Pb in the water samples from Lake Geriyo exceeds the permissible limit of 0.01 mg/L set by (WHO, 2003). The higher level of Pbobserved in the water samples from Lake Geriyomight be attributed to run off agricultural land which contains fertilizers, agrochemicals and pesticides (Anglin-Brown et al., 1995).

The level of Zn in the water samples was ranged between 0.020±0.003 and 0.057±0.014 mg/L. The concentrations of Zn in Lake Geriyo were observed to be within the permissible limits of 0.3 mg/L in water set by WHO (2003).

The concentration of cobalt in mg/L level during the year 2013-2014 was varied from 0.020±0.005 to 0.095±0.004 mg/L during the period of the research which is within the observed ranges 0.11 ± 0.01 mg/L to 0.73 ± 0.05 mg/L reported by Joseph (2012). Cobalt is an essential element which could be introduced anthropogenically into the aquatic ecosystem as runoff from industrial and agricultural activities (Joseph, 2012).

The concentrations of heavy metals were higher during the dry season than in the rainy season. All the values of the parameters studied were not within the allowable limits (WHO,2003) except for Zn. This maybe as a result of runoff from refuge dumps around the study area. The waste and sewage generated by industry can get into the water supply, introducing large organic pollutants into the ecosystem (Maitera, 2011).

5. Conclusion

Based on the results of this study, it was revealed that the levels of the heavy metals *(*Fe, Mn, Cu, Cd, Ni, Zn, Pband Co)in the water samples exceeded the WHO limitsindicating some level of pollution in Lake Geriyo. Zn was the only heavy metal that was within the WHO guide line. The results of the study implies that continuous monitoring of these parameters has to be carried out to ascertain the long-term impact of anthropogenic inputs to take remedial measures so as to ensure the health of aquatic life.

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