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Assessment of Some Trace Elements and Heavy Metals in river Jhelum of Kashmir Valley

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ABSTRACT: Trace elements are ubiquitous in the environment and have been recognised as one of the vital pollutants to river system. The Jhelum is greatly utilised for its water and food such as fish. Since it passes through many rural and urban settlements, the river gets polluted with sewage from settlements, agricultural runoff and effluent discharges from various industrial units. The effluent that finds its way into the river contains various types of pollutants including trace elements that get accumulated in riverine ecosystem including flora and fauna. In the light of such important concern, the present study was undertaken to evaluate the levels of some trace elements in water. For the purpose we have designed the study with trace elements such as As, Zn, and Cu, in water collected from six selected sites on seasonal basis and were analyzed as per standard methodology of APHA (2005). Trace elements in Jhelum river water were analyzed by ICP-OES and the data were subjected to statistical analysis by means of standard statistical packages. Significant levels of trace elements were found in water and were found to follow the trend as: Qamarwari > Aaramwari > Sopore >Baramulla>Bijbehara>Verinag. Among all studied trace elements, Zn concentration was recorded more in water as compared to other heavy metals. It is, therefore, suggested that trace element pollution, if ignored, can lead to alarming situation and steps should be taken to limit it.

Key words: Jhelum river, Trace elements, Heavy metals

I. INTRODUCTION

Trace elements and heavy metals are integral part of the environment, from abiotic to biotic and all kinds of lives, from human to microorganisms, anthropogenic activities including agriculture, landscape disturbances, mining, industrialization and habitat disturb balanced-environment with deficiency or loading of essential, non-essential and toxic elements into soil, air and ground and surface waters, have heavily affected human and animal health[1]. The weathering of rocks and minerals is too a big source of heavy metal contamination. Trace elements can participate in various biochemical processes, have significant mobility, can affect the ecosystem through the bioaccumulation and biomagnification processes and are potentially toxic for environment and human life [2]. Trace elements can disturb normal behavioural functioning of fish while damaging nervous system with enhanced lipid peroxidation, which is one of the most important organic expressions of the oxidative stress[1]. This shows that excessive presence of toxic trace elements could be one of the risk factors to decline of the fish population in aquatic ecosystem [3]. Aggravated concentrations of these heavy metals like As, Cd, Cr, Pb, etc. could be hazardous to riverine ecosystem wherein they can pose toxicity to fish and imbalance water chemistry as well. These heavy metals and trace elements after build up in the body of aquatic organisms make their way into food chain which are consumed by humans and cause toxicity. Accumulation, biotransformation, adsorption or absorption of these elements depend on various characteristics like, concentration of trace elements in water, physico-chemical properties of water, physico-chemical properties of these elements and distribution in body [4]. Some trace elements like Fe, Zn, Cu and Mn have been reported to be biologically important for growth and regulation of human body.

In very small quantities, Cr and Ni are essential in the body. However, some other trace elements like As, Cd and Pb have no known significance in human physiology and biochemistry and intake of these trace elements even at very low concentrations can be toxic. Even for those that are biologically important, dietary intake need to be within regulatory limits as their excess intake cause harm or toxicity [5,6].

The valley has a total water spread area of about 32765.3 hectares which constitutes about 2 per cent of the total area of Kashmir. The aquatic resources are in the form of rivers, canals, reservoirs, wetlands, rivulets, lakes, streams, nallahs, ponds and ditches. The river Jhelum along with its tributaries comprises the largest river system in Kashmir and is responsible for the water supply to most parts of the valley for irrigation and domestic purpose. During past three decades, rapid increase in population, urbanization, industrialization and unsustainable agricultural practices have heavily polluted the fresh water resources of Kashmir. Water from the farms, commonly known as agricultural run-off, draining into the rivers, is one of the major sources of water pollution to rivers with chemical fertilizers, pesticides, heavy metals and organic residues [7].

II. MATERIALS AND METHODS

For the study, the entire stretch of Jhelum was divided into six different sampling sites falling in three discrete regions. The sampling sites were selected on the basis of social geography, settlements, agricultural inputs, urban, rural, commercial and population pressure along either banks of the river Jhelum (Fig. 1). Sampling has been carried out in all the four seasons of the year.

