Original Research Article

AN IN-DEPTH STUDY ON TRACE METALS IN NEYYAR RIVER SITES, KERALA, INDIA

ABSTRACT:

Rivers are one of the most important waterbodies depended on by the whole environment for their daily lives. But now a days, water-related incidents are increasing much more because of the improper lifestyle of human beings. Trace metals are one of the main causes of the contamination of water. The present study deals with the analysis of five trace metals such as at five selected sites in the Neyyar River by using an atomic absorption spectrophotometer. The study period is from March 2022 to February 2023. According to rainfall the study period was portioned into three main seasons, monsoon (March 2022 to June 2022), post monsoon (July 2022 to October 2022) and pre monsoon (November 2022 to February 2023). Statistical analysis was done by the help of Two-way analysis of variance (ANOVA). Trace metals such as nickel, zinc, copper, iron, and manganese were selected for this study. It shows variation in some parameters. The water in the Neyyar River is in good condition.

Keywords: Neyyar River, Trace metals, Anova, significance

INTRODUCTION:

Rivers are getting polluted day by day due to environmental and human-induced pollution habits, mainly due to urbanization. Heavy metals are one of the main polluting agents in water. The term heavy metal refers to a combination of a group of metalloids with a density of 4 g/cm^3, which is greater than water (Duruibe *et al.*, [10]). Presently, the environmental pollution caused by trace metals is one of the major problems facing the entire world. Increase in the level of heavy metals that directly affects the whole environment. In order to reduce the pollution occurring in the environment and also to control the degradation of water resources, it is important to find the concentration of trace metals in water. Contamination of river water by heavy metals poses a risk to human health. Heavy metals are also known as trace metals because they are found in minute concentrations in universe. Heavy metals such as mercury, lead, and aluminium are the most common toxic metals that can accumulate in living organisms through waterbodies. Metals, including chromium, zinc, cadmium, lead, copper, and nickel, have more toxic importance in rivers (Jose and Takako [13]). Several researchers studied the trace metals in fresh water all over the world. Seasonal analysis of heavy metals in the Muvattupuzha and Periyar Rivers was conducted by Anju *et al.* [3]; the evaluation of heavy metals in the Ona River, Nigeria, was studied by Aina *et al.* [1]; pollution in soil water vegetation irrigated with ground water by heavy metals was analysed by Bharose *et al.* [7]; analysis of heavy metal in surface water of North Alabama was done by Okweye [17], Study on heavy metals in Narmada River water was done by Hussain *et al.* [11], study on contamination of heavy metals in river Yamuna was done by Nupur [16], a study on trace metals in the Neyyar River was conducted by Ancy Mol *et al.* [2]; Study on toxic metals in Cauvery river water was done by Bhuvaneshwari *et al.* [8], a study on heavy metals in Noyyal River water was done by Babunath and John [5]; Distribution of heavy metals in Godavari River basin was done by Jakir *et al.* [12], study on heavy metal contamination in River Ganga was done by Singh *et al.* [19], contamination of surface water in the Neyyar River by heavy metals was analysed by Badusha and Santhosh [6]; study on water in Kor River, Iran was done by Mokarram *et al.* [15] and presence of heavy metals in aquatic environment raises critical worries with respect to its immediate effect on biota and its backhanded ramifications for human wellbeing (Khan *et al.* [14]).

MATERIALS AND METHODS:

Study Area

The river Neyyar is the southernmost river in Kerala. It originated in Agasthyarkoodam, in the Western Ghats. It has a length of 56 km, is located from 8° 36' 56.2428" N and 77° 14' 45.5604" E to 8° 18' 20.0124" N and 77° 4' 47.0064" E, and reaches the Arabian Sea. Five sites of Neyyar river, including Arattu Kadavu (S1), Arakkunnu (S2), Vadakkekotta (S3), Alatharackal (S4), and Panchikattu Kadavu (S5), were selected for the present study. Between each site, there is a distance of more than 2 kilometres.

