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Assessment of heavy metals content due to idol immersion activities in surface water body (Futala Lake)

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ABSTRACT

Heavy metals are important environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary and environmental reasons. In the present study, level of occurrence of heavy metals like lead (Pb), arsenic (As), chromium (Cr), cadmium (Cd), iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) were estimated in Futala Lake, Nagpur city, Maharashtra, India. The monitoring was made over a period of three months viz. August (pr-immersion period), September (immersion period) and October (post-immersion period) respectively. The sampling points were selected on the basis of their importance. The heavy metal content had upward trends and followed the sequence: Fe> Mn> Pb> Cu> Cr >Cd> Zn>As. The area under study receives domestic sewage (poor) from pollution habitation, so also the activities like, cattle washing, dumping of garbage, cloth washing, bathing and idol immersion activities in large extent during and after festival seasons. Food chain polluted with toxic heavy metal is an important route for human exposure and may cause several dangerous effects on human hence constant monitoring and total ban on idol immersion activities is needed to maintain Futala Lake water quality fit for useful purposes.

Keywords: Heavy metal, Lake, Pollution, Idol immersion, Water quality

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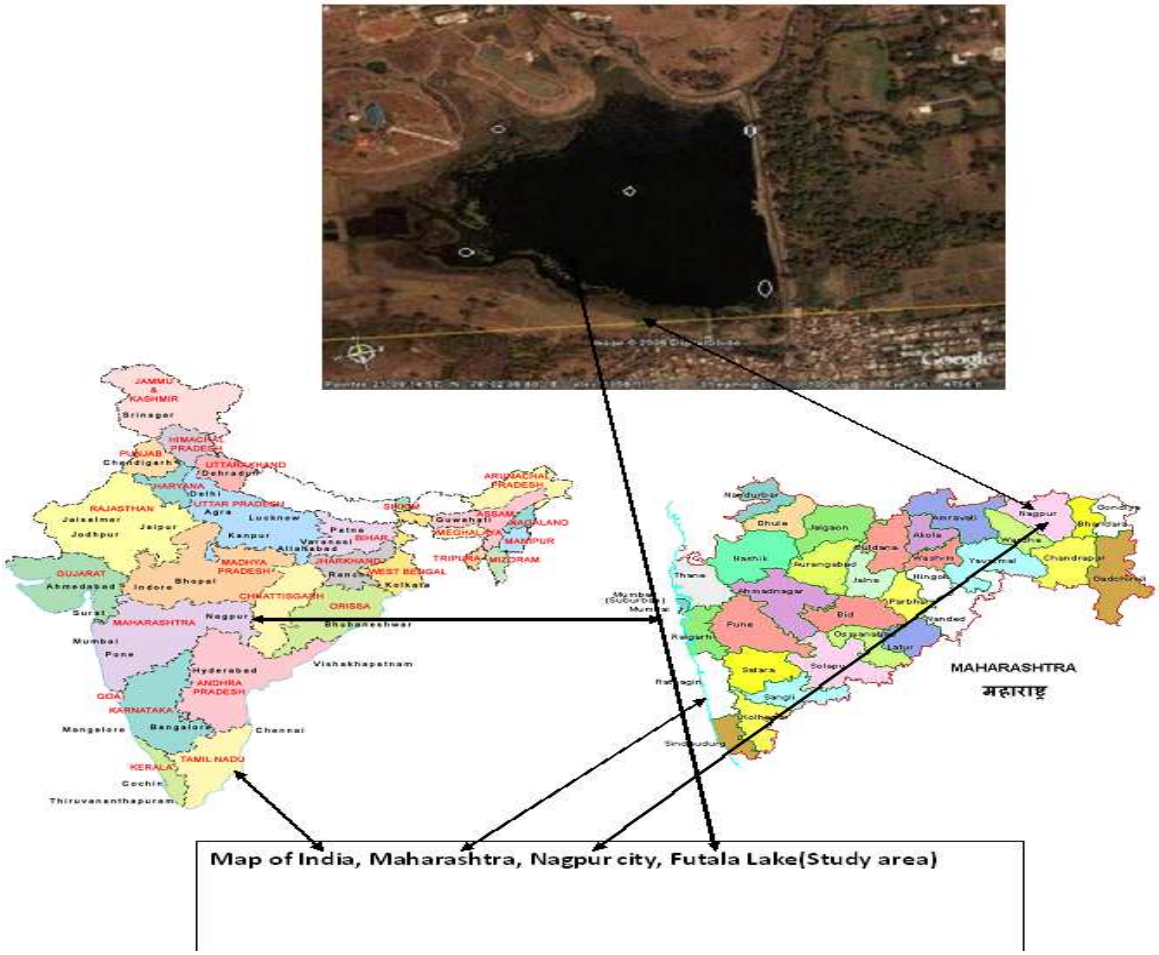
INTRODUCTION