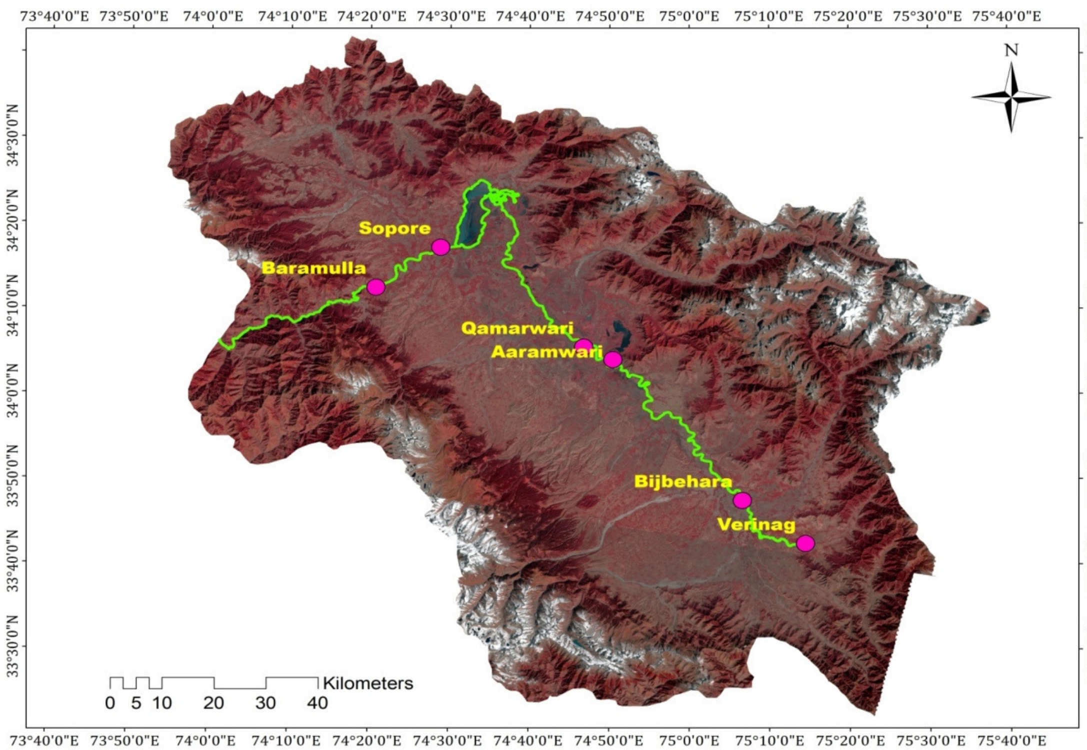

Fig. 1. Study area map with sampling sites.

The sampling sites have been divided into three regions:

Upstream region (Verinag and Bijbehara)

Middle stream region (Aaramwari and Qamarwari)

Downstream region (Sopore and Baramulla)

A volume of 500 ml water sample was collected from the depth of 30 cm and immediately transported to laboratory where the samples were filtered and then acidified with a few drops of concentrated HNO_3 and was preserved in polythene bottles for subsequent trace element analysis using Inductively Coupled Plasma Optical Emission Spectrophotometer (Varian Vista MPX, 720). The trace elements estimated include Cu, As and Zn.

III. RESULTS

In summer season, minimum concentration of As (0.10 µg/L) was recorded at Bijbehara and maximum (0.52 µg/L) was recorded at Qamarwari. In autumn, the highest As concentration (0.57 µg/L) was recorded at Qamarwari and lowest value (0.10 µg/L) was recorded at Bijbehara. During winter season, the maximum as concentration (0.61 µg/L) was recorded at Qamarwari and lowest (0.10 µg/L) was found at Sopore. In spring season, the highest As concentration (0.43 µg/L) was recorded at Qamarwari and lowest (0.10 µg/L) was recorded at Aaramwari (Table 1).

In summer season, the maximum Zn concentration (46.01 µg/L) was recorded at Qamarwari and lowest (8.02 µg/L) was found at Verinag. In autumn, again the highest Zn Concentration was observed at Qamarwari (76.44 µg/L) and lowest (14.64 µg/L) at Verinag. During winter season, the maximum Zn concentration (77.28 µg/L) was recorded at Aaramwari and lowest (20.51 µg/L) at Baramulla. In spring season, the highest Zn concentration (107.21 µg/L) was recorded at Qamarwari and lowest (8.68 µg/L) was recorded at Verinag (Table 1).