Sampling Method

Monthly samples were collected from each site early in the morning from march 2022 to February 2023. Two litres of fresh polythene sterilized bottles are used to collect the sample. In order to maintain a constant pH, 4 ml of pure nitric acid was added to each water sample. Then it is stored in sampling kits in order to maintain a temperature of 4˚C. The collected samples are immediately transferred to the laboratory for metal analysis. The analysis of metals from water samples was done by following the standard methods of APHA [4] and the FSSAI manual of methods of analysis of foods and water (2016). According to the rainfall, the whole study period is divided into 3 seasons, i.e., monsoon (March 2022 to June 2022), post monsoon (July 2022 to October 2022), and pre monsoon (November 2022 to February 2023).

Metal Analysis

Analysis of metals such as nickel, zinc, copper, iron, and manganese from water samples was done by following standard methods (APHA and FSSAI manual of analysis of water). The collected water samples are acidified with concentrated nitric acid. A sample of 100 cm^3 was collected in a beaker and digested with conc. HNO_3 at 120°C until a clear solution occurred (APHA, 2017). Then the sample is kept at 4°C before analysis. Heavy metals such as nickel, zinc, copper, iron, and manganese in the water sample was analysed using Atomic Absorption Spectrophotometer (AAS) i.e., Flame Atomic Absorption Spectroscopy method. Two-way analysis of variance (ANOVA) is used here for each heavy metal between seasons and also between sites.

RESULT AND DISCUSSION:

Trace metals have a major importance in both environmental and health issues due to their high toxicity for living organisms. The main sources of trace metals include weathering, mining, agricultural wastes from fields, burning of fuels, smelting, electroplating, incineration, and industrial wastes that were mixed with water bodies. The annual average of all trace metals was compared with standard drinking water quality, including WHO (2008), USEPA (2000), and BIS [8] (Table 1). The annual variation of trace metals such as nickel, zinc, copper, iron, and manganese is illustrated in Table 1. Two-way ANOVA for the selected trace metals is illustrated in Table 2.

Table 1: The comparison of trace metals in water in Neyyar River with national and international drinking water quality standards

Metals	Annual Average					BIS (IS 105000) (in mg/L)		WHO guideline (in mg/L)		USEPA (in mg/L)	
	S1	S2	S3	S4	S5	A	B	A	B	A	B
Nickel	0.112	0.084	0.097	0.092	0.143	-	0.2	-	0.1	-	-
Zinc	1.747	1.562	2.325	2.116	1.875	-	5	-	5	-	5
Copper	0.349	0.307	0.291	0.328	0.368	0.05	0.3	1	2	1	-
Iron	0.274	0.500	0.692	0.674	0.923	0.3	1	0.3	-	-	-
Manganese	0.032	0.021	0.025	0.028	0.030	0.05	0.3	0.05	0.5	-	0.05

Table 2: Two-way analysis of variance (ANOVA) of trace metals in water between sites and stations

Trace Metals	Comparison	F	p-value	F-crit
Nickel (mg/L)	Between Sites	1.641	0.255	3.838
	Between Season	4.744	0.044	4.459
Zinc (mg/L)	Between Sites	0.622	0.660	3.838
	Between Season	0.362	0.707	4.459
Copper (mg/L)	Between Sites	0.386	0.814	3.838
	Between Season	1.554	0.269	4.459
Iron (mg/L)	Between Sites	19.809	0.003	3.838
	Between Season	4.376	0.052	4.459
Manganese (mg/L)	Between Sites	1.141	0.403	3.838
	Between Season	1.470	0.286	4.459

Nickel is a ferromagnetic, hard metal that seems white in colour. The process of leaching, when the water comes into contact with pipes and fittings, is the primary source of nickel in drinking water. Fertilisers, detergents, metal plating, fuel combustion, and coinage are the main sources of nickel in water (Reimann and de Caritat [17]). The monthly variation of nickel at five different sampling sites in the present study area is shown in Figure 1. The levels of nickel during monsoon, post monsoon, and pre monsoon are 0.068 mg/L at S2 to 0.123 mg/L at S3, 0.083 mg/L at S2 to 0.195 mg/L at S5, and 0.030 mg/L at S3 to 0.133 mg/L at S5. The monthly variation of the amount of nickel in selected sites of the Neyyar River is shown in Figure 1. Two-way ANOVA shows no significant difference in nickel between sites hence, hypothesis is accepted and there is significant difference between seasons hence, hypothesis is rejected (Table 2). In the present study, analytical data of nickel is within the permissible limit of BIS (2012), WHO (2008) and USEPA (2000) except sites S1 and S2 (Table 1).

