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Determination of Heavy Metals, viz. Cadmium, Copper, Lead and Zinc in the Different Matrices of the Ganges River from Rishikesh to Allahabad through Differential Pulse Anodic Striping Voltametry

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Abstract: *River Ganges is considered to be the most pious river of India. That is why its increasing level of pollution becomes a major environmental concern. Due to industrial affluent, municipal sewage, household drainage etc. the increasing concentration of heavy metals as major pollutant is alarming. The present paper reported the concentration of heavy metals viz. cadmium, copper, lead and zinc ions in the different matrices of the river Ganges from Rishikesh to Allahabad. The concentration of these metals were determined through differential Pulse Anodic Striping Voltametry (DPASV) from the water and sediments of Ganges at different places from the above said locations. The results showed that the water at Narora barrage was maximum contaminated with Cd and Cu, while at Narora barrage and Jajmau, Kanpur, Pb and Zn were found at its maximum level than others. The Narora ghat river bank and Jajmau, Kanpur river bed sediments gave maximum amount of Cd, Cu and Pb while the maximum amount of Zn was found both in Narora bank as well as bed sediment and highest in the Jajmau river bank sediment.*

Keywords: *Heavy metals Narora barrage, Jajmau, differential Pulse Anodic Striping Voltametry.*

1. INTRODUCTION

With the industrial outburst, profuse use of fertilizers, heavy sewage effluents in agricultural land, domestic waste, medicinal waste resulted in the increase in the level of metal concentration in soil and water is significantly exceeding from those originating from the natural resources. This becomes a major environmental concern. Heavy metals are carcinogenic to humans. Higher concentration of metal in water and sediment during rainy season is mainly due to the industrial, agricultural or domestic runoff coming into the river [1]. River Water quality monitoring is necessary especially where the water serves as drinking water sources, are threatened by pollution resulting from various human activities along the river course . Water quality assessment based on bio-monitoring of rivers in Uttaranchal, in view of their religious importance and ecological sustainability was carried out by Semwal and Akolkar [2]. Trace metals are considered to be major toxicant in contaminated water worldwide [3,4]

The majority of chemicals discharged into aquatic system eventually end up in sediments that may act as a sink of pollution as well as a source of pollution. Sediments are ecologically important components of the aquatic habitat which play a significant role in maintaining the trophic status of any water body [5]

Thus, study of sediment helps in the understanding of pollution effect as the residence time of pollutants in sediment of impacted area is long. Distribution of heavy metals in sediments of the river Ganga and its tributaries have been carried out by several workers[6-8].

The DPASV is an electro analytical technique based on phenomena occurring at the interface between the electrode surface and the thin layer of solution adjacent to the surface. It is relatively inexpensive and is one of the most sensitive and selective techniques used in the determination of trace amounts of metals at natural levels having a scanning of "ppt" (parts per trillion)[9].

DPASV incorporates three electrodes, a working electrode, auxiliary counter electrode and reference electrode. The working electrode is a mercury film electrode (planar strip configuration). The mercury film forms an amalgam with the analyte sample which upon oxidation results in a sharp peak, The mercury film is formed over a glassy carbon electrode. The method is considered dynamic, because the electrochemical cell is operated in the presence of electrical current ($i > 0$), which, in turn, is measured by the controlled application of potential[10]

In this paper we have reported an assessment of the determination of heavy metals namely cadmium, copper, lead and zinc in the different matrices of the Ganges River from Rishikesh to Allahabad from water and sediments of Ganga River through Differential Pulse Anodic Striping Voltametry (**DPASV**) method.

2. MATERIALS AND METHODS

2.1. Collection of Samples

The locations of sampling collection from Rishikesh to Allahabad are shown in Fig. 1.

