

DETERMINATION OF HEAVY METAL CONTAMINATION IN THE HASDEO RIVER: CHAMPA INDUSTRIAL AREA OF CHHATTISGARH**Vandana Rathore*, Rashmi Verma****Department of Chemistry, Dr.CV Raman University Kota***Corresponding Author's E mail: vandanarathore@gmail.com

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ABSTRACT

The contamination of natural water bodies with heavy metals poses significant risks to human health and aquatic ecosystems. This study investigates the concentration of selected heavy metals, including copper (Cu), lead (Pb), iron (Fe), manganese (Mn), and zinc (Zn), in water samples collected from the Hasdeo River near the Champa Industrial Area in Chhattisgarh, India. Using Atomic Absorption Spectroscopy (AAS), water samples from upstream, midstream, and downstream locations were analyzed to evaluate industrial impact and spatial variations. Results revealed consistent Cu levels (0.016 PPM) across all sites, indicating minimal industrial influence. However, Pb concentrations progressively increased downstream, with levels ranging from 14.37 PPM to 17.27 PPM, suggesting cumulative contamination from industrial effluents. Fe and Mn exhibited significant spatial fluctuations, likely due to localized discharges, while Zn concentrations remained low, implying minimal contamination. These findings underscore the need for stricter industrial regulation and continuous monitoring to safeguard environmental and public health.

Keywords: Heavy metals, Hasdeo River, Atomic Absorption Spectroscopy, industrial pollution, lead contamination.

INTRODUCTION

The presence of heavy metals in water bodies is a critical environmental issue due to their potential toxicity, persistence, and bioaccumulation in aquatic ecosystems. Industrialization and urbanization have significantly contributed to the contamination of natural water sources with heavy metals, posing risks to both human health and biodiversity. This study focuses on assessing the levels of heavy metals in water samples collected from the Hasdeo River, which flows through the Champa Industrial Area in Chhattisgarh, India¹⁻⁴. The Hasdeo River is a major tributary of the Mahanadi River and serves as a vital water resource for the region. However, its proximity to the Champa Industrial Area raises concerns about the potential discharge of industrial effluents containing hazardous heavy metals into the river.

Industries in this area, including power plants, coal mining, and metallurgical operations, are known to contribute to environmental pollution. Heavy metals such as lead (Pb), cadmium (Cd), chromium (Cr), and mercury (Hg) are of particular concern due to their high toxicity even at low concentrations. Prolonged exposure to these metals through contaminated water can lead to severe health issues, including neurological disorders, kidney damage, and developmental abnormalities⁵⁻¹¹. Additionally, the accumulation of heavy metals in aquatic organisms can disrupt ecosystems and enter the food chain, amplifying their impact on human and environmental health. The objective of this study is to determine the concentration levels of selected heavy metals in the Hasdeo River water samples and compare them with permissible limits set by the World Health Organization (WHO) and national regulatory standards. This assessment aims to provide insights into the extent of contamination and its potential implications for public health and environmental sustainability¹²⁻¹⁷.

Methodology

Heavy metal detection

Atomic Absorption Spectroscopy (AAS) is a widely used analytical technique for detecting and quantifying heavy metals in water samples due to its high sensitivity and accuracy¹⁸⁻¹⁹. The procedure involves the following steps:

Sample Collection: Collected water samples from locations of the Hasdeo River, ensuring proper representation of behind industrial factories, surrounding industrial factories and Junction of the Hasdeo River. Stored the samples in clean, acid-washed polyethylene bottles to prevent contamination²⁰⁻²³.

Sample Preservation: Added a small amount of concentrated nitric acid (HNO₃) to the water samples immediately after collection to lower the pH below 2. This helps prevent metal adsorption onto container walls and microbial activity²⁴⁻²⁷.

Sample Preparation: Filtered the water samples using Whatman filter paper to remove particulate matter²⁸.