Heavy metals are a group of elements with a mass density greater than 4.5 g/cm^2, which tend to release electrons in chemical reactions and form simple cations. In the solid and liquid states they are characterized by good heat and electrical conductivity, and are glossy and opaque. They have high melting and boiling points. They are malleable with usually monatomic pairs. The metals classified as heavy metals include: Cu, Co, Cr, Cd, Fe, Zn, Pb, Sn, Hg, Mn, Ni, Mo, V, W Within the group of heavy metals one can distinguish both the elements essential for living organisms (microelements) and the elements whose physiological role is unknown, and thus they are “inactive” towards plants, animals and people. The metals serving as microelements in living organisms usually occur in trace amounts that are precisely defined for each species. Both their deficiency and excess badly affect living organisms. The strongest toxic properties are characteristic for inorganic metals compounds, which dissociate well and are easily soluble because they can easily penetrate through cell membranes and get into internal organs. These metals accumulate mainly in kidneys, the adrenal gland, liver, lungs, hair and skin, and they may cause high blood pressure, cancerous changes, damage to kidneys, liver and brain. In some cases they may also lead to mental disorders and loss of brain function. [1] The circulation and migration of metals in the natural environment are mainly related to such processes as rock decay, volcano eruptions, evaporation of oceans, forest fires and soil formation processes.

The sources of anthropogenic contamination or pollution of the environment by heavy metals include different branches of industry, the power industry, transport, municipal waste management, waste dumping sites, fertilizers and waste used to fertilize soil. 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 mined ores are dumped on the ground surface for manual dressing [2]. 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 from polluted waters; as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues, and milk, if lactating [3]. Humans are in turn exposed to heavy metals by consuming contaminated plants and animals, and this has been known to result in various biochemical disorders. In summary, all living organisms within a given ecosystem are variously contaminated along their cycles of food chain.



Map of India, Maharashtra, Nagpur city, Futala Lake(Study area)

STUDY AREA

Nagpur city is one of India's fastest growing cosmopolitan cities. The city is spread in an area of about 220 Km^2. The road length of city under the Nagpur Municipal Corporation (NMC) is 1200 Km. Nagpur city is situated at an altitude of over 290 meters above sea level rising up to 350 meters towards NW, W and SW of the city [4]. In many areas of Nagpur city tap water supply is not available and people are dependent mainly on the ground water sources. In and around Nagpur city (M.S.) there are large numbers of water bodies. Nag River which is a tributary of Kanhan takes it origin from Ambazari and flows towards east through Nagpur city. The Nag river water is completely polluted on account of draining of sewage into river [5]. Lakes are significant resource base of Nagpur city. Some of these are used to supply water for drinking purpose like Gorewada lake and Wena tank. The water

from Futala Lake is used for irrigation and water from Ambazari lake is used for industrial purpose. The Futala Lake with a coordinate of 21º8`44``N and 79º03` 48``E is closed water body. The Fulata lake is spread over 60 acres. The Futala Lake is located at the western side of the Nagpur city. The catchment area of dam is 6.475 sq. km. The length of west weir is 8.0m. Futala lake is having capacity to irrigate an area of 34.42 hectors of cultivated agriculture land and Telenkhedi Garden. The initial purpose for irrigating nearby agricultural land was prominent amongst the utilization of Futala Lake.

The other water bodies in Nagpur city are, namely Gandhisagar lake, Naik Lake, Lendi lake, Sakkardara lake and Khandan lake. In Naik and Lendi lake, the ingress of sewage from nearby locality is rampant. Both of these lakes have been very much encroached by the weeds. This has been resulted into total degradation of Naik and Lendi lake. The major lakes in Nagpur city which once use to be eco-friendly and useful purposed, have lost their grandeur and have rather becomes a source of nuisance. Thus it is quite imperative to know the quality states of these lakes water with a view to renovate them so that these serve for a useful purpose to the society. In order to save these waster bodies (Lakes), which would serve us as, reservoirs of fresh water, fishes and other products for hundreds of years, the studies on the level of their pollution in terms of heavy metal have been undertaken throughout the year.

