INTERNATIONAL JOURNAL OF ENVIRONMENT

Volume-3, Issue-3, Jun-Aug 2014 **ISSN 2091-2854**

Received:18 July *Revised:29 July* *Accepted: 20 August*

ASSESSMENT OF HEAVY METALS IN THE WATER OF SAHASTRADHARA HILL STREAM AT DEHRADUN, INDIA

Pawan Kumar 'Bharti'[1*], Pawan Kumar Tyagi[2] and Vijender Singh[3]

[1]Society for Environment, Health, Awareness of Nutrition & Toxicology (SEHAT-India), 20, Jamaalpur Maan, Raja Ka Tajpur, Bijnore (UP)-246735, India

[2]Department of Zoology and Environmental Sciences, Gurukula Kangri University, Haridwar (Uttarakhand)- 249404, India

[3]Department of Chemistry, Bhagwant University, Ajmer (Rajasthan), India

*Corresponding author:gurupawanbharti@rediffmail.com

Abstract

A study on heavy metals assessment in the water of Sahastradhara hill-stream was conducted with different five sites at significant differences. The present paper deals with the water quality status of Sahastradhara stream by the assessment of heavy metals. Heavy Metals were found in fluctuated trend from first upstream to last downstream. The values of almost all Heavy Metals were found in increasing manner especially after the fourth sampling site. After the third sampling station, a solid waste dumping site was found. So, there may be a relation between heavy metals in stream water and solid waste dumping site. Concentrations of all Heavy Metals at fourth and fifth sampling site were found very high.

Key words**:** water quality, river ecology, heavy metal, solid waste dumping site

Introduction

India is a blessed country when water sources come into question which is available in the form of numerous rivers and lakes. It has 14 major, 55 minor and numerous small rivers. India is often referred as the 'Land of Rivers'. In fact, riverbanks first hosted human civilizations in India as elsewhere in the world. Rivers in India play important social and economic roles. This is the reason why Indians worship rivers as goddesses. Our current life is totally dependent on rivers. The river systems provide irrigation, potable water, cheap transportation, electricity, as well as livelihoods for a large number of people all over the country (Bharti, 2004).

Rapid growth in industrialization to support the country's growing population and economy has polluted our rivers like never before. Studies show that domestic and industrial sewage, agricultural wastes have polluted almost all of Indian rivers. Most of these rivers have turned into sewage carrying drains. This poses a serious health problem as millions of people continue to depend on this polluted water from the rivers. Water-borne diseases are a common cause of illness in India today. The bad effects of river pollution are not limited to human population only. Pollution of river has affected animals, fish, and bird's population, sometimes threatening their very existence. Polluted water seriously affects the reproductive ability of animal and fish species in rivers thus making them extinct in future (Bharti, 2012a).

There are several sources of water pollution, which work together to reduce overall river water quality. Industries discharge their liquid waste products into rivers. Our agriculture practice that uses chemical fertilizers and pesticides also contribute to river pollution as rainwater drains these chemicals into the rivers. A domestic waste that we throw into rivers adds to pollution levels. As population grows, the size of towns and cities also grows. With that the amount of domestic wastes that we throw into river increases. In most of the towns and cities, the municipal drains carry our wastes to rivers. There are examples of rivers catching fire because of high pollution levels.

Nutrients, along with chemical contaminants, bacteria, solids, and oxygen demand enter the river either as point-source or non-point-source discharges. Point-source discharges include municipal regional sewer systems, smaller public and private domestic wastewater treatment plants, and industrial wastewater treatment plants. Point sources generally have a human-made discharge point such as a pipe or channel. Industrial sources often pre-treat their discharges then send them for mixing with other waste streams, followed by further treatment and discharge. Non-point source discharges include septic tank leachate, groundwater intrusion, runoff from highways, roads and parking lots, agricultural stormwater from row crops, pasture lands and forestry, and general stormwater systems. Non-point discharge has no fixed entry point to surface waters, other than the stormwater collection systems constructed to manage drainage. Runoff often flows in sheets with no particular path into these systems, creeks and tributaries.