Zinc is a metallic element that is found naturally. The main sources of zinc are chemical industries, domestic wastes, and soil, which get mixed with rainwater and discharged into the river. The levels of zinc at each site during monsoon, post monsoon, and pre monsoon include 1.072 mg/L at S2 to 2.581 mg/L at S3, 1.522 mg/L at S3 to 2.792 mg/L at S5, and 1.095 mg/L at S1 to 2.874 mg/L at S3. The monthly variation of the amount of zinc in selected sites of the Neyyar River is shown in Figure 2. Two-way ANOVA shows no significant difference in zinc between sites hence hypothesis is accepted and there is no significant difference between seasons hence, hypothesis is accepted (Table 2). In the present study, analytical data of zinc is within the permissible limit of BIS (2012), WHO (2008) and USEPA (2000) (Table 1).

Normally, a small amount of copper is found in water, which is because of anthropogenic and natural sources. Naturally by weathering, from rocks and soils. The levels of copper at each site during monsoon, post monsoon, and pre monsoon include 0.180 mg/L at S3 to 0.384 mg/L at S4, 0.258 mg/L at S4 to 0.379 mg/L at S2, and 0.232 mg/L at S2 to 0.497 mg/L at S5. The monthly variation of the amount of copper in selected sites of the Neyyar River is shown in Figure 3. Two-way ANOVA shows no significant difference in copper between sites hence, hypothesis is accepted and there is no significant difference between seasons hence, hypothesis is accepted (Table 2). In the present study, analytical data of copper is within the permissible limit of BIS (2012), WHO (2008) and USEPA (2000) (Table 1).

Iron is included in the trace metals. It is found in earth's crust as 5% level. The levels of iron at each site during monsoon, post monsoon, and pre monsoon include 0.256 mg/L at S1 to 0.927 mg/L at S5, 0.259 mg/L at S1 to 0.771 mg/L at S5, and 0.304 mg/L at S1 to 1.099 mg/L at S5. The monthly variation of the amount of iron in selected sites of the Neyyar River is shown in Figure 4. Two-way ANOVA shows significant difference in iron between sites hence, hypothesis is rejected and there is no significant difference between seasons hence hypothesis is accepted (Table 2). In the present study, analytical data of iron is within the permissible limit of BIS (2012), WHO (2008) and USEPA (2000) (Table 1).

The levels of manganese at each site during monsoon, post monsoon, and pre monsoon include 0.019 mg/L at S2 to 0.030 mg/L at S5, 0.025 mg/L at S3 to 0.048 mg/L at S1, and 0.013 mg/L at S2 to 0.036 mg/L at S4. The monthly variation of the amount of manganese in selected sites of the Neyyar River is shown in Figure 5. Two-way ANOVA shows no significant difference in manganese between sites hence hypothesis is accepted and there is significant difference between seasons hence, hypothesis is rejected (Table 2). In the present study, analytical data of zinc is within the permissible limit of BIS (2012), WHO (2008) and USEPA (2000) (Table 1).

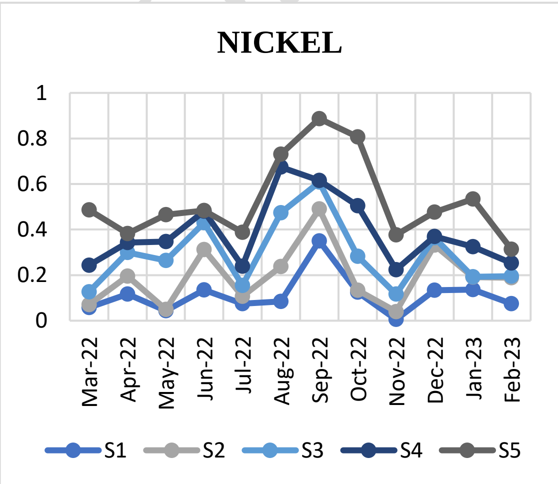

Figure 1: Monthly variation of amount of nickel in selected sites of the Neyyar River

