JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ASSESSMENT OF HEAVY METALS IN FRESH WATER LAKES OF DIFFERENT REGIONS IN MAHARASHTRA STATE, INDIA

[1] Pravin U. Meshram, [2] Shreya D. Indurkar,

[1] Professor& Head, [2]Research Scholar.

[1,2]Department of Environmental Science, Sevadal Mahila Mahavidyalaya & Research Academy, Nagpur-440 015, India.

Abstract : The present study was carried out to assess the heavy metals from a large set of lakes of Maharashtra state, India. Water samples were collected from eighteen lakes different districts of Maharashtra state, India. Heavy metals as lead, cadmium, copper, iron and manganese were selected for the study. Water samples were digested and analyzed by using ICP-OES. Lowest values in most of the heavy metals were found in Kirtanwadi lake, Ratnagiri district and Sambhaji lake, Solapur district. That may be indication due to low pollution level. High values of the heavy metals were found in some lakes such as Bandra lake, Ramala lake, Chandrapur district and Naik lake, Nagpur. Highest lead and cadmium concentrations of 0.09±0.053 mg/L and 0.041±0.003 mg/L were found in Naik lake, Nagpur. Henceforth, these results might increase the chance of damage of the aquatic eco-system.

***IndexTerms* - Heavy metals, Lead, Cadmium, Water quality, Lakes in Maharashtra state.**

I. INTRODUCTION

Heavy metals are constitutes of an important group of environmentally hazardous substances (Dixit and Tiwari, 2008). Heavy metals are emitted into the environment in different ways through natural sources such as continental dust, volcanic dust and gas and biogenic particles or through anthropogenic contributions i.e. transportation, industry, fossil fuels, agriculture etc. (Duffus, 2002). The rocks and soils directly exposed to surface water are the largest natural sources of metals. Their aggregation and distribution in soil, water and environment are raising at an alarming rate causing deposition and sedimentation in water reservoirs and affecting aquatic organisms as well (Okafor and Opuene, 2007). Heavy metal toxicity is a problem of increasing significance for ecological reasons (Nagajyoti et al., 2008).

Heavy metals in contrast to most pollutants are not biodegradable and they undergo a global ecological cycles in which natural waters are the main pathways. Trace elements may come from natural sources, leached from rocks and soils according to their geochemical mobility or come from anthropogenic sources, as the result of human land occupation and industrial pollution (Abolude et al., 2009). The ecological importance of metals give out their general toxicity and the fact that they are non-biodegradable and highly persistent and therefore be likely to accumulate in the environment (Ursinyova and Hladikova, 2000). From the aquatic environment view point, the main problem has been to avoid biological deterioration and to recognize the sources which threaten ecological equilibrium. In India, most of the water resources are gradually getting polluted due to the increase of foreign materials from the surroundings including organic matter of plant, animal, surface washing, industrial and sewage effluents (Lokeshwari and Chandrappa, 2006).

The aim of this work was to study heavy metals from different lakes of Maharashtra, India that provided better understanding of heavy metal levels in lakes.

2 Material and Methods

2.1 Chemicals and glasswares

All chemicals purchased from E. Merck of the highest analytical grade. All glassware and instrumentation used in this study. Glasswares were pre-washed with chromic acid and rinsed with deionized water according to the method of Tessier et al. (1979). All reagents were prepared using water from Millipore Elix 10 integrated with Milli-Q synthesis water purification unit.

2.2 Sampling

Water samples were taken in sterilized sampling bottles, below 10 to 20 cm of the surface from study sites. Water samples were collected in three replicates. All lakes were sampled and mostly from 1 meter's depth.

2.3 Sampling lakes

Study area covers a large geographical area, including a large set of lakes of Maharashtra state, India. Figure 2.1 shows a map of districts of Maharashtra state where study lakes are situated and Table 2.1 shows latitudes and longitudes of study lakes, districts of lakes in Maharashtra state, India.

