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Assessment of Heavy Metal Pollution Status of Vembanadu Lake—a Case Study, Kerala

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Abstract. Vembanadu Lake is the largest backwater systems of the Kerala State. The present study was carried out to evaluate the heavy metal contents from six different stations. Observations revealed that the heavy metal contents in some stations of this backwater system are beyond the standard limit.

Keywords: Heavy metal, Pollution

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1 Introduction

Humans now produce and use vast array of metallic substances for industrial, agricultural and domestic purpose. Day by day, its release into the water supplies and soil are increased very much. The episode, which brought the attention of the world towards heavy metal pollution was the Minamata disease, which occurred in Japan in 1956 [1]. Many of these substances are hazardous to environment and man itself. Heavy metals form a dangerous group of potentially hazardous pollutants, particularly in estuaries and near shore waters [2].

Heavy metals are those that exist as cations under biologically significant conditions and are generally termed as trace elements are those with density value greater than 5 gm/cm^3 [1]. The concentration of metal in a system is less than 0.1 percent, then the term trace is often used. Nriagu and Pacyana [11] reviewed the heavy metal production trend and found there has been a significant increase in production during the past 55 years period (1930–85). The major heavy metals are mercury, cadmium chromium, cobalt, copper, lead, nickel, zinc, iron and manganese. At a trace amount most of these metals are very essential to life but at higher levels become toxic. So many studies were carried out world over to monitor the heavy metal discharge into water bodies. George Thomas [7] had analysed the concentration of trace metals in the sediments of Ashtamudi estuary with special reference to the mangrove regions. Paul and Pillai [13] studied the concentration of trace metals in the water and sediments of Periyar River. Trace metals in the sediments of Cochin backwater has been studied by Venugopal *et al.* [17]. Nair *et al.*, [10] studied the seasonal and spatial variation in the distribution of heavy metals in the sediments of Cochin backwaters.

Heavy metals remain in the environment even after the source of pollution has been removed and they may become biologically available. The unique aquatic ecosystem is adversely affected by large scale heavy metal contamination. Aquatic organisms accumulate and concentrate these metals in their body and it will be transferred to the higher trophic levels, thereby biomagnifications occurs in the food chain. For studying environmental degradation knowledge on the distribution of heavy metals in the aquatic environment is important because these elements can be toxic even in traces and cause harmful effects [4,8]. The understanding of the distribution and concentration of heavy metals in surface water throws the light into the quality of water. In these aspects the present study takes its relevance.

Materials and Methods

The present study was done in the Vembanad Lake, the largest backwater in Kerala. The lake is lying between 9^0–40'-$10^0 12^1$ N and $76^0 15^1$–$76^0 25^1$ E longitudes extending from Alleppey to Azhikode. For the present investigation six stations are selected from this backwater, Station I-Market canal, Station II-Alappuzha town, Station III-R-Block Kayal, Station IV-Cherthala central, StationV-Kumarakom and Station VI-Vaikkom. Water samples were collected by using a well-cleaned water sampler and kept in clean plastic bottles. Atomic absorption spectrometry was used for the determination of heavy metals (Rantala and Loring, 1975).

2 Results

The distribution of boron in water samples of Vembanad backwater ranged from 0.103 to 0.187 mg/l. The highest value of boron was noted at station V (0.187 mg/l).A lowest value of 0.103 mg/l was noted at station III. A mean of 0.1485 mg/l was recorded in the present study. In the present study the cadmium level in samples of all the six stations were in a below detectable level. Generally the chromium content in the water samples was ranged between 0.015 mg/l to 0.047 mg/l. An average of 0.0313 mg/l was recorded. A maximum of 0.047 mg/l was obtained at station I and a minimum of 0.015 mg/l was obtained at station VI.