Table 1: Trace element and Heavy metal content of water in river Jhelum.

Parameters(µg/L)	Season	Verinag	Bijbehara	Aaramwari	Qamarwari	Sopore	Baramulla
Arsenic	Autumn	BDL	0.10 ± 0.01	0.10 ± 0.00	0.57 ± 0.03	0.10 ± 0.01	0.12 ± 0.00
Zinc		14.64 ± 1.71	36.13 ± 2.33	67.68 ± 1.33	76.44 ± 1.03	46.01 ± 2.05	31.02 ± 0.95
Copper		BDL	12.84 ± 1.41	22.39 ± 1.17	35.89 ± 1.05	47.73 ± 0.93	61.83 ± 1.70
Arsenic	Summer	BDL	0.10 ± 0.00	0.14 ± 0.00	0.52 ± 0.02	0.18 ± 0.01	0.16 ± 0.00
Zinc		8.02 ± 0.54	18.14 ± 2.13	28.52 ± 1.14	46.01 ± 2.35	31.88 ± 1.94	16.58 ± 2.12
Copper		BDL	7.52 ± 0.64	13.79 ± 1.20	22.87 ± 1.56	36.15 ± 1.25	46.47 ± 2.23
Arsenic	Winter	BDL	0.11 ± 0.00	0.12 ± 0.01	0.61 ± 0.01	0.10 ± 0.00	0.12 ± 0.01
Zinc		20.91 ± 0.63	47.44 ± 1.62	77.28 ± 2.18	44.55 ± 2.31	29.13 ± 1.31	20.51 ± 0.91
Copper		5.99 ± 1.68	19.24 ± 0.69	30.20 ± 1.63	26.08 ± 1.37	35.49 ± 1.38	31.23 ± 2.57
Arsenic	Spring	BDL	BDL	0.10 ± 0.01	0.43 ± 0.01	BDL	BDL
Zinc		8.68 ± 0.66	60.65 ± 1.60	97.36 ± 2.09	107.21 ± 2.59	48.79 ± 11.14	14.61 ± 1.78
Copper		BDL	10.97 ± 1.24	11.02 ± 1.19	17.88 ± 1.36	15.87 ± 1.84	10.12 ± 1.59

Data are given in Mean ± Standard error, n = 05, BDL = Below Detection Limit

In summer season, the maximum value of Cu (46.47 µg/L) was recorded at Baramulla and lowest (7.52µg/L) at Verinag. In autumn, again the highest value of Cuwas observed at Baramulla (61.83µg/L) and lowest (12.84µg/L) was recorded at Bijbehara. During winter season, the maximum Cu concentration (35.49 µg/L) was recorded at Sopore and lowest (5.99 µg/L) was found at Verinag. In spring season, the highest Cu concentration (17.88 µg/L) was recorded at Qamarwari and lowest (10.12 µg/L) was recorded at Baramulla (Table 1).

IV. DISCUSSION

Trace elements in general and heavy metals in particular are major toxicants present in surface water [8]. There are several reports of trace element contamination of surface water in many areas of India [7,9,10]. Pollution of heavy metals has been assessed to be influenced by distribution of particle size and the organic content present in water system [11,12]. The bioavailability of heavy metals depends on the concentration of anions, chelating agents present in the water, pH and the presence of absorptive sediments. Mishra (1990) [13] and Kannan (1991) [14] studied environment pollution and suggested that increase in trace element in surface water was due to addition of effluents from industrial and commercial areas.

During the present study, all trace elements showed significant fluctuation at different sites during different seasons.

