International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-6, June 2020
ISSN: 2395-3470
www.ijseas.com

Heavy Metal Analysis At Thamaraikulam Pond In Theni District

T. Nirmala,*[1] M. Jancy Rani,[2] and K. Jency Priya[3]
[1]M.Phil. Scholar, E-mail: jancyrani474@gmail.com
[2]Former Principal and Associate Professor, E-mail: sisternirmala10@gmail.com, Mobile No. 6362614606. PG and Research Centre of Zoology,
[3]Assistant Professor, E-mail: jencypriya9@gmail.com, Mobile No. 9940819797. PG and Research Centre of Mathematics,
Jeyaraj Annapackiam College for Women (A), Periyakulam, Theni District, Tamil Nadu.

Abstract

Today aquatic resources have been the most exploited natural system due to rapid population growth, industrial proliferations, urbanizations, drainage system and increasing living standard. Most of the human activity has directly or indirectly demise the hydrological environment. Heavy metals are the metals which have a higher density than that of water. Heavy metal concentrations were determined using Atomic Absorption Spectrophotometer. In Thamaraikulam pond the following heavy metals were analysed Zn, Cr, Co, Pb, Mg. Mn. and Fe in January, 2017. The heavy metal analyses of water and soil were found within the standard permissible limit except Manganese and Lead which was higher than the permissible value. This study also showed that this pond is highly acidic in nature and is hazardous to the living organisms.

Key words: Heavy Metal, Theni, Thamaraikulam Pond, Water and soil.

1.Introduction

The people residing in various districts of Tamilnadu and Kerala depend on the Mullai Periyar River and it is very useful to the people of Theni District. The population of Theni district is 1,245,899 and it depends on Mullai Periyar River. The water receives a large amount of wastes, such as industrial effluents, domestic wastes and was polluted by other anthropogenic activities. Today water resources have been the most exploited natural system due to rapid population growth, industrial proliferations, urbanizations and increasing living standard. Most of the human activity involving industrial, agriculture development and inadequate management of land has directly or indirectly decreased the hydrological environment[2]. The term heavy metal refers to an element which has a relatively high density and is toxic or poisonous at low concentrations. A heavy metal is a member of loosely defined subset of elements that exhibit metallic properties. It mainly includes the transition metals, some metalloids, lanthanides and actinides. The heavy metal accumulations in the aquatic resources are due to rapid population growth, manure pesticides, application of fertilizers in the field, urbanizations, drainage system and increasing living standard [23].

2. Literature review

Heavy metals are the metals which have a density of five times higher than that of water[11]. Heavy metals can pose health hazards if their concentration exceeds allowable limits [20]. The treatment process of industrial waste water like reduction, chemical precipitation, ion exchange, reverse osmosis, ion floatation, evaporation, adsorption settling and clarification are some of the methods to remove heavy metals[5, 8, 15, & 17]. The metals such as Zinc, Iron, Lead,

Manganese etc. are commonly present in the contaminated areas and get oxidized to carbon oxide from the organic contaminants[12]. The ratios of metals in the dissolved (suspended particulate matter) and solid phases (sediments) are similar in the Lake Balaton and the river of Zala[14]. Aim of this study is to determine the heavy metals present in this Thamaraikulam pond.

3. Materials and methods

3.1. Study area

Thamaraikulam pond is located in the Gokilapuram village in Uthamapalayam Taluk of Theni District in Tamilnadu. It covers the 663ha of land surrounded by paddy fields. In the plains, the temperatures range from a minimum of 13 ^{0}C to a maximum of 39.5 ^{0}C. The district is known for its salubrious climate, hills and lake. The 2,889 km^2 (1,115 sq mi) District lies at the foot of the Western Ghats between 9' 39' and 10' 30' North latitude and between 77' 00' and 78' 30' of East Longitude.

The source of the water to the town is from the Mullai Periyar River. It is one of the attractions for this town and lies in the middle as a link between Gokilapuram and Ramasamy Nayakkanpatty. The yearlong pleasant climate here is the treat for the residents and the visitors of bird species. The district receives the rainfall under the influence of both southwest and northeast monsoon**.**

3.2. Analysis of Heavy Metal by AAS

3.2.1. Collection of water samples: The water samples were collected in plastic container in early hours.

3.2.2. Sample preparation for AAS analysis: The pond water was filtered in a micro filter and it was used for analyzing the heavy metals by Atomic Absorption Spectroscopy.