The observed variation of fluoride was ranged from 0.041 to 0.113 mg/l. A value of maximum 0.113 mg/l was recorded at station I and the minimum value of 0.041 mg/l was obtained from two stations station V and VI. In stations II, III and IV the fluoride concentration was in a below detectable level. An average of 0.065 mg/l was recorded during the present study. An average iron value of 2.035 mg/l was recorded during the present study. A maximum of 2.54 mg/l was recorded at station V and a minimum of 1.49 mg/l was recorded of station III.The lead concentration was in a below detectable level in all the stations during the present study. A highest value of 0.039 mg/l was recorded at station III and lowest value of 0.006 mg/l was recorded at station IV. An average of 0.025 mg/l was recorded in the present study.

Discussion

Boron is a non essential element to organisms. In the present study maximum concentration of boron was observed at station V and it may be due to the influence of sewage and industrial effluents from the nearby paper mill. The minimum concentration was observed at station III.Cadmium is one of the most toxic elements in the biological systems [5, 15]. In estuaries the cadmium concentration is highly variable due to fresh water run off, tides, and current intermittent discharge of domestic and industrial effluents, hydrological parameters and ecological factors. Cadmium is a non-essential element and highly toxic to man and several other organisms even at extremely low concentration. This element mainly accumulates in kidney [9]. According to WHO [19] cadmium is related with heart diseases, hypertension and arteriosclerosis. At very low concentrations cadmium is toxic to aquatic organisms [1]. The main sources of cadmium pollution are usually the industrial and municipal wastes. Anthropogenic activities associated with smelting and mining, manufacture, use and disposal of cadmium products, fertilizers, sewage effluents, sludge and combustion of fossil fuels are also included.

During the period of study the cadmium concentration in all the six stations were in a below detectable level. It meant that the cadmium pollution in Vembanad backwater may be less compared to other heavy metals. Among heavy metals, chromium is virtually omnipresent in the environment. It is more abundant in the earth's crust than any other major heavy metals. The anthropogenic sources of chromium include burning of oil and coal, production of refractory materials oxidants and fertilizers. It is also used in metal plates and tanneries. A trace amount of these metals necessary for biological process [1].

The maximum concentration of chromium was observed at station I and it may be due to the disposal of industrial and automobile wastes at this area. The minimum concentration was observed at station VI.Fluoride is also harmful to aquatic organisms. In the present study the Fluoride concentration was maximum at station I and it may be due to the land runoff and anthropogenic activities in and around this station. The minimum concentration was observed at two stations such as V and VI.In three stations such as II, III and IV the fluoride concentration was in a below detectable level. The fluoride pollution in Vembanad backwater may be less during the present study.

Iron is found in all natural waters both in oxidized (ferric) and reduced (ferrous) forms. Among the heavy metals iron is an important transition element and is required for both plants and animals and as a modulator of the impact of other substance, iron plays an important role in aquatic systems [18]. Iron usually enters from the dumped waste into the aquatic ecosystem. In the present study the maximum concentration of iron was observed at station V and it may be due to the contamination of organic and inorganic solid wastes and industrial effluents and the pollution from the adjacent aquacultural farm. The river discharges and land run off may also be a reason. The present findings were agreed with the observation of Geetha Bhadran [6] at Ashtamudi estuary. There may be an increase in the quantity of heavy metals including iron due to the concentration from municipal solid wastes waters, urban run off and industrial effluents (Bell, 1988). The minimum concentration was observed at station III. Padmalal and Seralathan [12] reported a high iron concentration of 0.00314 mg/l in Vembanad backwater. The present study reveals that the iron concentration in Vembanad backwater increasing very much since 1991.

In earths crust the concentration of lead has been estimated at 12.5 ppm ranking it as the 36^{th} element in order of abundance. Lead had a tendency to concentrate in the water surface microlayer, i.e, the upper 0.3 pm. approximately, especially when surface organic materials were present thin films [3]. Combustion of leaded petrol, mining and smelter operations are the main sources of lead. In the present study, the concentration of lead was in a below detectable level at all the study stations. A high concentration of lead in water during post monsoon has been reported by Ramalingam *et al.* [14] in Cochin backwater. The pollution of lead in the Vembanad backwater may be very low.

