Studies on the Heavy Metal Content in a Sub-Urban Fresh Water Lake in Warangal District, Telangana, India.

P.Gowri

Department of Zoology, Govt. Degree College, Bhupalpally

DOI: 10.29322/IJSRP.13.01.2023.p13324
http://dx.doi.org/10.29322/IJSRP.13.01.2023.p13324

Paper Received Date: 2nd December 2022
Paper Acceptance Date: 3rd January 2023
Paper Publication Date: 16th January 2023

Abstract- The Heavy metals are most vulnerable environmental pollutants and their toxicity has been increasing significantly in the environment. The present study, evaluates the levels and occurrence of heavy metals like lead (Pb), chromium (Cr), cadmium (Cd), iron (Fe), zinc (Zn), and copper (Cu) in Chinna waddepally lake of Warangal District, Telangana State. The sampling stations were selected on the basis of the entry of pollutants in the lake. The heavy metal content have shown upward trend and followed the sequence: Fe>Cu>Pb >Zn> Cd>Cr. The area under study receives domestic sewage, and some undesirable activities like, washing of cattle, dumping of garbage, washing of clothes, bathing and idol immersion which take place in a large scale during and after several regular festivals.

Index Terms- Chinna Waddepally Lake, Pollution, Heavy Metals, Water Quality.

I. Introduction

Food chain polluted with toxic heavy metal is an important route for human exposure to toxicants and may cause severe damage to human population hence constant monitoring and a total ban may be done on idol immersion and there is a need to make Chinna waddepally Lake pollution free and the water quality should be monitored time to time and bring it fit for drinking purposes.

The fresh water resources have been continued to contaminated with run-off water from agricultural runoff, containing pesticides, fertilizers, soil particles, poisonous chemicals from industrial effluents, sewage, tannery industry, and household detergents etc,. This signifies the need and importance of developing an efficient, environmental-friendly and potential method of wastewater treatment. Discharge of pollutant can degrade the quality of water, and hence adversely affects the water aquatic organisms and human beings. To maintain the quality of natural water bodies that are subject to pollutants, many models have been developed to assist the managers in making these predictions.

The sources of pollution of the environment by heavy metals include tannary industry, dumping waste sites, and wastes discharged from chemical manufacture industries. The heavy metals from these sources are dispersed in the environment and they contaminate soil, water and air. They also (directly or indirectly through plants) get into human and animal bodies. Heavy metal pollution of surface and underground water sources results in considerable soil pollution and pollution increases when mines ores are dumped on the ground surface for manual dressing [Duruibe et al.,2007].Surface dumping exposes the metals to air and rain. When agricultural soils are polluted, these metals are taken up by plants and consequently accumulate in their tissues. Animals that graze on such contaminated plants and drink polluted waters these metals take their entry into the body. The marine organisms that breed on heavy metal polluted waters also accumulated by such metals of their body tissues, and pass through the milk during lactating [Garbarino et al., 1995]. Human beings are in turn exposed to heavy metals by consuming contaminated plants and animals, and this has been known to result in various biochemical and metabolic disorders. Therefore, all living organisms within the given ecosystem were contaminated through their cycles of food chain.

II. MATERIALS AND METHODS

For the determination of heavy metals in the lake water, 250 ml of surface water were collected in triplicate from each of the five sites in the colored, sterilized bottle and preserved with adding 1.0 ml concentrated HNO3. Suspended particulate matter was separated by filtering water samples through 0.45-µm Whatman GF/C filters. Sampling was done during the 2019-2020 in pre-monsoon, monsoon and post-monsoon seasons. Sampling was usually done in the morning hours before 8 AM. Sample bottles were acid washed a day before sampling day in 1-2% HNO3 solution, rinsed in distilled water and then dried in drying oven. During every sampling, total five samples of water were collected manually on a rowing boat by submerging pre-cleaned polyethylene bottles approximately 50 cm beneath the water surface and 8-9 feet deep from the bank of the lake by holding the bottles upward. Sample bottles were immediately transferred to the laboratories for the estimation of various heavy metals content in lake water [Singh et al,.2011]. For analyzing the heavy metal content of water, 100 ml of water samples were taken and digested using HNO3 and HClO4 in a 5:1 ratio until the white fumes appears, the water digests were filtered and diluted to 10 ml with 0.1N HNO3 solution [Singh et al,.2011]. The filtrate of water was then assayed by AAS (Elico SL-194) for Cd, Zn, Pb, Cu, Cr, Ni, Mn and As. The AAS value of blank (without sample) of each metal was deducted from the sample value for final calculations [APHA, 1995].