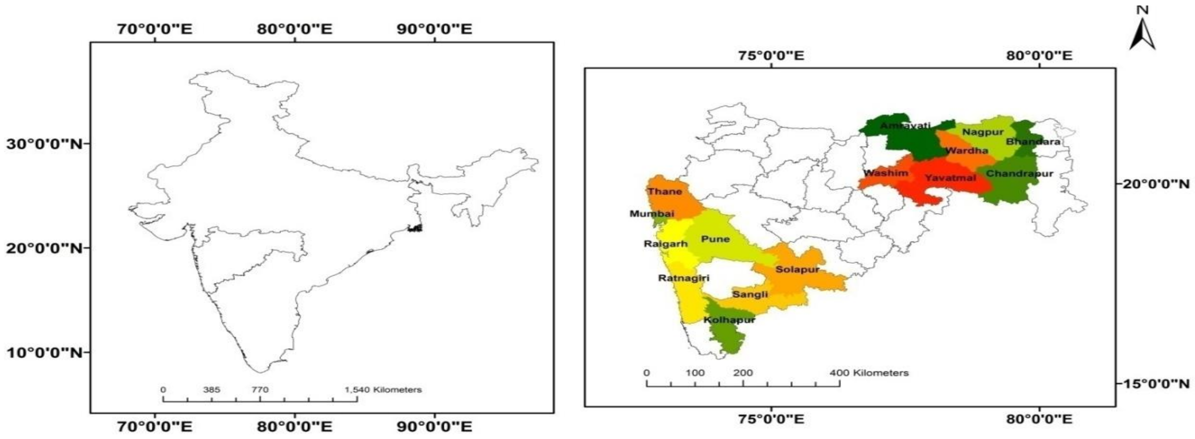

Figure 2.1: Map shows various districts of Maharashtra state where study lakes are situated

Table 2.1: Locations of study lakes in Maharashtra state, India.

District	Name of lake	Lakes code	Latitude	Longitude
Mumbai	Bandra lake	L1	72.83764N	19.05679E
Thane	Upavan lake	L2	72.95583 N	19.22139E
Ratnagiri	Kirtanwadi lake	L3	73.20861 N	17.47694E
Raigad	Vishrale lake	L4	73.11472 N	18.98278E
Pune	Pashan lake	L5	73.78572 N	18.53375E
Sangli	Morna lake	L6	74.09889 N	16.99944E
Solapur	Sambhaji lake	L7	75.90389 N	17.64778E
Kolhapur	Kalamba lake	L8	74.21250 N	16.65444E
Washim	Rishi lake	L9	77.48333 N	20.48333E
Yavatmal	Arunavati lake	L10	77.78333 N	20.11944E
Wardha	Mahakali lake	L11	78.45306 N	20.95500E
Amravati	Triveni lake	L12	77.89444 N	21.34028E
Chandrapur	Ramala lake	L13	79.30306 N	19.95361E
Bhandara	Nav lake	L14	79.65694 N	21.16083E
Nagpur	Ambazari lake	L15	78.27194 N	20.58917E
Nagpur	Futala lake	L16	79.04222 N	21.15306E
Nagpur	Gandhisagar lake	L17	79.09972 N	21.14556E
Nagpur	Naik lake	L18	79.11250 N	21.16083E

2.4 Methods of heavy metals analysis in water by ICP/OES

Heavy metals as lead, cadmium, copper, iron and manganese were selected for the study. Samples digested and analyzed by using ICP-OES (Perkin Elmer, Optima 4100DV) according to the method described in APHA (2005) and USDA (2008). Before the digestion of samples, glasswares used for the experiment, rinsed by 10% (v/v) nitric acid and deionized water. Samples digested using closed vessel microwave digestion (Milestone model Start D, Italy). Water samples were digested in Nitric acid. Blanks are used for the authentic determination of analysis. For analytical quality, water samples analysed in triplicates.

The digested water samples were diluted with 50 mL ion-free water in acid washed standard flasks and each sample filtered through 0.45 µm Whatman filter paper. After filtration, digested samples were analyzed using ICP-OES. Operational parameter settings of ICP-OES (Perkin Elmer, Optima, 4100DV) were shown in Table 2.2. Multi-elemental standard solutions (Merck) used for the standardization and prepared by diluting stock solutions of 1000 mg/L (Mohammed 2007).