Table 1: Spatial variation of heavy metal in Vembanad backwater system.

	Parameters (mg/l)						
	S1	S2	S3	S4	S5	S6	Average
Boron	0.165	0.165	0.103	0.134	0.187	0.137	0.1485
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium	0.047	0.036	0.046	0.024	0.02	0.015	0.0313
Fluoride	0.113	BDL	BDL	BDL	0.041	0.041	0.065
Iron	2.46	1.61	1.49	1.82	2.54	2.29	2.035
Lead	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc	0.032	0.035	0.039	0.006	0.029	0.01	0.025

Zinc is an essential element for the growth of animals and plants. The excess concentration of zinc in water bodies has to have toxic effects of varying intensities on fish population. Metaliferous mining activities, ore dressing and processing, sewage-sludge and the use of agro-chemicals such as fertilizers and pesticides are the main sources of zinc " [16]. Manufacturing process involving metals, atmospheric fall out and domestic wastes are also major sources of zinc in aquatic systems. The highest concentration of zinc was observed at station III and it may be mainly due to the oil waste from mechanised boats. Similar findings were done by Geetha Bhadran [6]. Also the water receiving industrial effluents and domestic sewage contain large amount of zinc, which will reflect in the water. The lower concentration of zinc was observed at station IV.

The present study reveals the extent of deterioration occurring in the Vembanad estuary-the largest backwater of Kerala. Densely populated regions, drastic changes in social and cultural behavior of the society, budding tourist destinations and exploits, arousing severe environmental degradation in the Vembanad regions. Now, the time exceeds to protect the Vembanad estuarine system by developing and executing all the possible management measures for conservation and rehabilitation of Kerala's largest backwater resource.

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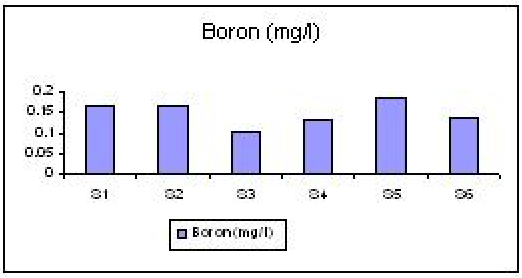
References

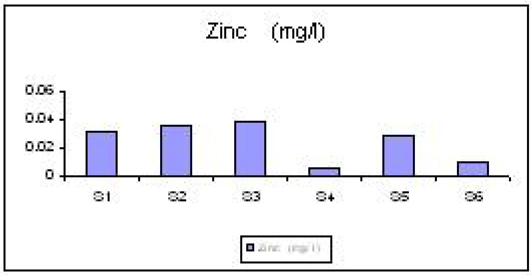
[1] Abbasi, S.A., Abbasi, N., and Soni, R., 1998. Heavy metals in the environment. Miltal Publications, New Delhi. 89–106.

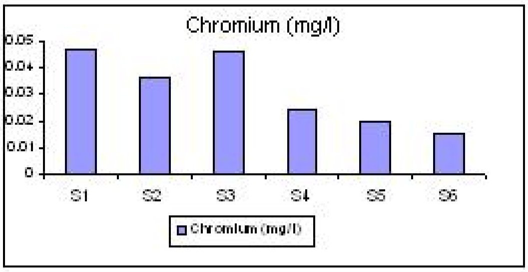
[2] Bryan, G.W., 1984. Pollution due to heavy metals and their compounds. In: Marine Ecology. 5: part III. Ed. O. Kine. John Wiley and Sons, New York. 1229–1431.

