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Impact Assessment of Heavy Metal Pollution of Shahpura Lake, Bhopal, India

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ABSTRACT: Monitoring and Assessment of water has become environmental concern due to the contamination by man kind. One of the most important crises of the 21st century is the availability of drinking water, a resource basic to our survival and growth. Most of the fresh water bodies all over the world are getting polluted thus decreasing the suitability of the fresh water. The area of the study, selected to estimate the levels of water pollution is the Shahpura lake of Bhopal, the state capital of Madhya Pradesh Province of India. The area under study receives domestic raw sewage from surrounding habitation; so also the activities like cattle washing, cloth washing, bathing, religious activities like idol immersion etc paves the way for high concentration of harmful chemicals in the lake water. Parameters like water temperature, concentration of heavy metals like lead, copper, cadmium, manganese, chromium were studied every month for a period of six months and seasonal variations were observed in each of them using standard methods. It was found that the concentration of the heavy metals in the lake water substantially increased after the religious activities like idol immersion around August and September. These heavy metals have a marked effect on the aquatic flora and fauna which through bio magnification enter the food chain and ultimately affect the human beings as well.

Key words: Pigments, Heavy metals, Religious activity, Lake, Sewage

INTRODUCTION

"Just as the world we inherited today is what our past generation left on us, the future generations would inherit the legacy we leave for them."Water is essential for life on earth. Water is a unique liquid, without it, life as we know is impossible. Water the "Elixir of Life" is facing a severe threat due to pollution. Water, due to its great solvent power, is constantly threatened to get polluted easily. The requirement of water in all forms of lives, from micro-organisms to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization Singh, *et al.*, 2002). The topic of our concern here is pollution of lake water. Water pollution refers to any type of aquatic contamination rendering the water body poisoned by toxic chemicals, which affect living organisms and all forms of life. Heavy metals constitute an important group of environmentally hazardous substances. During this century, many lakes in India have received elevated inputs of heavy metals as a result of an increase in atmospheric deposition. To study the extent of pollution in surface waters, we have selected the Shahpura Lake, which is situated in one of the posh localities of Bhopal, the capital city of state of Madhya Pradesh, India. It receives domestic raw sewage from surrounding habitation; so also the activities like cattle washing, cloth washing, bathing, religious activities like idol immersion etc paves the way for high concentration of hazardous chemicals in the lake waters. The domestic waste water contributes the largest source of heavy metal concentration in the lake, so it is expected that this reservoir can serve as a model for studying heavy metal concentration. The immersion of idols of Lord Ganesha and Deity Durga during Ganesh Utsav and Nav Ratris festival is a major source of contamination of lake water. The idol immersion

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activity is an anthropogenic activity which is responsible for adding pollution load in the lake. The idols are being made up of clay, hay, cloth, paper, wood, bamboo, thermo coal, adhesive material, paints, colored pigments etc, Bajpai (2002). Apart from it a large number of heavy metals are contributed by corrosion of metal pipes. Run–off waters from surroundings during rainy season are rich in heavy metals like Cu, Cr, and Pb etc. Lead from automobiles released into atmosphere find its way in the run off waters. The discharge of heavy metals in the environment has much obvious impact on aquatic systems. There may be an increase in residue levels in water, sediments and biota, decreased productivity and increase in exposure of humans to harmful substances, Moore (1984). Prapurna Naga (2002) carried out the analysis of heavy metal ions present in the lake water of Hussain Sagar Lake and found that the very presence of various heavy metal ions in their dissolved state, are hindering the beneficial uses of the lake waters. The area under study having Latitude 23^0 12' 00" E and Longitude 77^0 25' 30" N enjoys a sub-tropical climate with pronounced summer, winter and rainy seasons. The lake, in most parts is muddy due to the accumulation of silt but towards the north-western side, it has hard and clayey substratum. The maximum depth at full tank is 7-8 m and the deepest point lies in the center of the reservoir. The main inlet, the nalla joins the lake at its northern end.