Table 2.2: Summary of the operational parameter settings used for the ICP-OES (Perkin Elmer, Optima 4100DV)

Characteristics	Instrument condition
RF Generator	Fully Solid-state generator. Operating frequency-40 MHz
RF Power	Adjustable power from 750 to 1300 watts
Spray chamber	Scott type
Nebulizer	Cross Flow
Plasma gas flow	15.0 L/min
Auxiliary gas flow	L/min
Nebulizer gas flow	0.60 L/min

3 Results and discussion

Copper (Cu^{2+}) is an essential part of several enzymes and is necessary for the synthesis of haemoglobin. Cu^{2+} can combine with other contaminants such as ammonia, mercury and zinc to produce an additive toxic effect on fish (Yacoub, 2007). In the present study, it shows significant fluctuation of copper ranged between 0.229±0.001 mg/L (Sambhaji lake, Solapur district) to 0.754±0.034 mg/L (Bandra lake, Mumbai district). Lowest copper of 0.229±0.001 mg/L at Sambhaji lake, Solapur district shown in pink colour in the figure 3.1. Highest copper of 0.754±0.034 mg/L at Bandra lake, Mumbai district shown in white colour in the figure 3.1 and Table 3.1. In the present study, it shows significant fluctuation of Manganese ranged between 0.039±0.031 mg/L (Triveni lake, Amravati district) to 0.094±0.023 mg/L (Ramala lake, Chandrapur district). Lowest manganese concentrations of 0.039±0.031 mg/L at Triveni lake, Amravati district shown in purple colour in the figure 3.2 and table 3.1. Highest manganese concentrations of 0.094±0.023 mg/L at Ramala lake Chandrapur district shown in white colour in the figure 3.2.

In the present study, it shows significant fluctuation of Cadmium ranged between 0.001±0.001 mg/L (Kirtanwadi lake, Ratnagiri district) to 0.041±0.003 mg/L (Naik lake, Nagpur). Lowest cadmium concentrations of 0.001±0.001 mg/L at Kirtanwadi lake, Ratnagiri district shown in black colour in the figure 3.3 and table 3.1. Highest cadmium concentrations of 0.041±0.003 mg/L at Naik lake, Nagpur district shown in white colour in the figure 3.3.

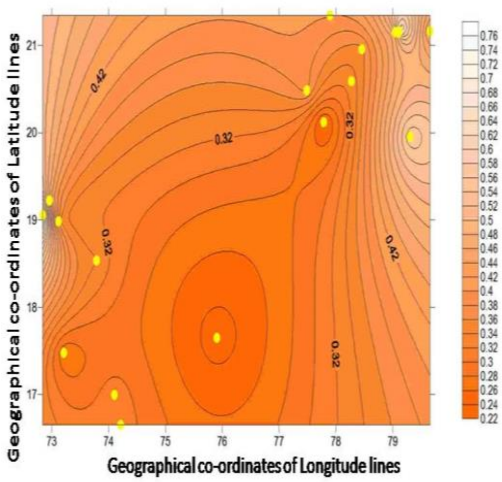

Figure 3.1: Surfer Contour/Post Map showing Copper of lakes of different districts of Maharashtra

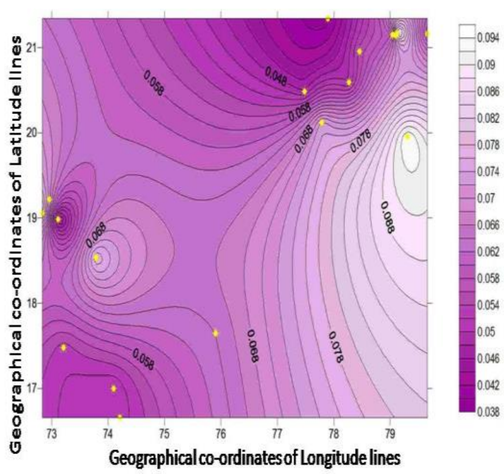

Figure 3.2: Surfer Contour/Post Map showing manganese of lakes of different districts of Maharashtra