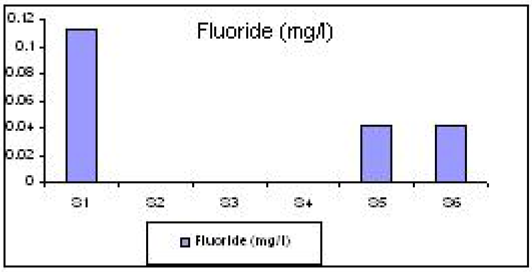
[3] Chester, R., Gardner, D., Riley, J.P. and Stoner. J., 1973. Mercury in some surface waters of the world oceans. Mar. Poll. Bull. 4 28–29.

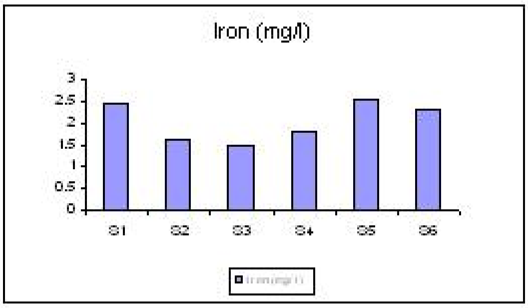
[4] Fernandez, T.V. and Jones, N.V., 1987. Some studies on the effect of zinc on Nereis diversicorlor (Polychaeta–Annelida). Trop. Ecol. 28 9–21.











[5] Frenet, S. and Kleeman, I., 1941. Cadmium food poisoning. J. Am. Med. Ass., 117 86–91.

[6] Geetha Bhadran.1997. Heavy metal pollution in Ashtamudi estuarine system. Ph.D. Thesis, Univ. of Kerala, Trivandrum.

[7] George Thomas, 1995. Comparative studies on the ecobiology of mangrove communities along the backwater system of Kerala. Ph.D. Thesis, University of Kerala, Trivandrum.

[8] Johnels, A., Westernamrk, T.W., berg, W., Person, P. and Sjostrand, B., 1967. Pike (Esox lucius L) and some other aquatic organisms in Sweden as indicators of mercury contamination in the environment, Oikos., 18 323–331.

[9] Lauwers, R., 1978. Health criteria for Cadmium. In: Cadmium 77, Proc.of the Ist International Cadmium Conference, San Fransisco, pp. 79–80.

[10] Nair, S.M. Balachand, A.N. and Nambisan, P.N.K., 1990. Metal concentrations in recently deposited sediments of Cochin backwaters, India. Sci. Total. Environ., 98 507–524.

[11] Nriagu, J.O. and Pacyana, J.M., 1988. Quantitative assessment of worldwide contamination of air, water and soils by trace metals, Nature 333 134–139.

[12] Padmalal, D., and Seralathan, P., 1991. Geochemistry of the Tertiary formation at Pozhikkara Cliff section,Kerala-Its palaeo environment significance Jour, Geol Publishing House,Meerut 850p.

[13] Paul, A.C. and Pillai, K.C., 1977. Trace metals in a tropical river environment–Distribution. Water,Air and Soil Pollut. 19 63–73.

[14] Ramalingam Pillai, A., Rema Devi, V., Saravanan, V. and Ouseph, P.P., 1994. Distribution of heavy metals and nutrients in the near shore sediments and waters along the South West coast of India. Proc. of the 6th Kerala Science Congress., TVM. 91–93.

[15] Schroeder, H.A., 1985. Cadmium as a factor in hypertension. I. Am. Med. Ass. 117 86.

[16] USEPA, 1980. Ambient water quality criteria for Zinc. Report No. EPA–440/5–pp. 80–079.

[17] Venugopal, P., Sarala Devi, K., Remani, K.N. and Unnithan, R.V., 1982. Trace metal levels in the sediments of Cochin backwaters. Mahasagar. Bull Nat. Inst. Oceanogr., 15 205–214.

[18] Wetzel, R.G., 1975. Limnology. W. B. Saunders company, Philadelphia.

[19] WHO, 1996. Guide lines for Drinking water Quality—2nd ed. 2 Health criteria and other supporting information.