The polluted water may have undesirable colour, odour, taste, turbidity, organic matter contents, harmful chemical contents, toxic and heavy metals, pesticides, oily matters, industrial waste products, radioactivity, high TDS, acids, alkalies, domestic sewage content, bacteria, virus, protozoa, rotifers, worms, etc. The organic content may be biodegradable or non-biodegradable.

Pollution of surface waters (rivers, ponds, lakes), ground waters, sea water are all harmful for human and animal health (Bharti, 2012b).

Metals that are naturally introduced into the water body come primarily from such sources as rock weathering, soil erosion, or the dissolution of water-soluble salts. Naturally occurring metals move through aquatic environments independently of human activities, usually without any detrimental effects.

Humans consume metallic elements through both water and food. Some metals such as sodium, potassium, magnesium, calcium, and iron are found in living tissue and are essential to human life. Probably less well known is that currently no less than six other heavy metals including molybdenum, manganese, cobalt, copper, and zinc, have been linked to human growth, development, achievement, and reproduction (Bharti, 2013). Even these metals, however, can become toxic or aesthetically undesirable when their concentrations are too great. Several heavy metals, like cadmium, lead, and mercury, are highly toxic at relatively low concentrations, can accumulate in body tissues over long periods of time, and are nonessential for human health.

The toxic heavy metals entering the ecosystem may lead to geo-accumulation, bioaccumulation and biomagnifications. Heavy metals like Fe, Cu, Zn, Ni and other trace elements are important for proper functioning of biological systems and their deficiency or excess could lead to a number of disorders. Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in biosystems through contaminated water, soil and air.

Therefore, a better understanding of heavy metal sources, their accumulation in the soil and the effect of their presence in water and soil on plant systems seem to be particularly important issues of present-day research on risk assessments (Lokeshwari and Chandrappa, 2006).

Heavy metals are introduced into aquatic system from various anthropogenic sources. Heavy metals constitute a special group of contaminants of aquatic systems and deserve special attention. Since metals are not removed by natural degradation processes, they may become enriched in sediments over time. Metal contamination of sediments is an issue of growing concerns worldwide. Both natural processes and anthropogenic activities are responsible for introducing metals in to the aquatic system (Bharti, 2012a). Many contaminants discharged into surface waters rapidly become associated with the particulate matter and incorporated in sediments. Metals in aquatic systems become part of the water-sediment system and their distribution is controlled by a dynamic set of physical-chemical interactions and equilibrium, largely governed by pH and type of legends and chelating agents, oxidation state of the mineral components and the redox conditions of the system. Metal contaminated sediments may release heavy metals back to the overlying water column and, thus, pose risk to aquatic life and ecosystems. Due to their particle reactivity, heavy metals tend to accumulate in sediment as a result may persist in the environment long after their primary sources have been removed (Bharti, 2012b).

In heavy metals analysis, the total concentrations of the metals are often determined. However, total concentration of trace metals provides no information concerning the fate of the metal in the terms of its interaction with sediments, its mobility, bioavailability, or resultant toxicity (Bharti, 2013). It is now widely accepted that measuring total metal concentrations cannot fully assess the role of aquatic sediments as a sink or as a source of pollutants. In addition, determination of total elements does not given an accurate estimate of the likely environmental impact. Instead, it is desirable to have information on the potential availability of metals (whether essential or toxic) to biota under various environmental conditions. Since the mobility of heavy metals, as well as their bioavailability and related eco-toxicity to plants, critically depends upon chemical forms in which, a metal is present in the sediment, considerable interest exists in trace element speciation (Bharti, 2012c).

Heavy metals travel from one level to another in the ecological system due to the accumulation in abiotic and biotic components. Heavy metals have a tendency to accumulate and store in a component or trophic levels. The storage of heavy metals has created harmful effects for biotic components. The heavy metals accumulated in sediment and percolated down in to ground water known as bio-accumulation of metal. From ground water, heavy metals may turn into two ways; one is though irrigation and second is through drinking by human beings. The accumulation of heavy metals through the food chain is called the biomagnifications. The concentrations of metal increased at every next trophic level, whereas metals can cause various harmful effects on irrigated agricultural soil, human beings and livestock by alteration in some biochemical reaction in body cells (Bharti, 2012c).