3.2.3. Preparation of standard ion for AAS: The calibration plot method described in the British pharmacopoeia[4] was adopted for the preparation of metal ion and Atomic Adsorption spectroscopy analysis. The absorbance of solutions was obtained using Atomic Adsorption spectroscopy for Chromium, Zinc, Manganese, Iron, Magnesium and Copper. The calibration graph was plotted and the regression equation was used to determine the heavy metal concentration where deionized water was used as control.

3.2.4. The analytical technique: The analytical technique used to determine heavy metal level in all samples was thermo element Sys-813 Atomic Absorption Spectroscopy (International Equipment trading Ltd, USA). At each step of digestion processes, acid blanks (laboratory blank) were prepared in order to ensure that the sample and chemical used were not contaminated. They were analyzed by Atomic Absorption Spectrophotometer before the sample and their values were subtracted to ensure that equipment read only the exact values of heavy metal. Each set of digestion had own acid blank and was corrected by using its blank. The absorption wavelength and detection limits for the various metals were 217.0 nm for Cu, 228.8nm for Cr, 279.5nm for Mn, 213.9nm for Zn, 324.7nm for Mn and 232.0 nm for Iron.

3.2.5. Preparation of soil sample for heavy metal analysis: The soil sample was sieved through the plastic sieve to remove the large particles. Soil sample was placed overnight on oven at 150^{0}C till it dried. Sample was weighed 5gms in flask for the digestion. Then sample was digested by Hydrochloric acid and Nitric acid in 1:3 ratios. The sample was digested for 2 hours at 100^{0}C with reflex condenser. The soil was allowed to cool. It was filtered with Whatmann filter paper into 100 ml standard flask and it was used for heavy metal analysis.

4. Result and Discussion

Thamaraikulam pond is also commonly known as Thamarai Pond and its soil and water was analyzed using AAS to find out the heavy metals from the samples collected in January,

2017. Heavy metal concentration was determined as Zn > Fe > Cr > Mg > Pb > Mn (Figure 1). The level of the zinc was least in amount (0.0001mg/l) when compared to permissible limit (0.0012mg/l). Iron (0.0002 mg/l) and Chromium (0.0013mg/l) level were also lower than the permissible limit of Fe (0.0020mg/l) and Cr (0.0028mg/l). Magnesium level was (0.0032mg/l) slightly higher than its permissible value (0.0031mg/l). Manganese (0.0056mg/l) and Lead (0.0045 mg/l) was higher than the permissible value (Mn - 0.0012mg/l and Pb - 0.0015mg/l) (Figure 1).

The study of Kayalvizhi *et al.*[10] in Thamaraikulam pond during 2010-2011 denoted that the heavy metal was decreased following the order Pb>Cr, whereas in Dindigul, it was Cr>Pb. but this study showed that Chromium (Cr) is greater than lead (Pb). J. K. Nzeve *et al.*[16] reported that heavy metal concentrations in the fishes of Masinga Reservoir, Kenya showed below the WHO set limit except for Chromium. Assessment of heavy metals in water and sediments in the northern delta lakes, Egypt showed higher value in Mn[19]. Also the study of Abimbola and Olutayo[1] reported in Dandaru river of Ibadan, South western Nigeri also revealed the highest presence of Zn, Pb, Cr, Fe, Cu and Mn in two different points. Zn, Fe and Cr are within the permissible limit in this study and if it exceeds, that will damage the health of the animals and humans.

Heavy metal residues were determined as greater or higher and follow the gradation like Zn > Fe > Cr > Mg > Pb > Mn. Nguyen *et al.*[14] study showed that metal concentration was lower during raining season and much higher during storm and snow season due to the retaining of suspended particulate matter. This study also showed that in zooplankton, Zn was much more elevated metal. The values of certain heavy metals such as Fe, Ni and Mn were beyond the limits set by UNEPGEMS[8] and accumulation of this Fe was observed highest in all the organs of fish living in that rivulet at Kasimpur, Aligarh. Manganese was exceeded the recommended value in this study as in the study of Javed and Usmani[8]. High level of this may cause lung, liver, vascular disturbances, reproductive abnormalities and brain damage and even tumor development in animals.

The same result as in this study was reported for Iron in water by Samir and Shaker.[19] High rain fall caused decrease in concentration of heavy metal soils. In this study also, Manganese is greater than lead as in study of Nibal Kh. Mousa and Aleksandra Badora[15] at Baghdad and Poland. High lead leads to acidity soils in Iraq[6] and it is one of the most poisoning heavy metals targeting organs like bones, brain, blood, kidneys, thyroid gland, reproductive and cardiovascular systems[7].