Awokunmi *et al*. (2010) in their study of Cadmium, cobalt, chromium, copper, lead, manganese, nickel and zinc levels in soils from a dump site. Mico *et al.*,(2006) employed atomic absorption spectroscopy method in analysis of Cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc in the agricultural soils of Segura River Valley in Spain.

III. RESULTS AND DISCUSSION

The pollution of aquatic systems has become a major concern worldwide (Abdel-Baki, Dkhil, and Al-Quraishy, 2013). There are a variety of sources that will pollute aquatic systems with heavy metals. These include animal matter, wet and dry fallouts of atmospheric particulate matter and human activities. The concentration, bioavailability and toxicity of heavy metals in aquatic systems can be affected by various factors including pH and temperature (Belin, *et al.*, 2013). Water quality in most major rivers in developing and emerging countries can suffer severe decline due to population growth, economic development and human activities in river catchment areas (Schaffner, *et al.*, 2009). Contamination of water-bodies is a major concern in today's era. The biological wealth of a water body is mainly dependent on its water quality and it is of major issue of concern to mankind today. Decrease in water quality (unfit for human consumption) is also attributed to the fact that today most water bodies are been loaded with toxic material and chemicals, human and industrial waste, organic matter and religious rituals of Idol immersions. The under mentioned research work is mainly concerned about the water quality assessment to evaluate the qualitative nature and quantitative extent of pollution in water body during pre-immersion, immersion, and postimmersion of idols in festivals season. Most of the heavy metals, if present beyond permissible limits in water are toxic to human beings, aquatic flora and fauna. It was observed that the values of these parameters significantly increased during the immersion period and then declined slowly in the post-immersion period due to self-purification mechanism of water body. With growing magnitude of these religious activities, pollution load is bound to increase manifold. Increasing lake water pollution causes contamination of the entire food supply chain. Chemical accumulating in aquatic organisms, particularly fish consumed by humans in large quantities, are of special concern because a high retention of toxic substances in fish tissue may be detrimental to human health. The input of biodegradable and non-biodegradable substances deteriorates the lake water quality and enhances silt load in the lake. Problem becomes more acute when dissolution of input in the environment exceeds the decomposition, dispersal, or recycling capabilities. The majority of pollutants entering the lake originate surface run-off from domestic and agricultural sources and idol immersion activities. There are various routes through which heavy metals can pollute aquatic systems. Deposition of atmospheric pollutants on solid surfaces or on the surface of water bodies as well as the erosion of soil is the more natural routes for heavy metal pollution (HosseiniAlhashemi, *et al.*, 2012). The concentration of most metals is usually low in pristine environments (VarolandSen, 2012). According to Harguinteguy *et al.*, (2014) human activities, which include mining, will produce pollutants that are discharged into aquatic systems either in dissolved or suspended form. Heavy metals accumulate in the soils at toxic levels as a result of long term application of untreated waste water and therefore soils irrigated by wastewater accumulate heavy metals in their soil surface (Sonayei *et al.*, 2009). According to (Puri, 2015) immersed non degradable materials contaminate the lake water and bio-accumulate the heavy metals in the biological system, transfer the toxic elements from primary producers to consumers to have an influence on human health.

Zinc:

Zinc (Zn) is a quite important material for enzyme and protein production Mane *et al.,* (2013). Trace metal such as Zn plays a biochemical role in the life processes of all aquatic plants and animals; therefore, they are essential in the aquatic environment in trace amounts. The high value of Zn is possibly caused by industrial activities and mining wastewater input Mulligan *et al.,* (2001).

In the present study the variation of zinc in collected water samples were observed 0.016 mg/L to 0.032 mg/L (August, pre immersion period); 0.012 mg/L to 0.022 mg/L (September, immersion period); 0.12mg/L to 0.023 mg/L (October-post immersion period) respectively. Zinc tends to be found in only trace amounts of unpolluted surface water and groundwater. Nevertheless, it is often found in domestic supplies as a result of iron piping corrosion, tanks and disinfection of brass fittings Dalia *et al.,*(2014) Zinc does not accumulate with continued exposure; rather, body content is modulated by homeostatic mechanisms that act mainly on absorption and liver levels [Walshe et al,.1990]. Zinc has been reported to cause the same signs of illness as does, lead, and can easily be mistakenly diagnosed as lead poisoning. Zinc is considered to be relatively non-toxic, especially if taken orally. However, excess amount can cause system dis-functions that result in impairment of growth and reproduction [Nolan,2003].