Water is an important substance required by all living organisms and for all anthropogenic activities (Dagaonkar and Saksena, 1992). The problem of environmental pollution due to toxic metals has begun to cause concern now in most major metropolitan cities (Bharti, 2007). Most of our water resources are gradually becoming polluted due to the addition of foreign materials from the surroundings. These include organic matter origin from plant and animal, land surface washing, Industrial & sewage effluents. In some tourist hilly regions, there are not any more industrial pollution, but tourist's anthropogenic activities may alter the water quality and the water quality of lakes of some tourist spot may affect the water quality of that water body.

Previously, the adequate research work was also carried out on various aspects of Sahastradhara stream viz. nutrient dynamics (Malik and Bharti, 2005a), Plankton diversity (Malik and Bharti, 2005b), Primary productivity (Malik and Bharti, 2005c), aquatic ecology (Malik and Bharti, 2007), fish habitat (Bharti and Malik, 2005), etc.

Material and methods

To assess the water quality of Sahastradhara hill-stream, five sampling stations were selected. Water samples were collected in plastic Jericanes and analyzed according to APHA (1995) and Trivedi and Goel (1984) using Atomic absorption spectrophotometer (AAS).

Grab sampling was generally applied during the sampling. A grab sample is an ordinary sample which is taken from a particular place representing the whole water quality. This type of sample is valid only when it is certain that the water quality is not changing in a short time and effluent discharges, if any, are fairly regular. It is advisable to collect and analyze the grab samples separately at various timings, if the water quality is known to change with time. In such cases the schedule of timings shall be dependent on the frequency of discharge or change in water quality.

The sampling of water from stream banks can be easily carried out using a wide mouthed polythene bottle but a sampler has to be used if the studies are to be undertaken at various strata of water. The sampling of sediments from the bottom of natural water bodies, stabilizing ponds or effluent drains is invariably carried out using special samplers. Heavy metals like Cadmium, Copper, Iron, Lead, Manganese, Nickel and Zinc were selected for the evaluation in water of Sahastradhara hill-stream. The samples were taken in plastic Jeri cane for analytical work. Stream water samples were analyzed by standard methods (APHA, 1995; Trivedi and Goel, 1984)**.** Heavy metals were analyzed in the laboratory using Atomic absorption spectrophotometer *AAS 4129* model.

Samples were collected in Borosil BOD bottles and Jeri canes for laboratory experiments. Caps of canes were closed tightly after filling up of cane. Some parameters were determined immediately on sampling sites, for rest parameters and heavy metals; samples were stored in refrigerator at 4°C. Heavy metals may be analyzed in the 6 months period from the preservation date. Collected, preserved, diluted water samples were prepared for the evaluation of metal concentrations with the help of AAS 4129.

Results and Discussion

Heavy metals in the water of Sahastradhara hill-stream were detected in very low concentration while upper sites has water free with some metallic contents due to the absence of anthropological activities. However, the area is free from industrial pollution, but due to the increasing tourist activities the water quality is going deteriorate since last few years in a tremendous way. Heavy Metals concentrations are given in table-1 and the increasing trend of Heavy Metals concentrations is indicated by the fig.-1. Heavy metal concentrations were found in increasing order towards downstream. Almost every metal was nil at site-I & site-II except those of iron, manganese and zinc. But in last downstream each metal was found in the water of Sahastradhara hill stream at Dehradun. Bharti (2008) indicated the similar trend in river water samples of Sahastradhara and suggest some strong reasons for heavy metal increment in river water.

Heavy Metals were found almost nil or in very low concentrations at all selected site. Heavy Metals like Cadmium, copper, lead were not found in high concentration at all sites during the study period. Cadmium, copper and lead were absolutely absent in upstream, while Manganese, Zinc and Iron concentrations were found within the limit in upstream samples. The concentration of iron was maximum observed 1.0 mg/l at fifth station. Lead was found maximum 0.03 mg/l at last downstream site and Zinc concentration was 0.05 mg/l. Malik *et al.*, (2009) described the role of Heavy Metals in the surface water of north India. The results of Bharti *et al.*, (2010) were also indicated the relation of Heavy Metals with some biological agents in a north Indian water body. Bharti et al., (2012) find out the distribution of heavy metals in water and sediment of Ichchhamati river in east Khasi hills in Meghalaya, India. Bharti and Singh (2013) also studied on heavy metal concentrations in water and sediment of Phrinkaruh river in north-east India.