Arsenic (As) is the 20th most common element in the earth's crust and is associated with igneous and sedimentary rocks. Although elemental As is not soluble in water, its salts exhibit a wide range of solubilities depending on pH and the ionic environment. In nature, As can exist in both inorganic and organic forms. Arsenic (As^{+3}) and arsenate (As^{+5}) are the inorganic while monomethylarsenic acid, dimethylarsenic acid, arsenobetaine, arsenocholine, arsenolipids and arsenosugars are the organic forms of arsenic [15]. Arsenicals are used commercially as alloying agents in the manufacture of transistors lasers and semiconductors, as well as in the processing of glass, pigments, textiles, paper, metal adhesives, wood preservatives and ammunition. The level of As in natural waters ranges from 1 to 2 µg/L [16]. Concentrations of As elevates in the areas having volcanic rock and sulphide mineral deposits and having human activities [16,17,18]. Traces of As have been found at all sites except Verinag. Though the range of As detected in Qamarwari was well below the detected limit, it was higher than other regions. It suggests that middle stream of the Jhelum river receiving toxic wastes more compared to other catchment area of the Jhelum.

Moreover, As concentration has been recorded more in summer and autumn compared to winter and spring seasons. Zinc, an essential metal, is a functional component of many metabolic processes; maintains a healthy immune system and plays essential role in normal body growth and development. Zn-dependent transcription factors and Zn-metalloenzymes are essential substances for many physiological functions [19]. The sources of Zn include mining of Zn ores and wastes from industries manufacturing products such as corrosion-resistant alloys and galvanized iron and steel products. Zinc oxide, used as a white pigment in rubber, for example, is the most common industrial Zn compound [20]. Tyre wear is a major source of Zn input in the environment. The other two major commercial Zn compounds are zinc chloride used in dry cells and Zn use in electroplating. Other sources of Zn include fertilizers and pesticides (zinc phosphide and zinc sulphide), printing processes, building materials, sewage wastewater, animal wastes, coal combustion and atmospheric depositions. The presence of Zn at levels above 3 mg/L makes drinking water opalescent and produces an undesirable stringent taste [21]. One of the major consequences of chronic Zn ingestion is the manifestation of Cu deficiency [22]. In aquatic ecosystems, Zn is an essential micro-nutrient but at higher concentrations, it can cause toxicity to animals. The Zn aquo-ions and other species are injurious to aquatic life at low pH, DO, alkalinity and higher temperatures of water. Zn concentration in the river water was found fluctuating significantly at all sampling sites throughout the study span. Maximum values of Zn were recorded during summer and autumn seasons at Qamarwari indicating maximum anthropogenic activities in the area [21].

Copper is one of the essential metals to sustain healthy development of the living organisms because many physiological processes depend on its presence. However, exposure to higher concentration produces many toxic effects in the biota [23]. Industrial waste, mining and metal plating are common sources of Cu in natural waters. The Cu is extensively used commercially because of its versatile nature. It is employed in plumbing, roofing and in chemical industry, for examples, as paints and pigments and azo dye manufacture [24]. Copper salts are applied in water supply systems for oxidation of Mn and also for biological growth control in reservoirs and distribution pipes. Copper compounds also find use in fungicides, insecticides, algicides, wood preservatives, electroplating, lithography, pyrotechnics, engraving, petroleum refining. Long term exposure to high level of Cu can give rise to several disorders such as irritation in eyes, nose and mouth, dizziness, stomach-ache, vomiting and diarrhoea. In severe cases liver and kidney damage may occur [23]. At concentrations in excess of about 3 mg/L, Cu can cause gastrointestinal irritation in some individuals [24]. Cu is found in surface water, groundwater, seawater and drinking-water, but it is primarily present in complexes or as particulate matter. Cu concentration in drinking-water varies widely as a result of variations in water characteristics, such as pH, hardness and Cu availability in the distribution system. Higher concentration of Cu was detected at Baramulla in all seasons which might be attributed to the cumulative effect of wastes diverted into Jhelum. Our results are supported by the findings of Prasath and Khan (2008) Sharma and Y.K. Walia [25-26].

V. CONCLUSION

The seasonal variation in water quality was found due to the regular inputs of pollutants from natural and anthropogenic activities. The results of the present study have indicated that trace elements have made their entry into the aquatic ecosystem and are a matter of great concern.

Trace element levels in water and sediment were found to follow the trend: Qamarwari > Aaramwari > Sopore > Baramulla > Bijbehara > Verinag. The presence of toxic trace elements in water is a matter of concern as it may impact on fish population production and cause health problems to humans. Concerned authorities at national, state and district level should take immediate measures (such as complete ban on discharge of untreated industrial effluents and municipal sewage into the river) for restoration of river Jhelum.

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