Copper

The presence of copper in water is complex and influenced by pH, dissolved oxygen, the presence of oxidizing agents and chelating compounds or ions. In pure water, the copper ion is the more common oxidation state. Copper is an essential nutrient. At high doses it has been shown to cause stomach and intestinal distress, liver, kidney damage and anemia (USEPA). Copper will bio concentrate in many different organs in fish and molluscs. Copper also causes reduced sperm and egg production in many species of fish, such as fathead minnows, as well as early hatching of eggs, smaller fry (newly hatched fish) and increased incidence of abnormalities and reduced survival in the fry (Taub, 2004). In the present study the variation of copper in collected water samples were observed 0.024mg/L to 0.0362mg/L (August, pre immersion period); 0.054mg/L to 0.076mg/L (September, immersion period); 0.048mg/L to 0.064mg/L (October-post immersion period) respectively.Cu is highly toxic to most fishes, invertebrates and aquatic plants than any other heavy metal except mercury. It reduces growth and rate of reproduction in plants and animals. The chronic level of Cu is 0.02-0.2 mgL-1 [Moore and Ramamoorthy,1984]. Copper becomes toxic for organisms when the rate of absorption is greater than the rate of excretion, and as copper is readily accumulated by plants and animals, it is very important to minimize the levels of copper in the waterway.

Lead

Lead is a well-known metal toxicant and it is gradually being phased out of the materials that human beings regularly use. The Fe and Pb concentrations increases significantly at all points. The high level of Pb in lake could be attributed to the sewage and agricultural discharge as well as from idol immersion activities and dust which holds a huge amount of lead from the combustion of petrol in automobile cars [Hardman et al,.1994]. In the present study the variation of Lead in collected water samples were observed 0.049mg/L to 0.078mg/L (August, pre immersion period); 0.082mg/L to 0.098mg/L (September, immersion period); 0.038mg/L to 0.068mg/L (October-post immersion period) respectively. Lead is the most significant toxin of the heavy metals, and the inorganic forms are absorbed through ingestion by food and water, and inhalation [Ferner,2011]. Lead poisoning also causes inhibition of the synthesis of haemoglobin; dysfunctions in the kidneys, joints and reproductive systems, cardiovascular system and acute and chronic damage to the central nervous system (CNS) and peripheral nervous system (PNS) [Ogudegbhu and Muhanga, 2005].

Chromium: (Cr)

Chromium compounds are used as pigments, mordents and dyes in the textiles and as the tanning agent in the leather. Anthropogenic sources of emission of Cr in the surface waters are from domestic wastes, laundry chemicals, paints, leather, road run off due to tire wear, corrosion of bushings, brake wires and radiators etc. Acute toxicity of Cr to invertebrates in highly variable, depending upon species. For invertebrates and fishes, its toxicity is not much acute. Chromium is generally more toxic at higher temperatures. Weathering of the earth crust is the primary and natural source of the chromium in the surface water. Though an essential trace nutrient and a vital component for the glucose tolerance factor, chromium toxicity damages the liver, lungs and causes organ hemorrhages [Dixit and Tiwari,2008]. In the present study the variation of Chromium in collected water samples were observed 0.012mg/L to 0.021 mg/L (August, pre immersion period); 0.012mg/L to 0.022 mg/L (September, immersion period); 0.012mg/L to 0.021mg/L (October-post immersion period) respectively. The high level of Cr in waste water effluent indicates excessive pollution from textile industries and tanneries (Lokhande, 2011).Many chromium compounds are relatively water insoluble. Chromium compounds are water insoluble because these are largely bound to floating particles in water. Chromium oxide and chromium hydroxide are the only water soluble compounds (Puri*et al.,* 2011).Lead and Chromium, which are part of colorful paints on idols, come into the water bodies. These heavy metals are very toxic even in very small quantity for human being through the process known as Bioaccumulation and Bio-magnifications. The input of biodegradable and non-biodegradable substances deteriorates the water quality and enhances silt loaded in the water bodies. The floating materials released through idol in the river and lake after decomposition result in eutrophication of the lakes.

Cadmium

Paint contents heavy metals such as chromium, lead, cadmium and mercury. The chemical paints used to decorate the idols increases heavy metals concentration. The concentration of Cd sharply increases in the month of September and October after the idol immersion activity as most of the heavy metal load is through the dissolved paints and pigments. In the present study the variation of Cadmium in collected water samples were observed 0.022mg/L to 0.044mg/L (August, pre immersion period); 0.062mg/L to 0.082mg/L (September, immersion period); 0.016mg/L to 0.056mg/L (October-post immersion period) respectively.

