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POLLUTION STATUS OF HEAVY METALS IN THE SOUTHERN STRETCHES OF RIVERINE STATIONS UNDER VEMBANADU LAKE

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ABSTRACT:

Vembanadlake is the largest estuarine ecosystem in Kerala. The lake is fed by major rivers like Achankovil, Manimala, Meenachil, Pampa and Moovattupuzha. Long-term stagnation of this lake had encouraged the accumulation of pollutants.The concentrations of Fe, Mn, Zn, Cu, Ni, Pb, Cd and Cr in water samples from Meenachal, Manimala, Pampa, Achankovil river stations were studied for four consecutive months. The Heavy Metal Pollution Index (HPI) was calculated from the data obtained for the water quality assessment based on heavy metal contamination of the four investigated rivers. The HPI values indicated that the water quality of the rivers except Achankovil was poor coming under the category of HPI: 50-75, which will be riskier to human health. The study is significant for creating awareness on the action plans forrestrictingthe pollutant influx into riversthere by creating a reductioninheavy metal pollution.

Keywords: - Carbohydrate, Chlorophyll, Crude fat, Crude fibre, Shade drying etc.

INTRODUCTION :

Heavy metals from industrial wastes are a major source of pollution. Anthropogenic activities generate industrial wastes, agricultural wastes, domestic wastes and mining release heavy metals into the environment. Heavy metals originate from both natural and anthropogenic sources (Mortvedt, 1996; Wei and Yang, 2010; Tiwari and Singh, 2014; Ali and Khan, 2018).

Among various organic and inorganic water pollutants, metal ions are found to be toxic, hazardous and harmful due to their non-degradable nature (Jumbe and Nandini, 2009). Concentrations of trace metals in coastal estuaries may be elevated due to high inputs from both natural and anthropogenic sources. Some metals were useful for the metabolic activity of the organism, but there is a narrow difference between their essentiality and toxicity.

Rapid growth in population leads to urbanization resulting in considerable land use, land covers changes, and creates a sequence of environmental and food security problems. Due to speedy urbanization the agricultural lands have been converted into no-agricultural activity (Tripathi, 2017). Such activities remove agriculturally productive topsoil, affects soil nutrient that is viable for agricultural growth. In addition to the removal of fertile top soil, it also emits harmful gases into the atmosphere which impacts the available natural resources. It was

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found that neighbouring areas of polluted water bodies has low organic matter content and soil nutrients, and high soil electrical conductivity , low pH, changes the chemical and biological characteristics of soil and water. It directly affects the food production system and could threaten the livelihood of present and future generations by degrading agricultural soil.(Jeetet al., 2021; Tripathi, 2017).

Vembanad Lake is the largest estuarine ecosystem in Kerala, India. The lake has got a freshwater-dominant southern zone and a saline-dominant northern zone, both separated by a causeway at Thanneermukkam, where the lake has its minimum width. Vembanadu Lake is part of the Vembanadu Kole wetland system, which extends from Alappuzha in the south to Azheekkode in the north (Radhakrishnan and Jayaprakas, 2015; Kolathayaret al., 2019).

The lake is fed by major rivers like Achankovil, Manimala, Meenachil, Pampa and Moovattupuzha. The Vembanadu wetland has created its own network of estuaries, lagoons and canals. The Vembanad wetlands have been listed as Wetlands of International Importance under the Ramsar Convention for the Conservation and Sustainable Use of Wetlands (Arya and Syriac, 2018).

Long-term stagnation of the Vembanaduwater body had encouraged the accumulation of pollutants towards the south of the barrage causing threatening to fisheries, human health and tourism. Sources of these pollutants were domestic sewage, untreated sewage from motor launches and houseboats, municipal and hospital waste, industrial and agricultural waste and coir soaking net, kerosene and oil exhaust from motorboats (Pakistan, 2016). The use of chemicals like insecticides, fungicides, nematicides and rodenticides were increasing widely in the Kuttanadu ecosystem. Sediments could contain and accumulate many metals added to natural water. Favourable physicochemical conditions of the sediment can remobilize and release metals into the water column. Toxic metals werebio-accumulative and relatively stable, as well as carcinogenic, and therefore required careful monitoring (Gupta and Ali, 2001). Moreover suspended sediments from dredging activities caused changes in water quality (Kjelland, 2015).

The main crop of Kuttanad is rice in the wetlands with coconut and vegetables on the surrounding slopes. It has been reported that about 500 tonnes of pesticides and about 20,000 tonnes of fertilizers are used annually in the Kuttanad region and a portion of this enters the waterways and lakes when water is pumped out of the paddy fields (Kumar and Kunhamu, 2021; Sruthi et al., 2017). Under these circumstances, a study on the status of heavy metal pollution in the southern stretches of the river stations below the Vembanadulake was conducted to assess heavy metal contamination in the Achancovil, Manimala, Meenachil and Pamapa river stations.