Conclusion

In the recent years, anthropogenic activities are increasing tremendously in Doon valley, as many tourist places are being developed in Uttarakhand. Sahastradhara hill stream is also very popular tourist place in north India. Local environment especially stream water quality is being degraded due to the increasing tourist activities and continuous solid waste generation in the vicinity of Sahastradhara stream. Sudden appearance of certain heavy metals in water of Sahastradhara hill stream is the big indication of anthropogenic activities and aquatic pollution in the valley. So, a special attention is required in the Sahastradhara stream area to control the water pollution as well as for the conservation of aquatic ecosystem and natural habitat of rare aquatic biodiversity. Increasing concentration of certain metals along with the downstreams locations may cause problems to its receivers or consumers as well as to the aquatic life forms. So, there is an urgent need to find out and eliminate the possible point and non-point sources of pollution of Sahastradhara stream.

Table-1: Heavy Metals at five locations at Sahastradhara stream (ppm)

S.N.	***Metals***	***Site-I***	***Site-II***	***Site-III***	***Site-IV***	***Site-V***
1	Cadmium	0.00	0.00	0.00	0.00	0.01
2	Copper	0.00	0.00	0.00	0.01	0.01
3	Iron	0.65	0.69	0.72	0.85	1.00
4	Lead	0.00	0.00	0.01	0.02	0.03
5	Manganese	0.04	0.06	0.08	0.16	0.21
6	Zinc	0.01	0.01	0.02	0.03	0.05

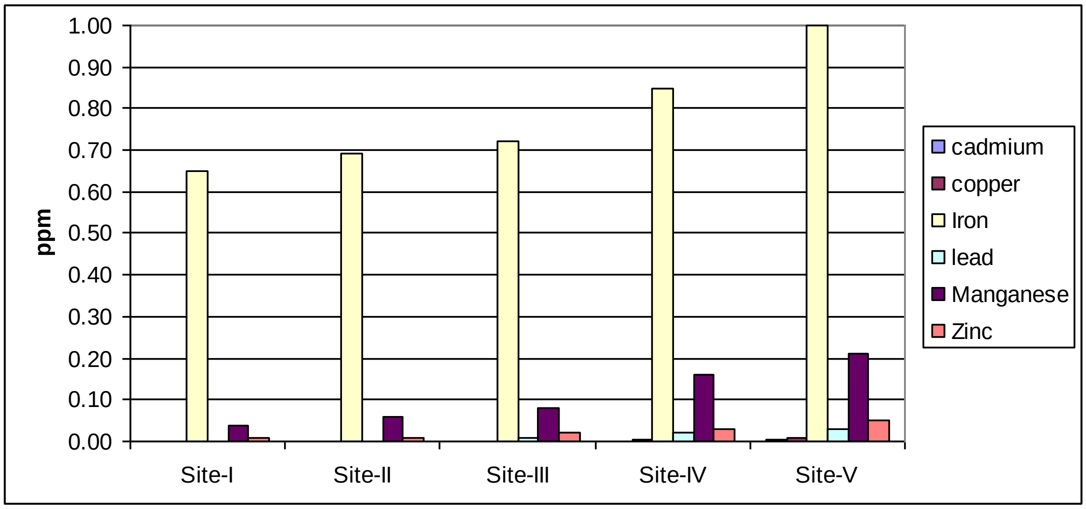

Fig- 1: Showing the Heavy Metals concentrations at various sampling stations.