The 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 mgL-1 [Green et al., 1986]. The higher levels of Cd obtained in Chinna Waddepally lake water samples relative to the amount in sediment might be due to contribution from other source such as agricultural runoff where fertilizers are used in addition to possible release of sediment bound metal also due to immersion activities. The water runoff may carry higher concentrations of these metals, which arise from anthropogenic activities such as industrial and municipal wastewater and use of chemical fertilizers and pesticides in agricultural [Zacharias,2002].

Manganese

Manganese, although is not a toxic metal, it imparts objectionable and tenacious stains to laundry plumbing fixtures. It is found to occur in the domestic waste water. According to the International standards for drinking water maximum allowable limit of Mn is 0.05 mg/L, based largely on staining rather than toxicity, has been prescribed by WHO [Sindhu and Rashmi,2002]. In the present study the variation of Manganese in collected water samples were observed 0.048mg/L to 0.072 mg/L (August, pre immersion period); 0.072mg/L to 0.094mg/L (September, immersion period); 0.064mg/L to 0.090mg/L (October post immersion period) respectively.

Iron

The concentration of Fe was found to be very high in Chinna Waddepally lake water samples collected from different sampling sites, mainly due to inflow of surface run of from hill torrents and agricultural wastes. (Agricultural and rocks) Exchangeable Fe usually relates to adsorbed metals on the sediment surface can be easily remobilized into Chinna Waddepally lake water. In the present study the variation of Iron in collected water samples were observed 0.078mg/L to 0.242mg/L (August, pre immersion period); 0.194mg/L to 0.321mg/L (September, immersion period); 0.098mg/L to 0.242mg/L (October-post immersion period) respectively. High concentration of iron generally causes inky flavour, bitter and astringent taste (Hassan, 2012). It can also dis-colour clothes, plumbing fixtures and scaling which encrusts pipes.

IV. CONCLUSION

The study provides information on the extent of heavy metal pollution in Lake Chinna Waddepally over time. The Chinna Waddepally Lake, in its most part is muddy due to the accumulation of silt but towards the north-western side, it has hard and clayey substratum. The monthly variation in concentration of heavy metals had definite upward trends. Higher concentration of heavy metals was recorded in pre-monsoon whereas minimum in monsoon season, due to dilution factor. The present study reveals that Fe, Cr, Pb and Mn are present in relatively higher concentrations. As the Chinna Waddepally Lake is also used for fishing, irrigation purposes, it is quite evident that these heavy metals may enter the food chain, and thus through bio-magnifications may enter the human body as well. The heavy metal content have shown significant increase during and after immersion of idols and then declined in the post immersion period. The heavy metal content followed the order Fe>Mn>Pb>Cu>Cr>Cd>Zn> As. myth logically river, lake water bodies are related with religious sentiments but scientifically these are not suitable for human uses. These religious activities can’t stop but awareness among people and proper way such as installation of various artificial ponds through which idol immersion practice can be carried out without harming environment. Discharge of pollutant can degrade the quality of water, and hence adversely affect the water beneficial uses as well as the health of its aquatic ecosystem. To manage the quality of natural water bodies that are subject to pollutant inputs, many models have been developed to assist managers in making these predictions. The suggested measure to improve Chinna Waddepally lake water quality should include blanket ban on idol immersion activities.

TABLE : 3.1- MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 1 DURING THE YEAR 2019-2020

Sl. No.	Parameters	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Min	Max
1	Lead (Pb)	0.3	0.2	0.45	0.75	1.2	1.8	1.7	1.55	1.4	1.5	1.65	1.75	0.2	1.8
2	Nickel (Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		
3	Chromium (Cr)	0.15	0.09	0.06	0.08	0.09	0.13	0.11	0.08	0.07	0.15	0.2	0.25	0.06	0.25
4	Copper (Cu)	0.5	0.75	0.95	1.35	1.5	1.8	1.42	1.25	1.31	1.28	1.35	1.43	0.5	1.8
5	Zinc (Zn)	0.86	0.45	0.52	0.6	1.25	1.22	1.15	1.2	1.05	0.95	1.25	1.18	0.45	1.25
6	Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
7	Cadmium (Cd)	0.05	0.04	0.06	0.03	0.08	0.5	0.2	0.4	0.2	0.15	0.24	0.33	0.03	0.5
8	Iron (Fe)	0.43	0.38	0.45	0.4	0.75	0.62	0.53	0.7	0.65	0.56	0.66	0.73	0.38	0.75