MATERIALS & METHODS

Shahpura Lake is subjected to enormous anthropogenic stress; receive heavy inputs of domestic waste and sewage. The lake water is used for drinking purposes by cattle and the local inhabitants use it for fisheries and various recreational activities. Sampling sites were selected by keeping in mind the feeding sources of the lake. The study period of six months was divided into two seasons based on the intensity and duration of rainfall pre monsoon (summer) and post monsoon (rainy season) i.e., from May 2004 to October 2004. The water samples after collection were subjected to analysis following the procedures prescribed by APHA (1985). The parameters namely temperature, selective heavy metals were analyzed at regular intervals. For the heavy metal analysis, the samples were preserved by adding 5 mL concentrated nitric acid in one liter of sample to maintain the pH below 4.0 following the procedure suggested by Agemian and Chau (1975).The samples were then filtered through Whatmann filter paper No. 40 and the filtrate was directly used for analysis in the Atomic Absorption Spectrophotometer (Perkin Elmer Analyst 100). At the time of sampling the samples are acidified as per standard, international method reference given by APHA, (1985).

RESULTS & DISCUSSION

The water was found to be green in color because of algae and accumulation of nutrients, untreated sewage and eutrophication, having a foul odor during summer. The color of water turns muddy in the rainy season and the intensity of the odor vanish gradually. The green color is due to the floating green algae in the surface waters. High productivity rates are associated with fertile or green colored lakes that experience large algal blooms during summer months. The foul odor is due to the decomposition of organic matter in the water. Seasonal data of temperature is given in Fig. 1.

Temperature is one of the most important ecological feature. It controls behavioral characteristics of organisms, solubility of gases and salts in water. The surface water temperature varied between 31.5 °C to 19 °C in different months. Not much variation is observed at different stations of the same month.Pophali et al (1990) , Dayal, *et al.*, (1994) and Jain, *et al.*, (1995) examine that heavy metal load in water and sediment was also reported in surface water bodies polluted due to urban sewage discharge.Copper salts are used in water supply systems to control biological growth in reservoirs and distribution pipes. The municipal waste and sewage, corrosion of Cu containing pipelines or fittings are the principal anthropogenic source of Cu in the surface waters. Large amounts of Cu in drinking water are toxic, the USPH limit in drinking water is set at 1.0 mg/L.

The maximum concentration of Cu (1.4 mg/L) is reported in the month of May at stations 1 and 4, whereas the minimum concentration 0.16 mg/L is reported at station 2 in the month of June as shown in Fig. 2.