PROBLEM ON HAND

Festivals are an integral part of rich and diverse cultural heritage of India. Idol worship has been in the practice in India since ancient time. The religious scripts, mythology and rituals have attempted to drive the importance of preserving nature by adoring it through the centuries. To worship god and goddess only natural things like milk, curd, ghee, coconut, beetal, and river water were usually used. In India idol immersion is another anthropogenic activity. The idols of Lord Viswakarma, Lord Ganesh, Goddess Durga etc. are worshipped with all rituals by Hindu are immersed in water bodies between the months of August to October respectively every year. Similarly during the Mohram festival, tazias are being immersed by Muslims in the month of May every year. The time span of festival may vary from one and half day to ten days. Ganesh idols are immersed in water body which includes lakes, river etc. Consequent pollution of such water bodies has been a matter of concern. In addition to silting, toxic chemicals used in making idols tend to leach out and pose serious problems of lake water pollutions. Studies carried out to assess deterioration in lake water quality due to immersion of idols have revealed that lake water quality deteriorates in respects of conductivity, biochemical oxygen demand and concentration of heavy metals. The pollution from Ganesh Chaturthi idols also damages the ecosystem; kills fishes, other marine life and harms other life depended on the water such as birds, animals and human beings. Idols are immersed in lotic or lantic water bodies based on the difference in the water residence time and the flow velocity. However in present day scenario, metals, ornaments, oily substances, synthetic colors, chemical are used to make polish and decorate these idols for worship followed by immersion of these idols in our surrounding aquatic environment which gets severally affected [6]. When the idols are immersed in water bodies, their colors, chemicals, and other components that are used for idol preparation get dissolved and lead to significant changes in the water quality. When immersed, these colors and chemicals dissolve slowly leading to significant alteration in the water quality. 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. Thus too many religious activities and religious fanatics have now become a major threat to the ecosystem. Far eater impact of pollution is seen during the festival season, when immersion of idols in these natural aquatic ecosystems destroyed the whole ecological balance. Futala Lake is subjected to enormous anthropogenic stress, receives heavy inputs of domestic waste and sewage. The Futala lake is used for irrigation, drinking purposes by cattle's, local inhabitant's use it for fisheries and various recreational activities.

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 HNO_3. Suspended particulate matter was separated by filtering water samples through 0.45-µm Whatman GF/C filters. Sampling was done during pre-monsoon, monsoon and post-monsoon. Sampling was usually done in the morning and evening hours. Sample bottles were acid washed a day before sampling day in 1-2% HNO_3 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 (PE) 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 [7]. For analyzing the heavy metal content of water, 100 ml of water samples were taken and digested using HNO_3 and $HClO_4$ in a 5:1 ratio until the white fumes appears, the water digests were filtered and diluted to 10 ml with 0.1N HNO_3 solution [7]. 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 [8].

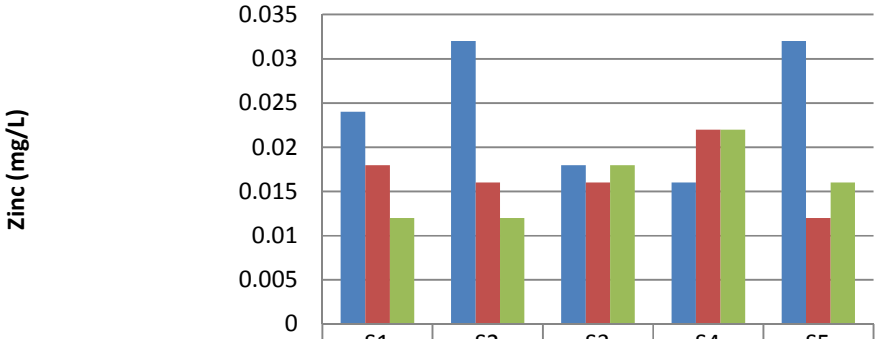
Quality Assurance and quality control

Appropriate quality assurance procedures and precautions were carried out to ensure reliability of the results. Double distilled water was used throughout the study. Glassware was properly cleaned, and the reagents were of analytical grade. Reagents blank determinations were used to correct the instrument readings.