TABLE : 3.2 - MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 2 DURING THE YEAR 2019-2020

Sl. No.	Parameters	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Min	Max
1	Lead (Pb)	0.42	0.35	0.48	0.55	0.85	1.22	1.05	0.94	0.8	0.95	1.1	1.15	0.35	1.22
2	Nickel (Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		
3	Chromium (Cr)	0.05	0.05	0.03	0.06	0.1	0.23	0.13	0.9	0.84	0.68	0.89	0.95	0.03	0.95

4	Copper (Cu)	1.5	1.6	1.4	1.2	1.7	1.5	0.75	1.32	0.98	1.15	0.96	1.16	0.75	1.7
5	Zinc (Zn)	0.75	0.58	0.67	0.53	1.15	0.97	0.85	0.68	0.42	0.68	0.95	1.25	0.42	1.25
6	Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
7	Cadmium (Cd)	0.04	0.04	0.03	0.05	0.07	0.15	0.11	0.09	0.087	0.05	0.075	0.09	0.03	0.15
8	Iron (Fe)	0.64	0.57	0.54	0.76	2.9	3.26	2.18	0.83	0.74	0.62	0.46	0.59	0.46	3.26

TABLE : 3.3- MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 3 DURING THE YEAR 2019-2020

Sl. No.	Parameters	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Min	Max
1	Lead (Pb)	0.35	0.25	0.33	0.47	0.58	0.73	0.95	0.72	0.48	0.36	0.45	0.75	0.25	0.95
2	Nickel (Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		
3	Chromium (Cr)	0.1	0.05	0.03	0.05	0.6	0.05	0.06	0.03	0.03	0.04	0.02	0.02	0.02	0.6
4	Copper (Cu)	0.57	0.42	0.57	0.86	0.93	0.78	0.95	1.15	0.52	0.63	1.05	1.16	0.42	1.16
5	Zinc (Zn)	0.15	0.24	0.19	0.25	0.46	0.28	0.35	0.43	0.51	0.23	0.31	0.27	0.15	0.51
6	Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
7	Cadmium (Cd)	0.004	0.003	0.003	0.004	0.007	0.005	0.007	0.004	0.003	0.004	0.005	0.003	0.003	0.007
8	Iron (Fe)	0.35	0.42	0.31	0.53	1.25	1.73	1.37	1.8	1.5	1.7	1.36	1.17	0.31	1.8

TABLE : 3.4 - MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 4 DURING THE YEAR 2019-2020

Sl. No.	Parameters	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Min	Max
1	Lead (Pb)	0.3	0.45	0.58	0.85	1.5	1.8	1.4	1.5	1.3	1.5	1.25	1.15	0.3	1.8
2	Nickel (Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		
3	Chromium (Cr)	0.04	0.03	0.04	0.03	0.04	0.2	0.27	0.15	0.08	0.06	0.05	0.03	0.03	0.27
4	Copper (Cu)	1.2	1.5	1.7	1.4	1.85	2.15	1.9	1.75	1.25	1.5	1.1	0.95	0.95	2.15
5	Zinc (Zn)	0.5	0.63	0.47	0.55	0.74	0.95	1.2	0.85	0.35	0.44	0.55	0.4	0.35	1.2
6	Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
7	Cadmium (Cd)	0.04	0.05	0.08	0.06	0.1	0.17	0.13	0.08	0.05	0.07	0.06	0.03	0.03	0.17
8	Iron (Fe)	0.33	0.25	0.4	0.35	0.95	0.78	0.85	0.63	0.75	0.7	0.85	0.63	0.25	0.95

Fig.1-MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 1DURING THE YEAR 2019-2020