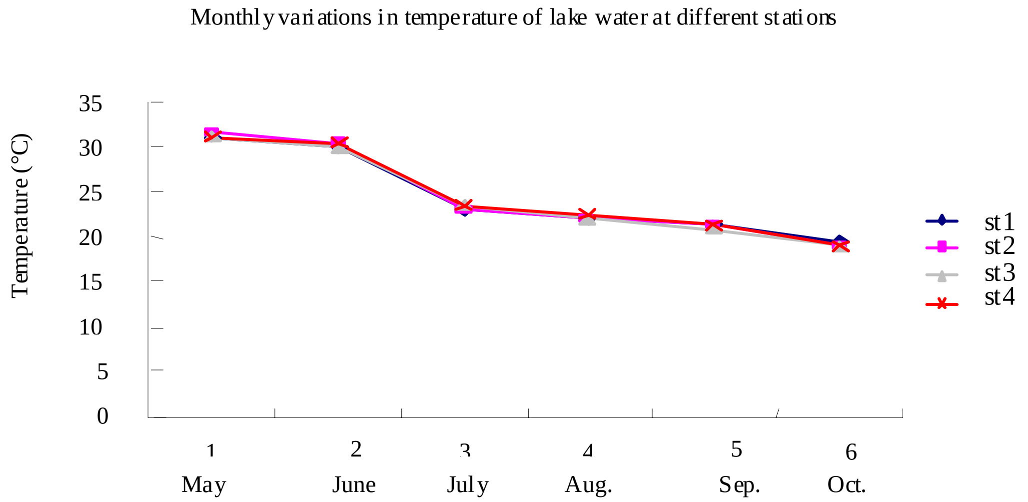

Fig. 1. Graph showing monthly variations in the lake water at different stations

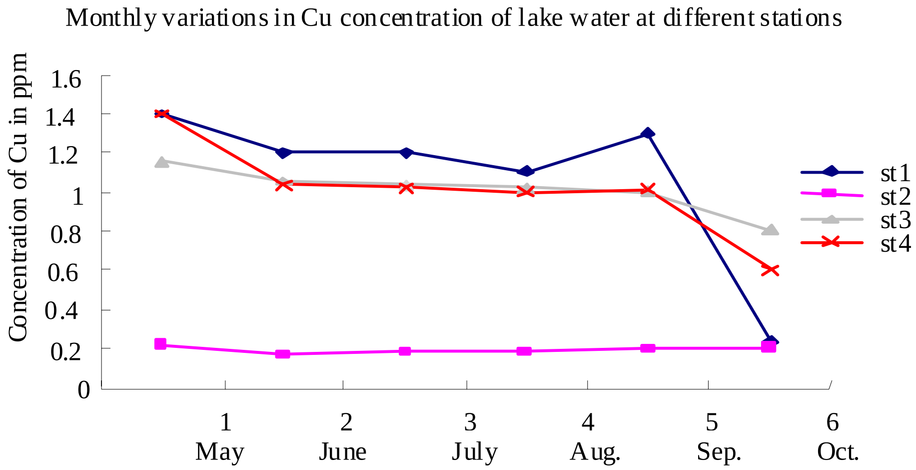

Fig. 2. Graph showing monthly variations in Cu concentration of lake water at different stations

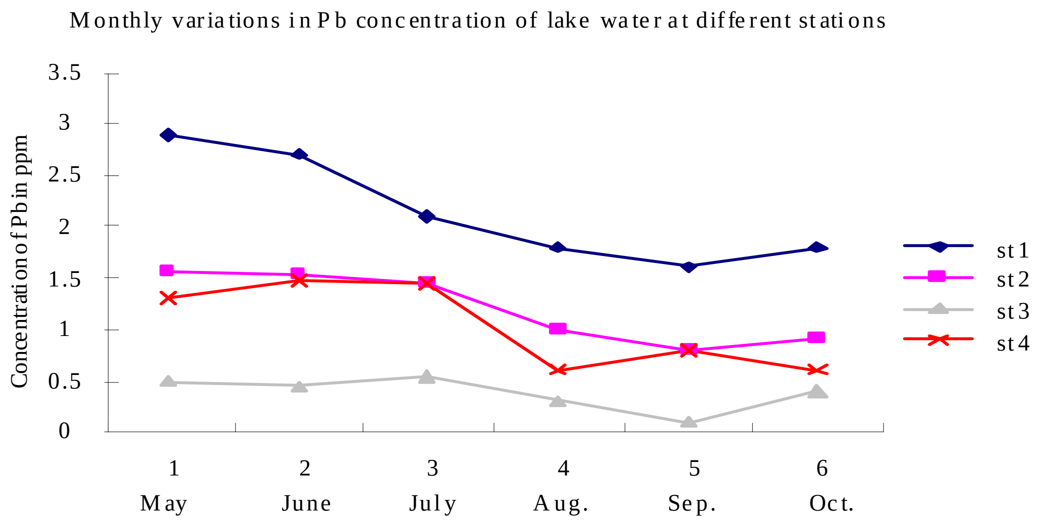

Fig. 3. Graph showing monthly variations in Pb concentration of lake water at different stations

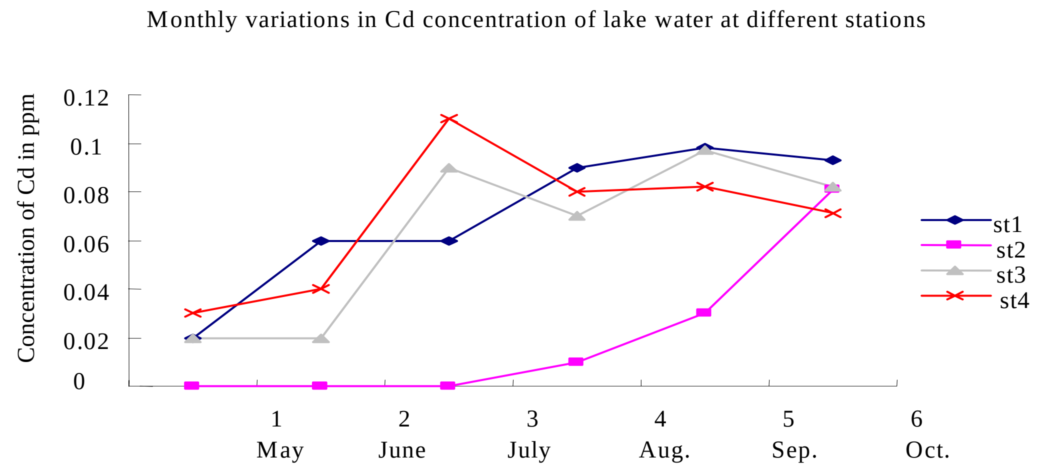

Fig. 4. Graph showing monthly variations in Cd concentration of lake water at different stations