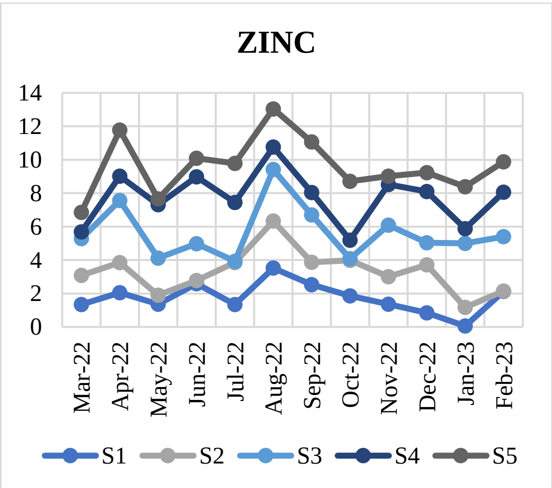

Figure 2: Monthly variation of amount of zinc in selected sites of the Neyyar River

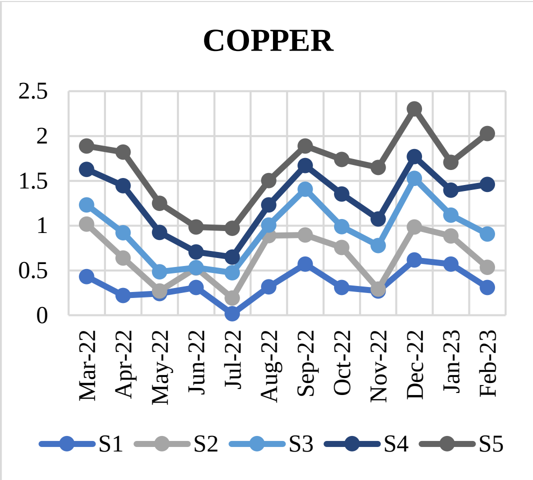

Figure 3: Monthly variation of amount of copper in selected sites of the Neyyar River

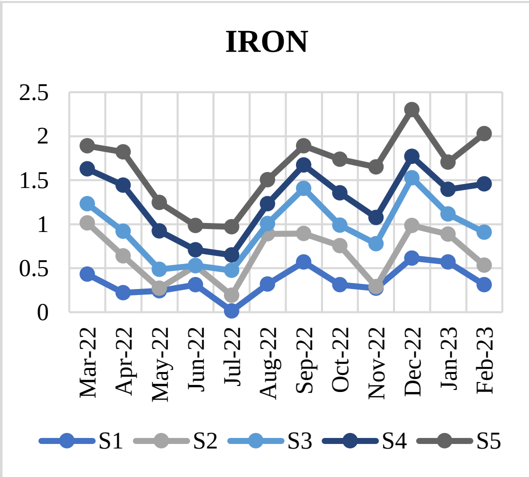

Figure 4: Monthly variation of amount of iron in selected sites of the Neyyar River

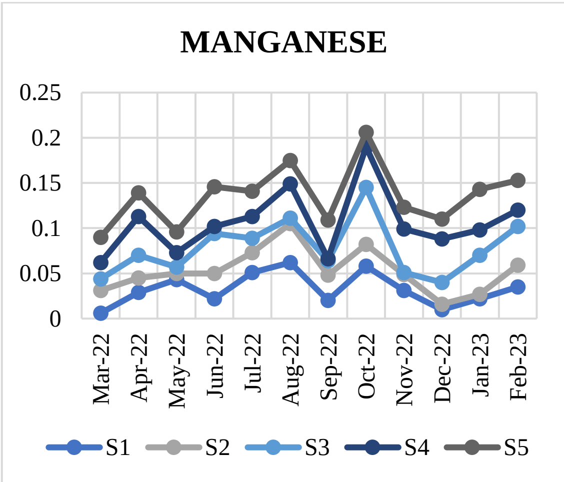

Figure 5: Monthly variation of amount of manganese in selected sites of the Neyyar River

CONCLUSION:

In the Neyyar River, all the trace metals are found under the permissible limits except the trace metal nickel when compared with the drinking water standards of WHO (2008), BIS (2012), and USEPA (2000). The concentration of trace metals was low at S1, and it increased when it reached S5. The increase in the concentration of trace metals in the downstream is due to the presence of anthropogenic pollutants. Overall, the quality of Neyyar River water is good and can be used for further purposes.

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