RESULTS AND DISCUSSION

The average results of all the heavy metal parameters for Futala Lake water samples are presented in Table and Chart number 1-7. 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 post-immersion 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.

Chart and Table 1



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.024	0.032	0.018	0.016	0.032
September (Immersion)	0.018	0.016	0.016	0.022	0.012
October (Post-immersion)	0.012	0.012	0.018	0.022	0.016

Zinc

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 annual average concentration of Zn in water

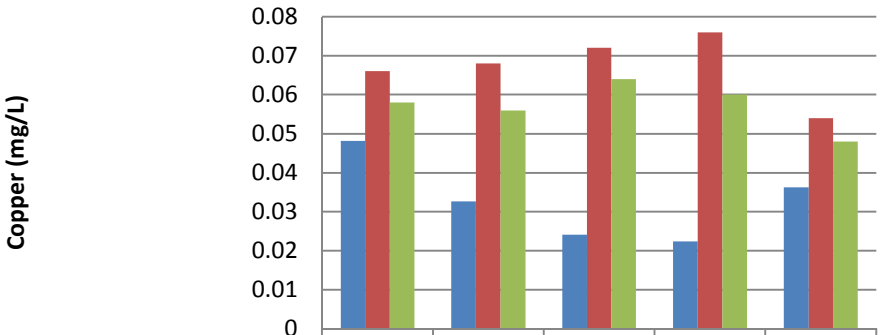
samples of Futala Lake was found to be below the permissible limit set by WHO [9]. Zinc does not accumulate with continued exposure; rather, body content is modulated by homeostatic mechanisms that act mainly on absorption and liver levels [10]. Zinc has been reported to cause the same signs of illness 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 [11]. Variation in zinc in collected water sample were 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.

Copper

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} [12].

The chronic levels of Cu are 0.02-0.2 mg/L. 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. Variation in copper in collected water sample were 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.

Chart and Table 2



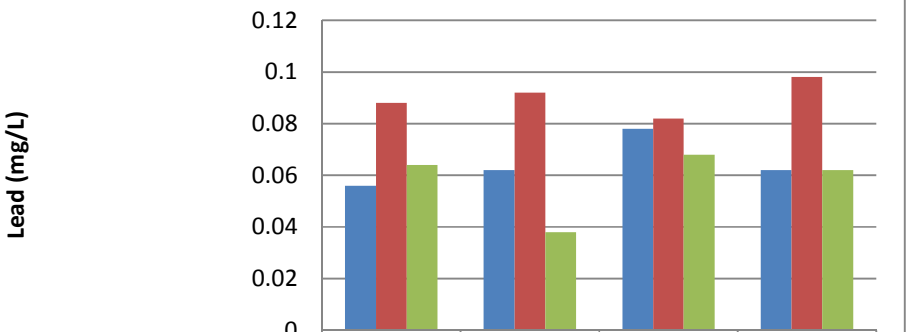
	S1	S2	S3	S4	S5
August (Pre-immersion)	0.0481	0.0326	0.0241	0.0224	0.0362
September (Immersion)	0.066	0.068	0.072	0.076	0.054
October (Post-immersion)	0.058	0.056	0.064	0.06	0.048

Lead

Lead is the most significant toxin of the heavy metals, and the inorganic forms are absorbed through ingestion by food and water, and inhalation [13]. 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) [14]. Lead is one of the oldest metals known to man and is discharged in the lake water through paints, solders, pipes, building material, gasoline etc. Lead is a well known metal toxicant and it is gradually being phased out of the materials that human beings regularly use. Combustion of oil and gasoline account for >50% of all anthropogenic emissions, and thus form a major component of the global cycle of lead. Atmospheric fallout is usually the most important source of lead in the freshwaters. According to the USPH (United States Public Health Drinking Water Standards), the permissible limit for Lead in drinking water is <0.05 mg/L [15]. After heavy downpour in August and September its concentration decreases but in October there is slight increase in its value after the idol immersion activity as Pb is contributed by paints and enamel used to color the idols. Pb also finds its way in the runoff waters of the lake through the vehicle washing and gasoline combustion. The Fe and Pb concentrations increases significantly at all points. The elimination of the major pollution sources such as totally ban on idol immersion activities, and annual monitoring in order to follow the course of pollution will be the main steps for improving the Futala lake water quality. The high level of Pb in Futala lake water 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 [16]. The high level of Pb in water of the Lake can be attributed to heavily traveled roads that run along the lakes and agricultural runoff which contain fertilizers and pesticides. Higher levels of Pb often occur in water bodies near highways and large cities due to high gasoline combustion due to idol immersion activities, lead and chromium which are part of colorful paints on idols gets enter into Futala Lake water bodies [17]. Variation in lead in collected water sample were 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.