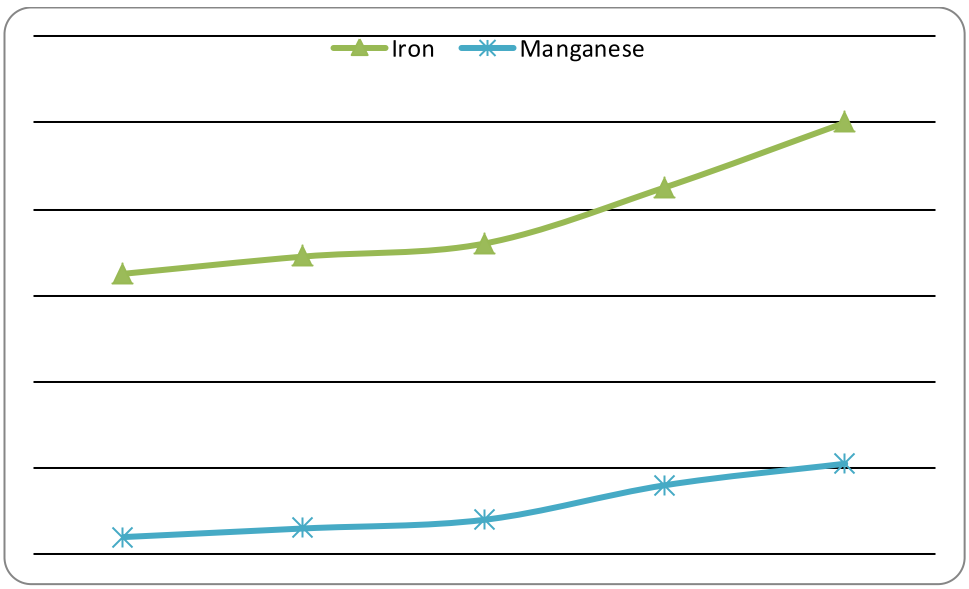

Fig- 2: Fluctuation in Iron and Manganese concentrations at various sampling stations of Sahastradhara stream

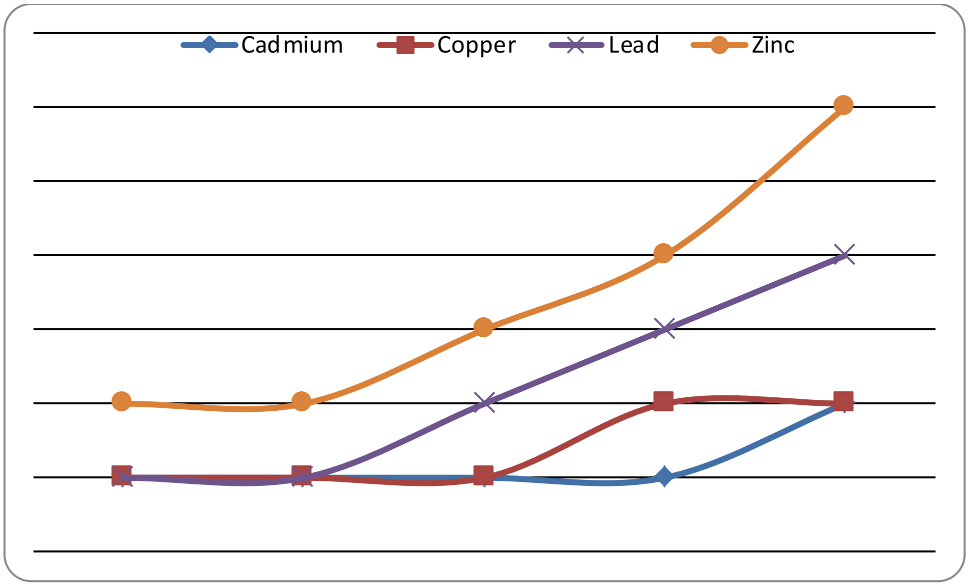

Fig- 3: Fluctuation in Cadmium, Copper, Lead and Zinc concentrations at various sampling stations of Sahastradhara stream

Reference

APHA, 1995. Standard methods for examination of water and waste water. *American Public Health Association*, 19th edition. Inc, New York, pp. 1170.

Arjariya, A., 2003. Physico-chemical profile and plankton diversity of Ranital lake, Chhatarpur, M.P., *Nature Env. Poll. Tech.* 2(3), 327-328.

Bharti, Pawan K., 2004. Limnological study of Sahastradhara hill-stream, Dehradun, *M.Sc. Dissertation, Gurukula Kangri University, Hardwar* pp, 102.