MATERIALS AND METHODS

2.1 Water Sampling

Sampling was carried out during the year 2016 to 2017 before the2018 floods in Kuttanadu. Data on heavy metals like iron, manganese, zinc, copper, nickel, lead,cadmiumand chromium for the months of January, February, March and April were collected for the study. Water samples were randomly collected from different riverine locations in the southern stretches of Vembanad wetlands covering four sampling locations (fig.1).The water samples collected at a depth of one foot from water surface consisted of 3 composite samples from each site. Samples were collected and placed in an ice-box and transported to the laboratory immediately for further analysis. The collected samples were filteredand acidified with concentrated nitric acid as suggested by the standard procedure. The concentrations of heavy metals were

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determined using atomic absorption spectrometry after acid-digestion procedure (APHA, 2012). All analyses were carried out in triplicate, and the results were expressed as mean.

2.2 Heavy metal pollution index (HPI)

Effect of heavy metals on water quality was assessed based on heavy metal pollution index developed and formulated in terms of itsconcentration in water samples (Mohan et al., 1996).

The HPI shows the overall quality of water with respect to content of the heavy metals. The weighted arithmetic average of the concentrations was used to calculate HPI values using the Eq. 1 Where Wi is the unit weightage defined as the reciprocal value of Si where Si is the maximum permissible limit for drinking water given by BIS (2012), and n is the number of parameters considered. Qi isthe sub-index of the with parameter and calculated by Eq. 2

HPI= $\sum_i^n W_iQ_i / \sum_i^n W_i$ Eq 1

Qi=$\sum_i^n (M_i-I_i)/(S_i-I_i) \times 100$ Eq 2

Where Mi is the monitored value of heavy metalin ppb(µg/L),Si is the standard value (maximum permissible limit) of the ith parameter (µg/L), Ii is the ideal value of the ith parameter (Prasad and Bose, 2001).

RESULT AND DISCUSSION:

Analysis of heavy metals in water samples from four riverine stations viz., Manimala,Meenachil,Achankovil and Pampa in the year 2016-17 revealed the presence of iron, Manganese, Zinc, Copper, Lead, Cadmium, and Nickel. Chromium was below detectable level in all the water samples. Highest concentration of 103ppb in Iron was observed forMeenachil river water samples (table 4).Manimala and Meenachil river water samples recorded high concentration of cadmium when compared to other river stations(Table3 and Table 4). Highest concentration of lead and zinc was 3.07 ppb and 14ppb respectively which was found in water samples from Pampa river (Table2). The average heavy metal concentration of Achankovil river is given in Table 1.

3.1 Data evaluation and indexing approach

The Heavy Metal Pollution Index (HPI) is a very useful tool for assessing the overall pollution of water bodies with regard to heavy metals. The HPI of four river stations Manimala, Meenachil, Achankovil and Pampa was calculated. Average concentrations of each of the eight heavy metals (Fe, Mn, Zn, Cu, Pb, Cd, Cr and Ni) for four consecutive months from January to April were measured and HPI values were determined. Table 5 provides details on the calculation of HPI, Wi and Qi valuesquoting data from Achankovilwas set as an example. The critical value of the heavy metal pollution index is 100 (Milivojević, 2016). The HPI status categories are shown in Table 6. The HPIs of different sampling sites were compared to assess the pollution load and water quality assessment for the selected sites in Table 7.

Examination of the data revealed that the maximum HPI of 68.39 was observed for Pampa river station, followed by Manimala (HPI-59.46) and Meenachil (HPI-59.330). This indicated the poor water quality of these rivers with respect to the level of heavy metals contents indicating significant pollution. This representationhad a long-lasting threat to human health. This maybe mainly due to industrial and domestic waste/waste-water discharge into river.

The least HPI was observed at the Achankovil River (HPI-38.01). Among various organic and inorganic water pollutants, the metal ions are found to be toxic, hazardous and harmful due to their non-degradable nature (Jumbe and Nandini, 2009). Sediments are the final repository of many chemical compounds including heavy metals from natural and anthropogenic sources. Favourable physico-chemical conditions of the sediment can remobilize and release metals into the water

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column. Hence contaminated sediments can endanger creatures in the benthic environment (Begum et al., 2009). Sixteen major industries around Cochin discharge had nearly 0.104 million m3/d of waste containing organic load released into nearby backwaters. The Cochin estuarine system receives annual effluents containing a large amount of heavy metals (Balachandran et al., 2002).