Table 3.1: Heavy metals in water samples in lakes of different districts of Maharashtra, India

Lakes code	Cu	Mn	Cd	Pb	Fe
L1	0.754±0.034	0.081±0.011	0.016±0.001	0.049±0.021	0.081±0.043
L2	0.455±0.032	0.069±0.013	0.01±0.001	0.044±0.013	0.101±0.067
L3	0.263±0.064	0.053±0.013	0.001±0.001	0.01±0.011	0.056±0.035
L4	0.365±0.012	0.042±0.012	0.009±0.002	0.022±0.009	0.068±0.029
L5	0.341±0.002	0.078±0.022	0.018±0.011	0.048±0.030	0.094±0.072
L6	0.312±0.023	0.05±0.031	0.01±0.001	0.037±0.011	0.091±0.080
L7	0.229±0.001	0.064±0.014	0.013±0.002	0.035±0.010	0.167±0.092
L8	0.31±0.004	0.051±0.016	0.012±0.003	0.044±0.021	0.089±0.038
L9	0.387±0.041	0.048±0.022	[illegible]	[illegible]	[illegible]
L10	0.231±0.001	0.073±0.011	[illegible]	[illegible]	[illegible]
L11	0.354±0.006	0.055±0.020	0.009±0.001	0.029±0.013	0.174±0.085
L12	0.401±0.003	0.039±0.031	0.01±0.0009	0.041±0.008	0.129±0.094
L13	0.578±0.033	0.094±0.023	0.039±0.002	0.064±0.003	0.23±0.099
L14	0.407±0.041	0.056±0.010	0.008±0.0008	0.043±0.017	0.153±0.077
L15	0.329±0.002	0.05±0.014	0.019±0.0009	0.046±0.031	0.103±0.045
L16	0.483±0.005	0.06±0.032	0.025±0.001	0.076±0.048	0.125±0.046
L17	0.522±0.070	0.076±0.024	0.034±0.002	0.081±0.051	0.185±0.111
L18	0.641±0.001	0.089±0.032	0.041±0.003	0.09±0.053	0.271±0.124

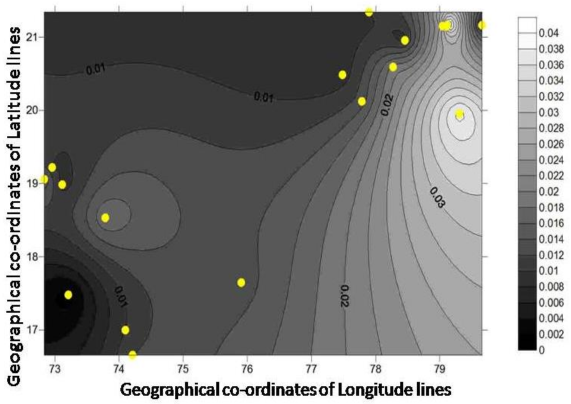

Figure 3.3: Surfer Contour/Post Map showing Cadmium of lakes of different districts of Maharashtra

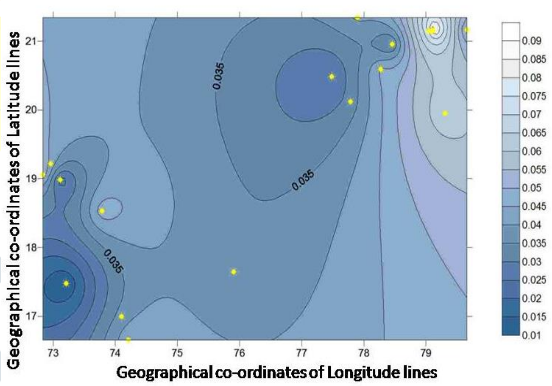

Figure 3.4: Surfer Contour/Post Map showing lead of lakes of different districts of Maharashtra