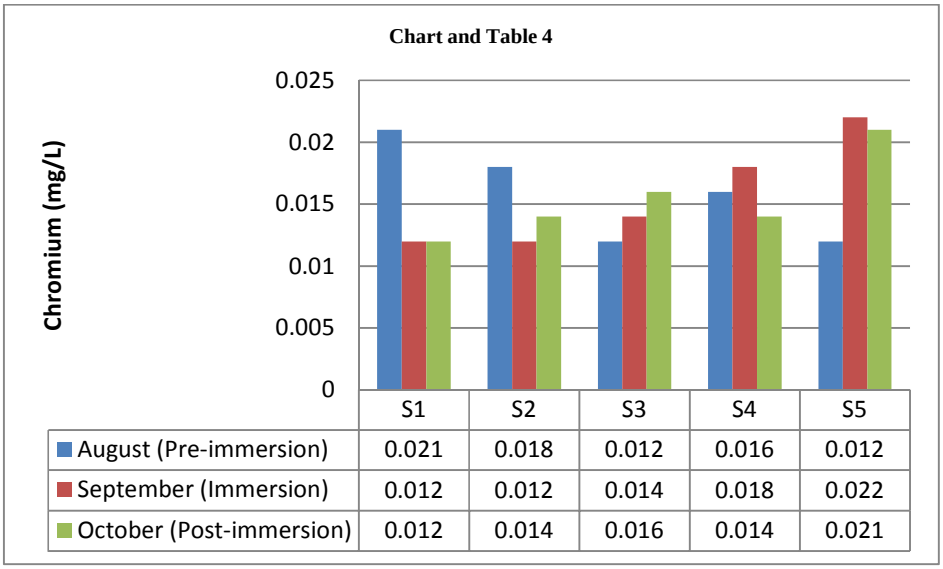
Chart and Table 3



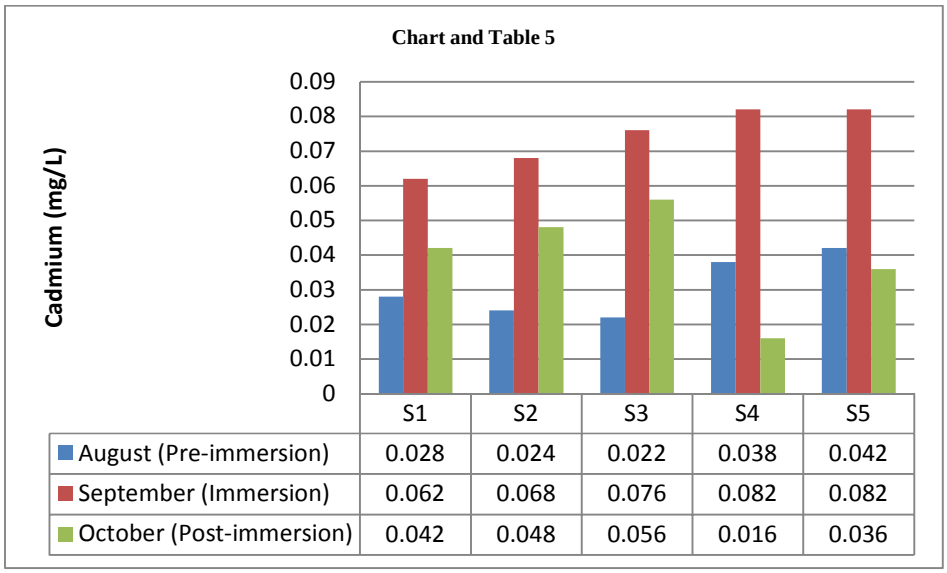
	S1	S2	S3	S4
August (Pre-immersion)	0.056	0.062	0.078	0.062
September (Immersion)	0.088	0.092	0.082	0.098
October (Post-immersion)	0.064	0.038	0.068	0.062