Bharti, Pawan K. and Malik, D.S., 2005. Sahastradhara Nadi Ke Vibhinna Sthaano par Machhliyon ke Anukool Vaassthaano ke liye Upyukt dashaayen, In: proceedings of 'Rashtriya Sangoshthi: Uttaranchal me Maatsyiki ki Bhaavi Sambhavnaaye' organized by department of zoology, H.N.B. Garhwal University, Srinagar on 28-29 October 2005 pp, 84-87.

Bharti, Pawan Kr., 2007. Why are Indian standards not strict?, *Current Science* 93(9), 1202.

Bharti, P.K., 2008. Status of water quality and ecotourism enhancement in Sahastradhara stream at Dehradun, In: Third Uttarakhand State Science Congress organised by UCOST, Dehradun held on 10-11 November, 2008 at IIT, Roorkee.

Bharti, P.K.; Malik, D.S. and Yadav, R., 2010. Influence of Heavy Metals on Abundance of Cyanophyceae Members in Three Spring-fed Lake in Kempty, Dehradun, In: 'Advances in Aquatic Ecology, Vol-III' ed. by V.B. Sakhare, *Daya Publishing House, New Delhi* pp, 107-111.

Bharti, P.K., 2012a, Hill-stream Ecology, *Biotech Books*, Delhi pp, 246.

Bharti, P.K., 2012b. Solid Waste and River Ecology, *Lambert Academic Publishing*, Germany pp, 65.

Bharti, Pawan K., 2012c. Heavy Metals in Environment, *Lambert Academic Publishing GmbH & Co. KG, Saarbrucken*, Germany pp, 70.

Bharti, P.K.; Malik, D.S.; Kumar, P. and Bharti, U., 2012. Heavy metal in water and sediment of Ichchhamati river in East Khasi Hills, Meghalaya, In: 'Advances in Aquatic Ecology, Vol-6' (Eds. V.B. Sakhare and P.R.D. Escalante), *Daya Publishing House, New Delhi* pp, 88-94.

Bharti, Pawan K. and Singh, V., 2013. Heavy metals distribution in sediment and water of Phrinkaruh river in East Khasi hills, Meghalaya. *International Journal of Higher Education and Research* 2(1), 55-63.

Bharti, Pawan K., 2013. Aquatic Environment and Toxicology, *Discovery Publishing House*, Delhi pp, 284.

Dagaonkar, A. and Saksena, D.N., 1992. Physico-chemical and biological characterization on tample tank, Kaila Sagar, Gwalior, *J. Hydrobiology* 8, 11-19.

Lokeshwari, H. and Chandrappa, G.T., 2006. Impact of heavy metal contamination of Bellandur Lake on soil and cultivated vegetation, *Current Science* 91(9), 622-627.

Malik, D. S. and Bharti, P.K., 2005a. Nutrient dynamics in Rhithron zone of Shivalik Himalayan stream Sahastradhara, Dehradun (Uttaranchal), *Env. Cons. J.* 6 (2), 63-68.

Malik, D. S. and Bharti, P.K., 2005b. Fluctuation in planktonic population of Sahastradhara hill-stream at Dehradun (Uttaranchal), *Aquacult* 6 (2), 191-198.

Malik, D. S. and Bharti, P.K., 2005c. Primary production efficiency of Sahastradhara hill-stream, Dehradun, *Env. Cons. J.* 6 (3), 117-121.

Malik, D.S. and Bharti, P.K., 2007. Ecology of Sahastradhara Hill-stream at Dehradun (Uttaranchal), In: 'Advances in Aquatic Ecology, Vol-1' (Ed. V.B. Sakhare, *Daya Publishing House, New Delhi* pp, 1-11.

Malik, D.S. ; Bharti, P. K.; Negi, K.S. and Yadav, R., 2009. Distribution of Metals in Water of an Artificial Lake at Mussoorie, Uttarakhand, In: 'Aquatic biology and aquaculture' edited by V.B. Sakhare, Ambajoagi, MS, *Manglam Publication, New Delhi* pp, 77-95.

Pande, R.K. and Mishra, A., 2000. Water quality study of fresh waters of Dehradun (Sahastradhara stream and Mussoorie lake), *Aquacult* 1(1), 57-62.

Trivedi, R.K. and Goel, P.K., 1984. Chemical and biological methods for water pollution studies. *Enviro Media Publication, Karad* pp, 1-251.