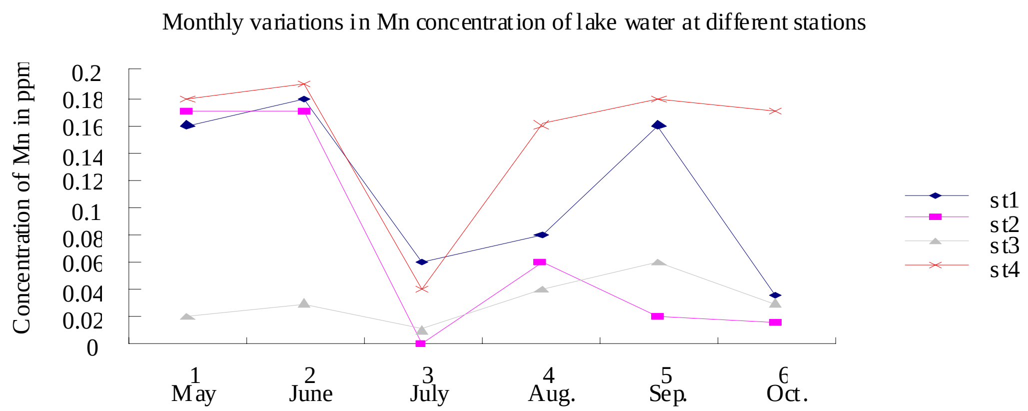

Fig. 5. Graph showing monthly variations in Mn concentration of lake water at different stations

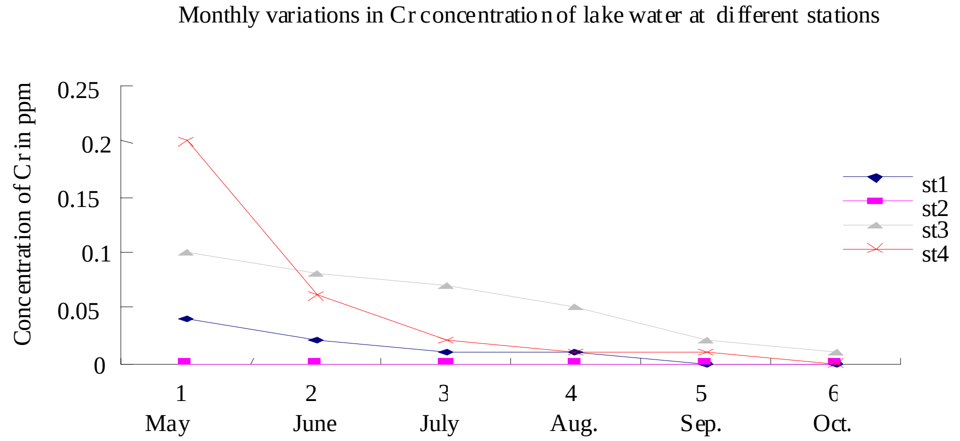

Fig. 6. Graph showing monthly variations in Cr concentration of lake water at different stations

Relatively higher concentrations are reported at stations 1, 3 and 4 where the anthropogenic activity is maximum. Station 2 being at the center has minimal concentration of the heavy metal as equitable mixing of the water is not occurring. 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 levels of Cu is 0.02-0.2 mg/L, (Moore, 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 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, (Moore, 1984). According to the USPH (United States Public Health Drinking Water Standards), the permissible limit for Lead in drinking water is <0.05 mg/L (De, 2002). The highest value 2.9 mg/L was recorded at station 1 in the month of May and the lowest value 0.1 mg/L was recorded at station 3 in the month of September in Fig. 3. The concentration of Pb is found out to be comparatively higher in the months of May and June due to high rates of evaporation of lake water. 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 run off waters of the lake through the vehicle washing and gasoline combustion.