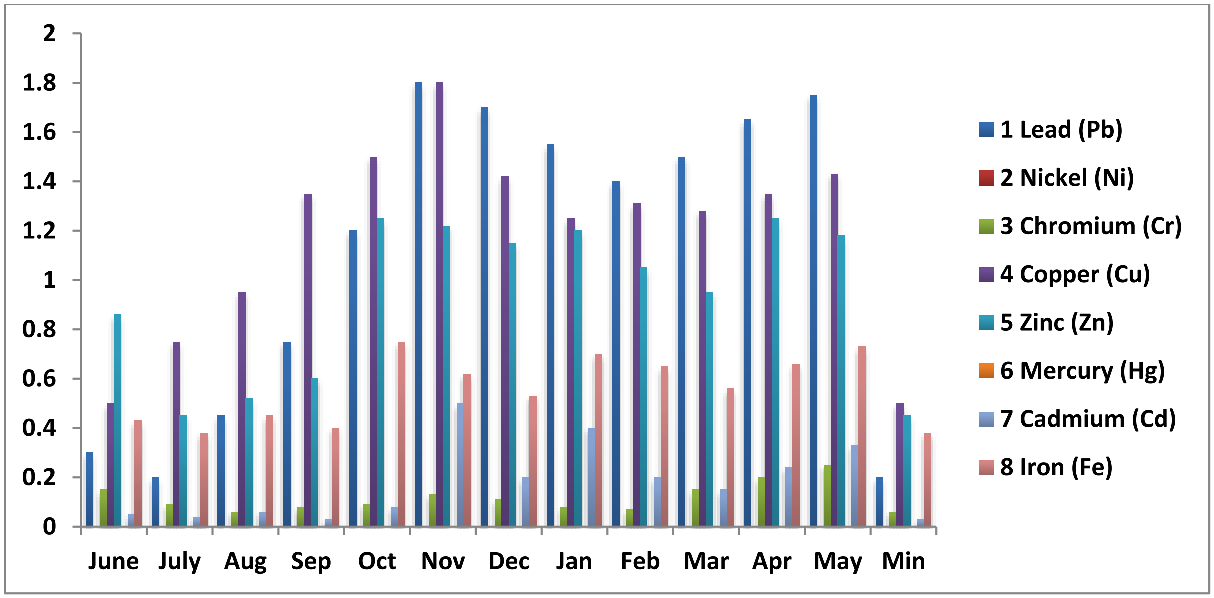


Fig.2-MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 2 DURING THE YEAR 2019-2020

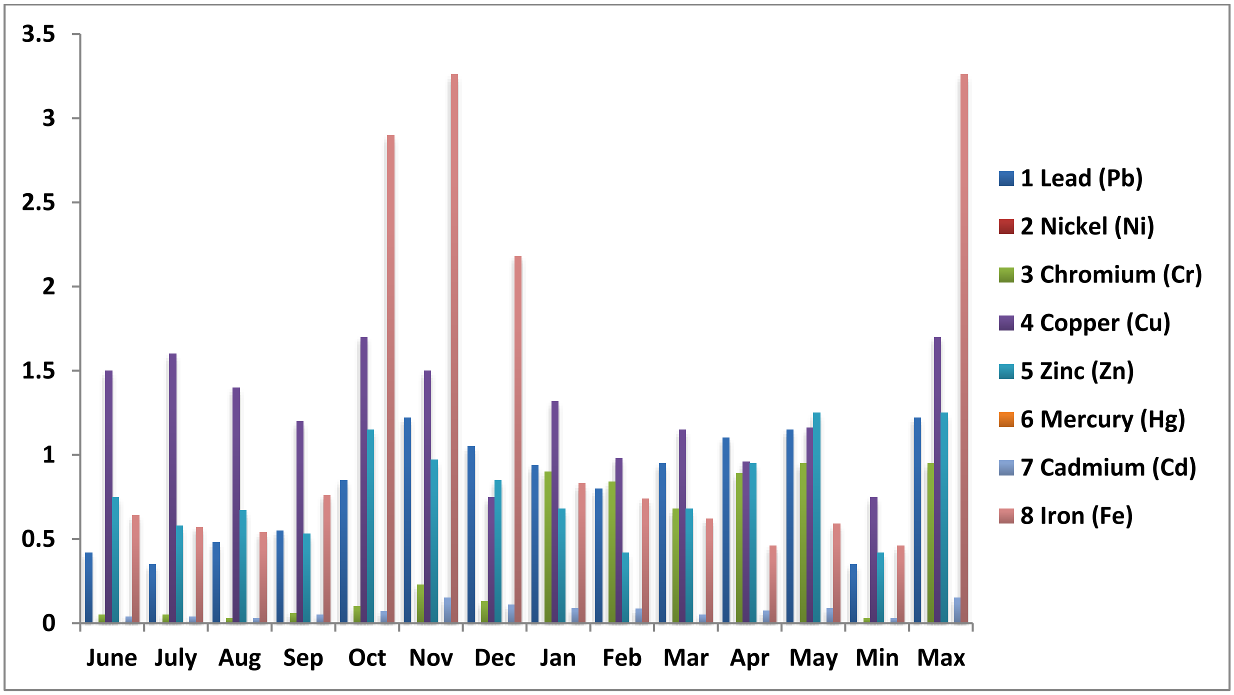


Fig.3-MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 3 DURING THE YEAR 2019-2020