Chromium: (Cr)

In aquatic environment, Cr is one of the bio-chemically active transition metals. The annual average Cr concentration in water samples of Futala Lake was found to be above the permissible limits for consumption and domestic use set by WHO [9]. 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 [18]. 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. According to the USPH standards, the permissible limit for chromium in drinking water 0.05 mg/L. During and after monsoon the concentration gradually decreases, as rainfall flushes out the lake water. 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. Lead and chromium which adds through Sindur during idol immersion, in Futala lake water body, are very toxic, even, in very small quantity for human beings through bioaccumulation and biomagnifications. [19].Variation in chromium in collected water sample were 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.



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.021	0.018	0.012	0.016	0.012
September (Immersion)	0.012	0.012	0.014	0.018	0.022
October (Post-immersion)	0.012	0.014	0.016	0.014	0.021



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.028	0.024	0.022	0.038	0.042
September (Immersion)	0.062	0.068	0.076	0.082	0.082
October (Post-immersion)	0.042	0.048	0.056	0.016	0.036

Cadmium

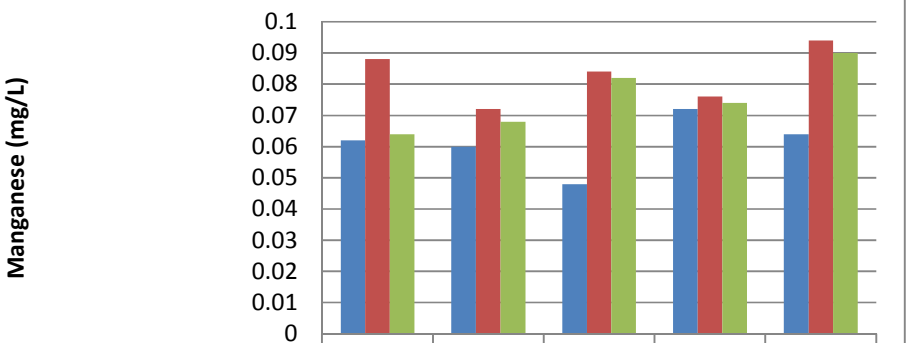
The higher concentration of cadmium is extremely toxic to fish population. Its effects on the growth rate have been observed even for concentrations between 0.005 and 0.01 mgL^{-1} [20]. The annual average Cd concentration in water samples of Futala Lake was found to be above the permissible limit for consumption and domestic use set by standard for surface water, WHO [9]. The higher levels of Cd obtained in Futala 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 [21]. Cadmium is contributed to the surface waters through paints, pigments, glass enamel, deterioration of the galvanized pipes etc. The wear of studded tires has been identified as a source of cadmium deposited on road surfaces. The permissible limit for the drinking water set by WHO is 0.01 mg/L [22]. 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. Variation in cadmium in collected water sample were

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.

Manganese

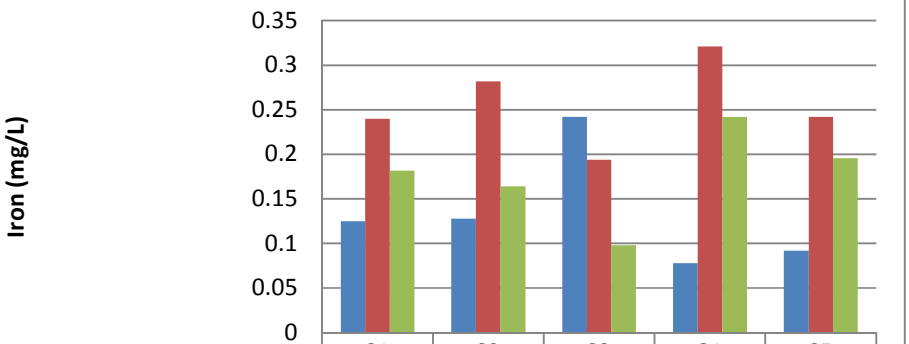
Manganese, although is not a toxic metal, it imparts objectionable and tenacious stains to laundry plumbing fixtures. It is found to occur in the domestic waste water. According to the International standards for drinking water maximum allowable limit of Mn is 0.05 mg/L, based largely on staining rather than toxicity, has been prescribed by WHO [22]. Variation in manganese in collected water sample were 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.