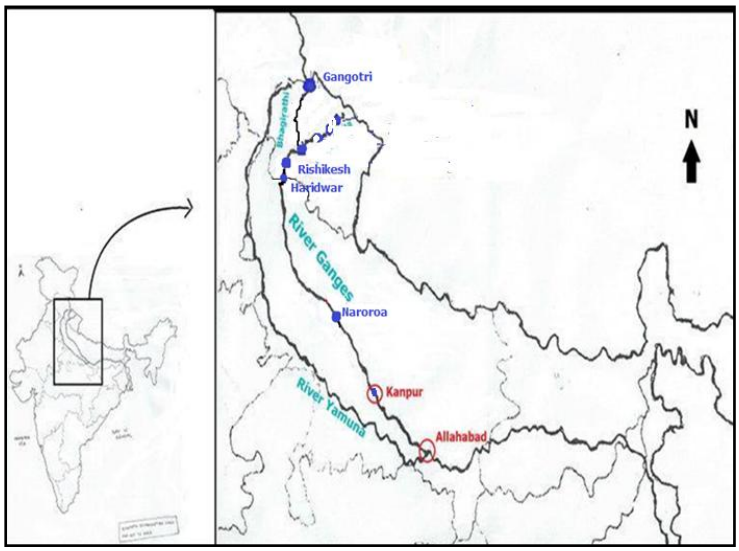

Figure 1. *Broad locations of the collection of samples*

Water samples were collected from 0.5m below surface water of the river and sediment collected from the bottom and at the bank of river (Fig.2). The water and sediment samples collected from different locations were kept in clean glass jars and transported to the laboratory in the cold black box. The samples were stored in the freezer till analysis. Trace metals (Cd, Cu, Pb and Zn) in the sediment were determined by digesting 1g sediment sample with concentrated HNO3 made up to 50 ml volume. The sediment elutriates were prepared by shaking sediment in water at 1:4 ratio for 24h. The supernatant was separated by centrifuging at 6,000 rpm for 60 min at 4 ºC. Elutriate was stored at 4 ºC until analysis. Elutriate were acidified and directly used for the estimation of trace metals by Differential Pulse Anodic Striping Voltametry (**DPASV**) method.

The DPASV was performed with a PAR Polarographic Analyzer (174A) fitted with an ***X*** - ***Y*** recorder (Omnigraphic Model 2000). The working electrode was a Metrohm 410E HMDE and a standard calomel electrode (SCE) were used as the reference electrode; a platinum coil served as the counter electrode. A chronometer (Systronics) was used in the control of the different stages of the stripping voltammetric procedure. A magnetic stirrer with a synchronous motor and a Teflon-covered bar were also used. The solutions in the electrochemical cell (PAR 6062) were de-aerated prior to the voltammetric determination by passing purified nitrogen through for 15 min. During the experiments nitrogen was passed over the solution. The information on the analyte was obtained by measuring the magnitude of the electrical current that appeared in the working

electrode by applying a voltage between a working and an auxiliary electrode. The registration of the current potential was related to the amount of analyte found in the electrode interface [11].

Figure 2. *Collection of Samples*

3. RESULTS AND DISCUSSION

Table 1 shows the results of heavy metal concentration in water samples from Rishikesh to Allahabad. PH in water samples of ganges was found in the range of 7.53 to 8.69 from rishikesh to Allahabad.

Table 1. *Measurement of Heavy Metals in water of River Ganges*

Locations	Cd (mg/L)	Cu (mg/L)	Pb(mg/L)	Zn (mg/L)
Rishikesh	0.7± 0.4	ND	4.9±0.1	12.8±0.1
Haridwar	0.6±0.5	ND	4.7±0.2	ND
Narora Colony Ghat	1.3±0.5	ND	2.4±2.1	16.7±0.2
Narora Barrage	13.1±0.1	36.00±1.00	26.9±0.5	53.5±0.1
Narora Lower Canal	0.7±0.4	ND	3.6±0.6	8.3±0.1
Bithoor, Kanpur	4.5±0.4	ND	4.6±0.09	8.8±0.2
Jajmau, Kanpur	7.1±3.2	10.00±1.00	24.0±0.4	106.3±0.1
Allahabad	1.2±0.4	ND	5.00±0.1	23.5±0.4

In all the collected samples the concentration of heavy metals was higher as recommended by WHO for drinking purposes. Table 2 shows the results of heavy metals concentration in sediments of Ganga River at different locations. These results showed that the water at Narora barrage was maximum contaminated with Cd and Cu, while at Narora barrage and Jajmau, Kanpur, Pb and Zn were found at its maximum level than others. The Narora ghat river bank and Jajmau, Kanpur river bed sediments gave maximum amount of Cd, Cu and Pb while the maximum amount of Zn was found both in Narora bank as well as bed sediment and highest in the Jajmau river bank sediment. Water and sediment samples trace elements analysed and the pattern followed from Rishikesh to Allahabad was found Zn>Cu>Pb>Cd. After Jajmau, Kanpur, the amount of contaminants is lowered significantly. This may be attributed due to the heavy

industrial outburst and tannery inflow polluting Ganges to its maximum level at Kanpur and its nearby area.

Table 2. *Measurement of Heavy Metals in Sediment of River Ganges*

Locations	Cd (mg/Kg)	Cu (mg/Kg)	Pb(mg/Kg)	Zn (mg/Kg)
Haridwar	2.6±1.73	35.29	38.55±1.98	172.65±34.8
Narora Ghat, (River Bank Sediment)	28.48±0.09	85.04	99±3.07	413.13±54.3
Narora Ghat, (River Bed Sediment)	16.09±0.86	36.47	35.59±4.02	402.71±42.4
Jajmau, Kanpur (River Bank Sediment)	4.39±1.98	18.9	29.54±2.7	457.12±51
Jajmau, Kanpur (River Bed Sediment)	30.54±1.05	672.9	73.55±3.3	286.86±41.07

4. CONCLUSION

The present study with DPASV suggests that the contamination of water and sediment at Narora Barrage and Jajmau Kanpur is alarming where the pollutants accumulated due to the point source discharges from tannery industries. Comparison with freshwater sediment quality guidelines provide criteria for the evaluation of trace metal concentration in river sediments in response to adverse affects on the river's biological components.

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