The high HPI values were mainly caused by industrial and domestic wastewater discharged into the river. HPI values were above the critical index limit at all sites except Achankovil. The HPIs for the four river stations were calculated and presented in Table 7.

CONCLUSION:

In conclusion, our study on the pollution of river stations in Achankovil, Manimala, Meenachil and Pampa showed that all places except Achankovil were polluted by heavy metals which was classified as poor quality and unsafe for drinking, mainly due to discharge of pollutants from industry, agricultural waste and tourism. The study could significantly contribute in creating awareness campaigns, designing control measures and action plans to reduce the inflow of pollutants into rivers.

CONFLICT OF INTERESTS: - The authors declare that there is no conflict of interests regarding the publication of this paper.

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Table1: Average of heavy metal concentration (ppb) in Achankovil river

Month	Fe	Mn	Zn	Cu	Pb	Cd	Cr	Ni
January	61	14	Trace	89	0.80	0.15	0	0
February	320	30	43	24	2.60	0.10	0	0
March	0	Trace	Trace	0	1.10	0.34	0	0
April	14	Trace	Trace	0	2.34	0.02	0	0
Sum	**395**	**44**	**43**	**113**	**6.84**	**0.62**	**0**	**0**
Mean	**98.75**	**11**	**10.75**	**28.25**	**1.71**	**0.15**	**0**	**0**

Table2: Average of heavy metal concentration (ppb) in Pampa river

Month	Fe	Mn	Zn	Cu	Pb	Cd	Cr	Ni
January	11	10	42	80	2.40	0.15	0	0
February	330	28	0	23	3.50	0.30	0	0
march	13	0	0	0	3.06	0.18	0	0
April	4.7	0	14	0	3.40	0.11	0	0
Sum	**358.70**	**38**	**56**	**103**	**12.36**	**0.74**	**0**	**0**
Mean	**89.68**	**9.50**	**14**	**25.75**	**3.09**	**0.19**	**0**	**0**

Table3: Average of heavy metal concentration (ppb) in Manimala river

Month	Fe	Mn	Zn	Cu	Pb	Cd	Cr	Ni
January	15	8	38	97	2.3	0.2	0	0
February	290	30	0	24	2.8	0.15	0	0
march	85	0	0	0	1.2	0.18	0	0
April	6	0	0	0	4.4	0.298	0	0
Sum	**396**	**38**	**38**	**121**	**10.7**	**0.83**	**0**	**0**
Mean	**99**	**9.5**	**9.5**	**30.25**	**2.68**	**0.21**	**0**	**0**

Table4: Average of heavy metal concentration (ppb) in Meenachil river

Month	Fe	Mn	Zn	Cu	Pb	Cd	Cr	Ni
January	90	21	0	19	2.68	0.11	0	0
February	320	30	46	27	3.4	0.28	0	0
march	1.5	0	0	0	3.85	0.23	0	0
April	1.0	0	0	0	0.83	0.22	0	0
Sum	**412.5**	**51**	**46**	**46**	**10.76**	**0.84**	**0**	**0**
Mean	**103.12**	**12.75**	**11.5**	**11.5**	**2.69**	**0.21**	**0**	**0**

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Table 5: HPI calculation for riverine water samples from Achankovil

Heavy metal	Concentration (ppb)mi	Standard permissible level(ppb) Si	Ideal level(ppb) Ii	Unit Weightage, Wi	Sub index (Qi)	Wix Qi
Fe	98.75	300	0	0.0033	32.92	0.1097
Mn	11.00	300	100	0.0033	44.50	0.1483
Zn	14.33	15000	5000	0.0001	49.86	0.0033
Cu	28.25	1500	50	0.0007	1.50	0.0010
Pb	1.71	3	0	0.3333	57.00	19.0000
Cd	0.1543	10	0	0.1000	1.54	0.1543
Cr	0	50	0	0.0200	0.00	0.0000
Ni	0	20	0	0.0500	0.00	0.0000
				£ Wi=0.5107		£ WixQi= 19.416
			Heavy metal pollution index HPI=19.416/0.5107=38.018			

Table 6: Status categories of HPI

Sl no	HPI	Category
1	<25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very poor
5	>100	Unsuitable for drinking

Table 7: Comparison of water quality based on HPI of different riverine

Sl no	River stations	Heavy metal pollution index (HPI)	Category
1	Achankovil	38.02	Good
2	Pampa	68.41	Poor
3	Manimala	59.46	Poor
4	Meenachil	59.33	poor

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