Acute toxicity generally appear in aquatic plants at concentration of 0.1-5.0 mg/L. Acute toxicity of Pb in invertebrates are reported at concentration of 0.1-10 mg/L, Moore (1984). Higher levels pose eventual threat to fisheries resources.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 (Sindhu, 2002).

The maximum value of Cd is reported as 0.11 mg/L at station 4 in the month July and at station 2 in the months of May, June and July Cd is not detected i.e., it is below detection limit as shown in Fig. 4.

Higher values of Cd at stations 1, 3 and 4 suggest that the input of heavy metal is done through the anthropogenic activity at these stations. 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.

There are a few recorded instances of Cd poisoning in human beings following consumption of contaminated fishes. It is less toxic to plants than Cu, similar in toxicity to Pb and Cr. It is equally toxic to invertebrates and fishes. (Moore 1984). 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, 2002). The maximum concentration of Mn is reported as 0.19 mg/L at station 4 in the month of June and minimum concentration is reported as 0.01 mg/L at station 3 in the month of July as shown in Fig. 5. 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 municipal 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 (De, 2002). As shown in Figure 6 the maximum concentration of Cr 0.2 mg/L is recorded at station 4 in the month of May and the lowest value 0.0 mg/L is recorded at station 2 in all months. High value in the month of May is due to high rates of evaporation, thereby increasing its concentration in the lake water. During and after monsoon the concentration gradually decreases, as rainfall flushes out the lake water.Acute toxicity of Cr to invertebrates is highly variable, depending upon species (Moore, 1984). For invertebrates and fishes, its toxicity is not much acute. Chromium is generally more toxic at higher temperatures.

CONCLUSION

Seasonal variations are evident in all the heavy metals examined. The heavy metal load of the reservoir indicates the heavy metal toxicity of the water body which varies sharply at different sampling stations. Most of the heavy metals, if present beyond permissible limits in water are toxic to human beings, aquatic flora and fauna. In the present study, we find that Cu, Cr, Pb, Cd and Mn are present in relatively higher concentrations as compared to their permissible limits. As the Shahpura lake is also used for fishing purposes, it is quite evident that these heavy metals may enter the food chain, and thus through bio magnifications enter the human body as well. Periodical monitoring of the water quality is thus required to assess the condition of surface water of the water body and immediate steps should be taken to check the anthropogenic activity around the lake. This will be helpful in saving the lake from heavy metal pollution.

REFERENCES

APHA, (1985). Standard Methods for the examination of water and waste water. 16th. Ed. *APHA, AWWA-WPCF*, Washington, D.C.

Agemian, H. and Chau, A. S. Y., (1975). An atomic absorption method for determination of 20 elements in the lake sediments after acid digestion. Anal. Chem. Acta., **80**, 61-66.

Bajpai, A., Pani, S., Jain, R. K. and Mishra, S. M., (2002) Heavy Metal contamination through idol immersion in a tropical Lake, Eco. Environ. Cons., **8**(2), 157-159.

De, A. K., (2002). Environmental Chemistry, 4th. Ed, New Age International (P) Ltd., New Delhi, 232-272.

Dayal, G. and Singh, R. P., (1994). Heavy metal content of municipal solid waste in Agra , India. Pollut. Res., **13** (1) , 83-87.

Jain, S. and Salman, S., (1995). Heavy metal concentration in highly eutrophic lake sediments and overlying water. Pollut. Res., **14** (4) , 471-476.

Moore, J. W. and Ramamoorthy, S., (1984). Heavy Metals in Natural Waters: Applied Monitoring and Impact Assessment, Springer-Verlag; New York, 28-246.

Pophali, S., Siddiqui, S. and Khan, L. H., (1990). Sources and distribution of heavy metals in the abiotic components of a polluted urban stream in Bhopal. IJEP **10** (8) , 600-603.

Prapurna, N. and Shashikanth, K., (2002). Pollution level in Hussain Sagar Lake of Hyderabad-A case study, Pollut. Res., **21**(2) , 187-190.

Sindhu, P. S., (2002). Environmental Chemistry. 1st. Ed, New Age International (P) Ltd., New Delhi, 75-243.

Singh, S. P., Deepa, P. and Rashmi, S., (2002) Hydrobiological Studies of two ponds of Satna (M.P.), India, Eco. Environ. Cons., **8** (3) , 289-292.