Chart and Table 6



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.062	0.06	0.048	0.072	0.064
September (Immersion)	0.088	0.072	0.084	0.076	0.094
October (Post-immersion)	0.064	0.068	0.082	0.074	0.09

Chart and Table 7



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.125	0.128	0.242	0.078	0.092
September (Immersion)	0.24	0.282	0.194	0.321	0.242
October (Post-immersion)	0.182	0.164	0.098	0.242	0.196

Iron

The concentration of Fe was found to be very high in Futala 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 Futala lake water. Variation in iron in collected water sample were 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.

Arsenic

Similar to lead and mercury, arsenic toxicity symptoms depend on the chemical form ingested [13]. Arsenic acts to coagulate protein, forms complexes with coenzymes and inhibits the production of adenosine triphosphate (ATP) during respiration [23]. No special variation was observed in case of arsenic, however in collected water samples, arsenic always remained below detectable limit (BDL) throughout study period.

CONCLUSION

The study provides information on the extent of heavy metal pollution in Lake Futala over time. The Futala 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 Futala 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. Mythologically 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. The suggested measure to improve Futala lake water quality should includes blanket ban on idol immersion activities.

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REFERENCES

[1] Szyczewski P.; Siepak J, ; Niedzieiski P; Sobcrynski T *Polish J of Environ Stud*. **2009,** 18,5,755-768
[2] Duruibe J. O., Ogwuegbu M.O.C and Egwurugwu J.N., *Int. J. Phy. Sci*. **2007,** 2(5), 112-118
[3] Garbarino JR, Hayes H, Roth D, Antweider R, BrintonT I, Taylor Virginia, U.S.A. **1995,** 1133,
[4] P.C. Pande, K. Suryanarayan and G.G. Deshpande, *Mineral Research*,**1969,** 2(20)
[5] S. P. Pande, V.S. Narayanswami, and M. Z. Hasan, *Indian, J. Environ. Hlth*., **1979,** 21(1), 35
[6] Mehta, P. *THE EXPERIMENT*, **2013**, 17(1), 1161-1176
[7] Singh, J., Upadhyay, S.K., Pathak, R.K. and Gupta, V. *Toxicol. Environ. Chem*., **2011,** 93(3): 462-473.
[8] APHA, Standard methods for examination of water and waste water. American Public Health Association, Washington,USA, **1995.**
[9] International standard for drinking water quality WHO, Geneva, **2004.**
[10] Walshe, C.T., Sandstead H.H. and Prasad A.S, *Health precept*, **1990,** 102(2), 5-46.
[11] Nolan K., *Copper Toxicity syndrome J.*, **2003,** 12(4), 270-283.
[12] Moore, J.W. and Ramamoorthy, S. Springer-Verlag, New York, **1984,** 28-246.
[13] Ferner D J, Toxicity, heavy metals, e-*Med. J*.**2011,** 2(5)1.
[14] Ogudegbhu MOC, Muhanga W, Zambia, *J. Environ*.**2005,** (1): 66-75.
[15] De, A.K., Environmental Chemistry, 4th Ed., New Age International (P) Ltd., New Delhi,**2002,** 232-272.
[16] Hardman, D.J., Mcelodowney, S. and Watte, S., Longman Scientific Technical, England. **1994.**
[17] Banat, I.M., Hassan, E.S. El-Shahawi, M.S. and Abu-Hilal. A.H., *Environ, Inter*., **1998,** 24(2): 109-116.
[18] Dixit S and Tiwari S. *Int. J. Environ. Res*. **2008,** 2(1), 37-42.
[19] Bajpaiz, A., Vyas A., Verma N, Mishra D.D. *Poll, Res*, **2008,** 27(3),517-522.
[20] Green, W.J., Canfield, D.E., Lee, G.F. and Jones, R.A., Vally, *Antatica Hydrobiol*., **1986,** 134: 237-248.
[21] Zacharias, I, Bertachas I, Skoulikides N., *Res Magnt*, **2002,** 7, 55-62
[22] Sindhu, P.S., and Rashmi, S., *Eco. Environ. Cons*., **2002,** 8(3), 289-292.
[23] Institute of Environmental Conservation and Research INECAR. Ateneo de naga University, Philippines, **2000.**