Although pH was high in April and low in February, level of pH is not more than 6 (Table 1) as in the study of Iraqi soils[6]. Its effects on soil nutrients was due to positive ions on soil surface replaced by negative ions which causes the ability of binding to form complex of nutrients[13]. Nitrogen and Potassium was high in December, 2016 and low in April, 2017, while Phosphorous was recorded high in April and low in December and low Electrical conductivity in December and high in January (Table 1). A solution with a high number of hydrogen ions is acidic and has a low pH value. This study also showed that this pond is highly acidic to neutral in nature and is hazardous to most of the life forms. pH is considered as an important factor which influences aquatic production[21]. Conductivity increases with the increase of ions' mobility and dissolved solids in water as in the study where higher the total dissolved solids greater the ions in water[3]. According to Wetzel[22], high concentration of nitrogen is the indication for organic pollution and eutrophication. Nitrogen is produced either directly from end product of

decomposition of organic compound or oxygenic matter or due to the domestic activities and fertilizers used in the fields[24]. Potassium is the main cation in fresh water lake may be due to the rainfall and sedimentary rock strata as in the study of Ramachandra Mohan Muniyellappa[18]. Phosphorous fluctuation may be due to the leaching of soil by rain or cattle dung or weathering of phosphorous bearing rocks and these are the main sources of it to natural waters[9].

5. Conclusion

The main concern with heavy metals is their ability to accumulate in the environment and leads to heavy metal poisoning. Unlike some organic pollutants, heavy metals are not biodegradable and cannot be metabolized as well as decomposed. In Thamaraikulam pond the following heavy metals were analyzed Zn, Cr, Pb, Mg. Mn and Fe. Zinc was present in the very least amount. Pb, Mg and Mn are recorded as higher than the limit of WHO and other metals are within the permissible limit. These heavy metals analyses of water and soil were found within the standard permissible limit. Thamaraikulam pond favours high diversity of birds on that area and used for agricultural purpose and domestic use. It has to be tested for its potable nature to animals and human beings using physico-chemical analysis and to determine the heavy metals present in the living organisms such as fish and birds on which it depends for its livelihood. This pond is acidic to neutral in nature and is hazardous to most of the life forms. Metals are essential but excess becomes toxic and dangerous to even humans.

6. References

1. Abimbola Olumide Adekanmbi, Olutayo Israel Falodun. Physicochemical, microbiological and heavy metal studies on water samples and bacteria obtained from Dandaru River in Ibadan, South-western Nigeri. 2015,
2. Ajayi AO, Adejumo TO. Microbiological assessment and physic- chemical properties of water sources in AkungbaAkoko, Nigeria. Journal of Toxicology and Environmental Health Science, 2011; 3 (13): 342-346.
3. Bhatt LR, Lacoul P, Lekhak HD, Jha PK. Physico-chemical characteristics and phytoplankton of Taudaha lake, Katmandu. Poll. Res., 1999; 18 (4): 353-358.
4. British Pharmacopoeia. British Pharmacopoeia Commission Office, London, UK. 2005, Vol. 2, 1267-1268.
5. Gupta KV, Mohan D, Sharma S, Park TK. Removal of chromium (VI) from Electroplating Industry Waste water using baggage fly ash-a sugar Industry waste material. The environmental protection, 1999; 24 (11): 863-866.
6. Gzar HA, Mottar ZH. Desorption of lead, copper and zinc from Iraqi silty contaminated soil. Al-Qadisiya Journal for Engineering Sciences, 2015; 8(4): 540-557.
7. Homady M, Hussein H, Jiries A, Mahasneh A, Al-Nasir F, and K. Khleifat. Survey of some heavy metals in sediments from vehicular service stations in Jordan and their effects on social aggression in prepubertal male mice. Environmental Research, 2002; 89: 43-49.
8. Javed M, Usmani N. Assessment of heavy metals (Cu, Ni, Fe, Co, Mn, Cr, Zn) in rivulet water, their accumulations and alterations in hematology of fish *Channa punctatus*. 2014; 13(3): 492-501.
9. Jhingran VG. Fish and Fisheries of India 2nd edition. Hindustan publishing corporation Delhi, India, 1982.