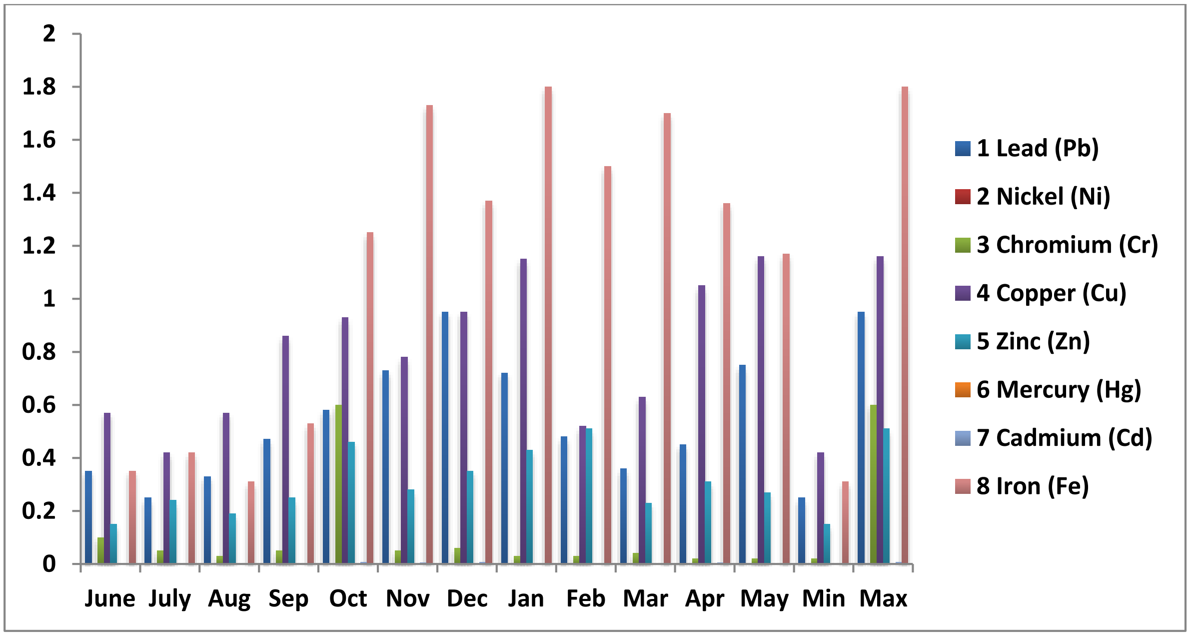
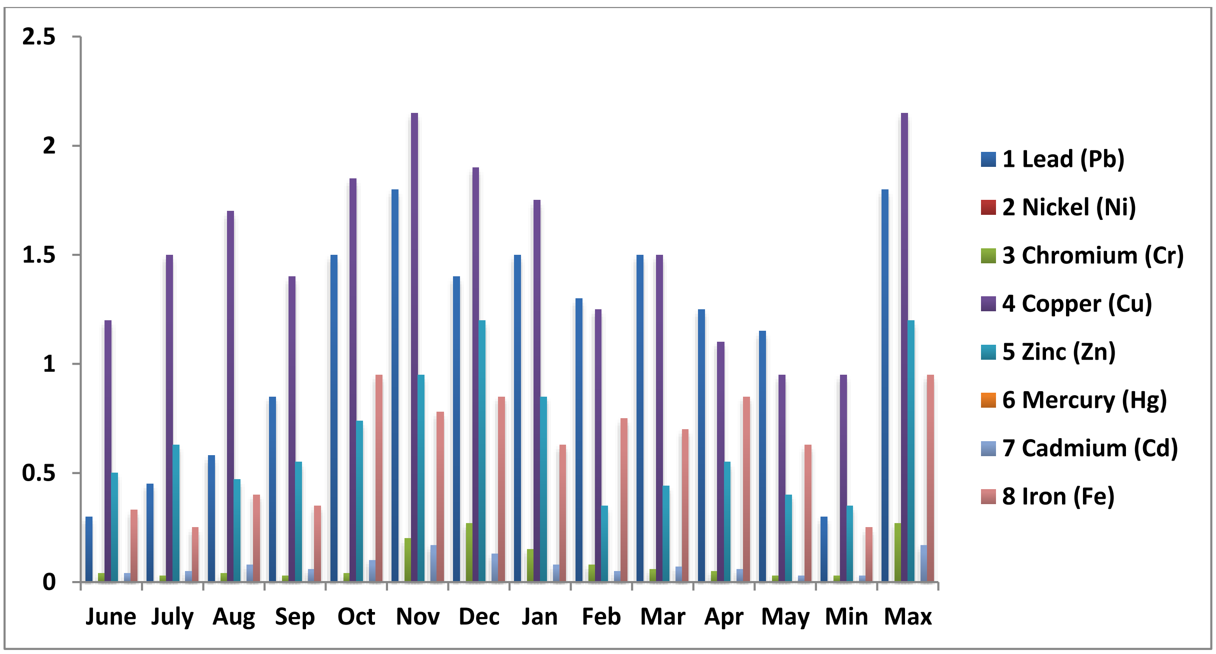