Lead is a microelement naturally present in trace amounts in all biological materials in soil, water, plants and animals. It has no physiological function in the organism. Too much lead can harm various systems of the body including the reproductive and nervous systems and the kidneys. Present study showed significant fluctuation of Lead ranged between 0.01±0.011 mg/L (Kirtanwadi lake, Ratnagiri district) to 0.09±0.053 mg/L (Naik lake, Nagpur). Lowest lead concentrations of 0.01±0.011 mg/L at Kirtanwadi lake, Ratnagiri district shown in blue colour in the figure 3.4 and table 3.1. Highest lead concentrations of 0.09±0.053 mg/L at Naik lake, Nagpur district shown in white colour in the figure 3.4.

Iron is an important metal in both plants and animals, especially in the cellular processes (Lovell, 1989). Fe^{2+} is quantitatively regarded the most important trace metal for autotrophs due to its indispensability for many enzymes and redox processes (Iqbal et al., 2006).

Iron concentration up to 0.1 mg/L is acceptable while 1.0 mg/L or more iron in fresh water could be harmful for life (Trivedi and Gurdeep, 1992). The insoluble Fe^{3+} is reduced to soluble Fe^{2+} in water by bacterial reduction. Fe^{2+} is found in natural fresh and groundwater, but have no health based guideline value, although high concentrations give rise to consumercomplaints due to its ability to discolour aerobic waters at concentrations above 0.3 mg/L (WHO, 2003). Though Fe^{2+} is considered as an essential element in human nutrition, if it is however found in water at enhanced concentrations, serious pollution and health problems may be anticipated (Benson and Etesin, 2008).

In the present study, it showed Iron range between 0.056±0.035 mg/L (Kirtanwadi lake, Ratnagiri district) to 0.271±0.124 mg/L (Naik lake, Nagpur). Lowest iron concentrations of 0.056±0.035 mg/L at Kirtanwadi lake, Ratnagiri district shown in blue colour in the figure 3.5 and table 3.1. Highest iron concentrations of 0.271±0.124 mg/L at Naik lake, Nagpur district shown in white colour in the figure 3.5.

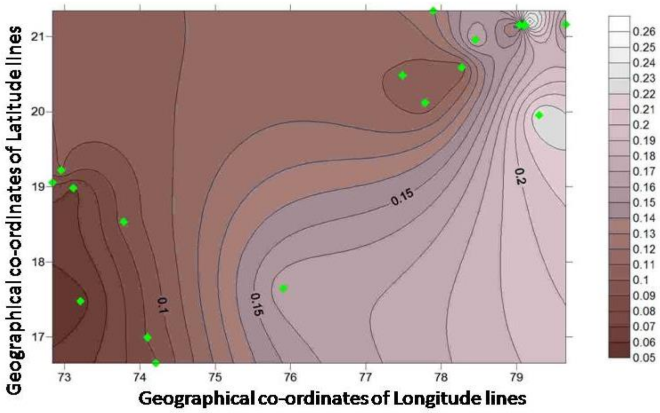

Figure 3.5: Surfer Contour/Post Map showing iron of lakes of different districts of Maharashtra

Conclusion

Study area covers a large geographical area, including a large set of lakes of Maharashtra state, India. Eighteen lake water samples were collected from different districts of Maharashtra state, India. Heavy metals of water lead, iron, cadmium, copper and manganese were determined using standard methods. Lowest values in most of the heavy metals were found in Sambhaji lake, Solapur district and Kirtanwadi lake, Ratnagiri district. That may be indication due to low pollution level in these lakes. High values of the heavy metals were found in some lakes such as Bandra lake, Ramala lake, Chandrapur district and Naik lake, Nagpur etc. That may be indication due to high pollution level in lakes. High levels of heavy metals in these lakes indicate the unsafe condition for human consumption and environmental health

ACKNOWLEDGMENT

The authors are thankful to the Principal, Sevadal Women's Science College, Nagpur for providing laboratory and library facilities.

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