10. Kayalvizhi J, Nirmala T, and Medona Mary R. Level of Heavy metals in soil sediments from wetlands of Theni and Dindigul districts. International Journal of Recent Scientific Research, 2015; 6 (11): 7372-7376.
11. Khosy M, Nair. Trace Metals in Sediments of River Pamba. Poll. Res., 2002; 21(3): 235 -242.
12. Kirpichtchikova TA, Manceau A, Spadini L, Panfili F, Marcus MA, Jacquet T. Speciation and solubility of heavy metals in contaminated soil using X-ray microfluorescence, EXAFS spectroscopy, chemical extraction, and thermodynamic modeling. Geochimica et Cosmochimica Acta, 2006; 70(9): 2163-2190.
13. McCauley A. Soil pH and organic matter. Nutrient management module, 2017; 8(17): 4449-4458.
14. Nguyen HL, Leermakers M, Osan J, Torok S, Baeyens W. Heavy Metals in Lake Balaton: Water Column, Suspended Matter, Sediment and Biota. Science of the Total Environment, 2005; 340 (1-3): 213-230.
15. Nibal Kh Mousa, Aleksandra Badora. Heavy metals concentration in soils and some aspects chime-remediation in Iraq and Poland. Int. Res. J. Environment Sci., 2018; 7(8): 27-29.
16. Nzeve JK, Njuguna SG, Kitur EC. Bioaccumulation of Heavy Metals in Clarias gariepinus and *Oreochromis spirulus niger* from Masinga Reservoir, Kenya. IOSR Journal of Environmental Science, Toxicology and Food Technology, 2014; 8 (10, 1): I 58-63.
17. Raj AS. Adsorption behaviour of Nickel on activated carbon. Indian Journal of Environmental protection, 2004; 24 (7): 530-533.
18. Ramachandra Mohan Muniyellappa, Water quality monitoring of Magadi Hill Range Lakes and Reservoirs of India. Hydrology, 2018; 6 (1): 18-31.
19. Samir M. Saeed, Ibrahim M. Shaker. Assessment of heavy metals pollution on water and sediments and their effect on O*reochromis niloticus* in the Northern Delta Lakes, Egypt. Environmental Science, 2008, 475-490.
20. Shparyk YS, Parpan VI. Heavy metal pollution and forest health in the UK Ranian Carpathians. Environmental pollution, 2004; 130, 55-63.
21. Swingle HS. Standardzation of chemical analysis for water and muds. FAO, Fish-Rep. 1967; 4(4): 397-421.
22. Wetzel RG. Limnology 2nd edition Saunders. Coll. Publ., 1983, 267.
23. Zhang M.K., Liu Z.Y. and Wang H. (2010)., Use of single extraction methods to predict bioavailability of heavy metals in polluted soils to rice., Communications in Soil Science and Plant Analysis, 41(7), 820-831.
24. Zutshi DP, Khan AV. Eutrophic gradient in the dial lake, Kashmir. Indian J. Env. Health, 1998; 30 (4): 348-354.

Figure 1. Heavy metal analysis of water at Thamaraikulam pond in January, 2017.

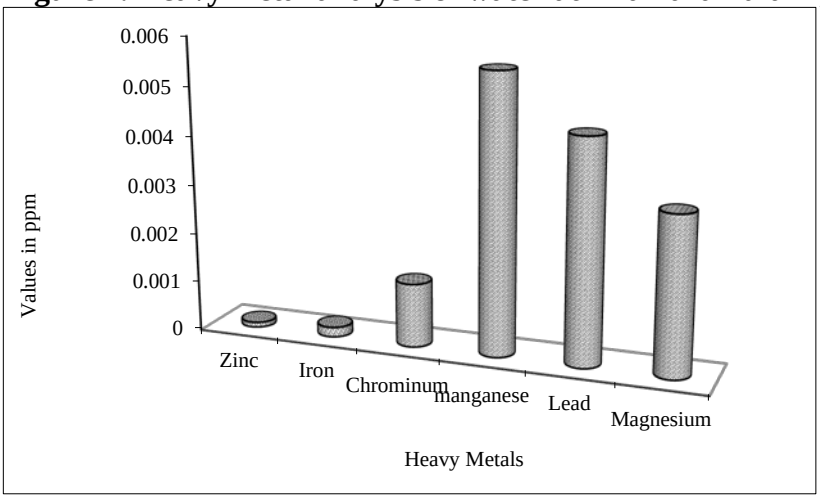

Table 1. Physico-Chemical Analysis of a few parameters in Thamaraikulam Pond during 2016-2017

Parameters in Year	December	January	February	March	April	May	Average
	2016	2017					2016-17
pH value	6.5	6.6	6.4	6.5	6.8	6.7	**6.58**
Available Nitrogen (ppm)	89	88	88.2	85.2	85	88	**87.23**
Potassium(mg/l)	101	100	103	102	99	103	**101.33**
Phosphorous (ppm)	13	13	13.5	14.1	15.3	13.5	**13.73**
Electrical Conductivity (S/m)	1.12	1.42	1.35	1.33	1.4	1.35	**1.33**