Fig.4-MONTHLY VARIATIONS OF HEAVY METALS (mg/l) AT CHINNA WADDEAPALLY LAKE SITE- 4 DURING THE YEAR 2019-2020



REFERENCES

[1] Abdel-Baki, A., Dkhil, M., & Al-Quraishy, S. (2013).Bioaccumulation of some heavy metals in tilapia fish relevant to their concentration in water and sediment of Wadi Hanifah, Saudi Arabia. African Journal of Biotechnology, 10(13), 2541–2547.

[2] APHA, Standard methods for examination of water and waste water. American Public Health Association, Washington,USA, 1995.

[3] Bajpaiz, A., Vyas A., Verma N, Mishra D.D. Poll, Res, 2008, 27(3),517-522.

[4] Banat, I.M., Hassan, E.S. El-Shahawi, M.S. and Abu-Hilal. A.H., Environ, Inter., 1998, 24(2): 109-116.

[5] Belin, S., Sany, T., & Salleh, A. (2013). Heavy metal contamination in water and sediment of the Port Klang coastal area , Selangor , Malaysia, 2013–2025.

[6] Dixit S and Tiwari S. Int. J. Environ. Res. 2008, 2(1), 37-42.

[7] Ferner D J, Toxicity, heavy metals, e-Med. J.2011, 2(5)1.

[8] Green, W.J., Canfield, D.E., Lee, G.F. and Jones, R.A., Vally, Antatica Hydrobiol., 1986, 134: 237-248.

[9] Hardman, D.J., Mcelodowney, S. and Watte, S., Longman Scientific Technical, England. 1994.

[10] Harguinteguy, C. A., Cirelli, A. F., & Pignata, M. L. (2014). Heavy metal accumulation in leaves of aquatic plant Stuckenia filiformis and its relationship with sediment and water in the Suquía river(Argentina). Microchemical Journal, 114, 111–118.

[11] Hosseini Alhashemi, A., Sekhavatjou, M. S., Hassanzadeh Kiabi, B., & Karbassi, A. R. (2012). Bioaccumulation of trace elements in water, sediment, and six fish species from a freshwater wetland, Iran. Microchemical Journal, 104, 1–6.

[12] International standard for drinking water quality WHO, Geneva, 2004.

[13] Moore, J.W. and Ramamoorthy, S. Springer-Verlag, New York, 1984, 28-246

[14] Nolan K., Copper Toxicity syndrome J., 2003, 12(4), 270-283.

[15] Ogudegbhu MOC, Muhanga W, Zambia, J. Environ.2005, (1): 66-75.

[16] Schaffner, M., Bader, H.-P., & Scheidegger, R. (2009).Modeling the contribution of point sources and non-point sources to Thachin River water pollution.The Science of the Total Environment, 407(17), 4902–15.

[17] Sindhu, P.S., and Rashmi, S., Eco. Environ. Cons., 2002, 8(3), 289-292.

[18] Singh, J., Upadhyay, S.K., Pathak, R.K. and Gupta, V. Toxicol. Environ. Chem., 2011, 93(3): 462-473.

[19] Sonayei, Y.; Ismail, N. and Talebi, S. (2009). Determination of heavy metals in Zayandeh Road River, Isfahan-Iran. World Applied Sciences Journal;6:1204-1214.

[20] Varol, M., & Şen, B. (2012).Assessment of nutrient and heavy metal contamination in surface water and sediments of the upper Tigris River, Turkey. CATENA, 92, 1–10.

[21] Walshe, C.T., Sandstead H.H. and Prasad A.S, Health precept, 1990, 102(2), 5-46.

[22] Zacharias, I, Bertachas I, Skoulikides N., Res Magnt, 2002, 7, 55-62

AUTHORS

First Author – P.GOWRI, Department of Zoology, Govt. Degree College, BHUPALPALLY, E-mail: sirija2003@gmail.com