Preparation of Standard Sample solutions: Prepared standard solutions of the target heavy metals (e.g., Pb, Cd, Cr, Hg) at varying concentrations. 50.00 mL volumetric flask was filled with 0.5 mL of a 100 ppm stock solution that had been pipetted. Deionized water was then added to dilute it until the mark was reached. "1 ppm" was the label for the solution. A 50 mL volumetric flask and the 100 ppm solution

were utilized to create a number of standard solutions with the following concentrations of 1ppm, 2ppm, 3ppm, 4ppm and 5ppm. Then calibrated the AAS instrument using these standard solutions to generate a calibration curve for each metal²⁹⁻³³.

Sample Analysis: Injected the prepared water sample into the AAS instrument. Measured the absorbance of the specific wavelength corresponding to each metal of interest³⁴⁻³⁵.

Result and discussion

The concentration of copper (Cu) was consistent across all samples at 0.016 PPM. This uniformity suggests stable Cu levels across the sampling points, likely indicating minimal or no industrial influence on Cu contamination in the study area. Lead (Pb) concentrations varied among the samples, with Sample 1 recording 14.37 PPM, Sample 2 at 15.34 PPM, and Sample 3 the highest at 17.27 PPM. The progressive increase in Pb concentration from Sample 1 to Sample 3 indicates potential cumulative contamination along the river's flow, possibly resulting from industrial effluent discharges. Despite variations in magnitude, all values were within a narrow percentage range, pointing to consistent exposure across the sampled sites. Iron (Fe) concentrations showed significant fluctuations, with Sample 1 measuring 2.353 PPM, Sample 2 registering negligible levels (0.000 PPM), and Sample 3 at 1.176 PPM. These variations may reflect localized industrial discharges influencing Fe levels, particularly in Sample 1, which might be situated closer to industrial activity. Manganese (Mn) levels exhibited a distinctive trend, with 1.038 PPM in Sample 1, decreasing to 0.278 PPM in Sample 2, and slightly increasing to 0.785 PPM in Sample 3. This pattern suggests partial sedimentation or dilution effects, with Mn concentrations reducing before stabilizing further downstream. Zinc (Zn) concentrations were relatively low in all samples, with Sample 1 at 0.416 PPM, and Samples 2 and 3 at 0.185 PPM. The decline in Zn concentration from Sample 1 to Sample 2 suggests possible downstream dispersion, followed by stabilization at a low level.

Table no. 1 Copper Conc. of samples

S.No	Sample ID	Conc (PPM)	Con (%)
1	Sample 1	0.016	0.0000
2	Sample 2	0.016	0.0000
3	Sample 3	0.016	0.0000

Table 2: Absorbance data of Copper

Concentration (ppm)	Absorbance
0.000	0.000
0.500	0.017
1.000	0.038
1.500	0.057
2.000	0.075

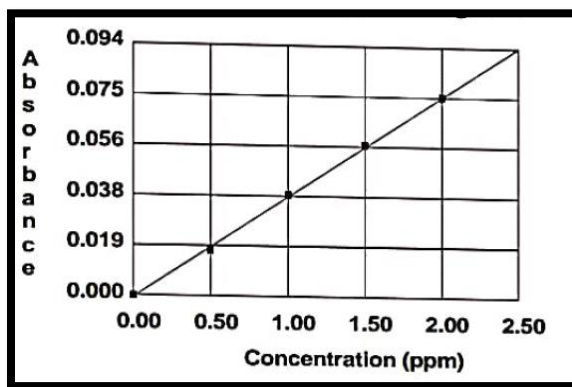


Figure 1: Linear Graph of Conc. of Copper

Table 3: Lead Conc. of sample

S.No	Sample ID	Conc (PPM)	Conc (%)
1	Sample 1	14.37	0.0014
2	Sample 2	15.34	0.0015
3	Sample 3	17.28	0.0017

Table 4: Absorbance data of lead

Concentration (ppm)	Absorbance
0.000	0.000
20.00	0.021
40.00	0.041
60.00	0.063
80.00	0.082

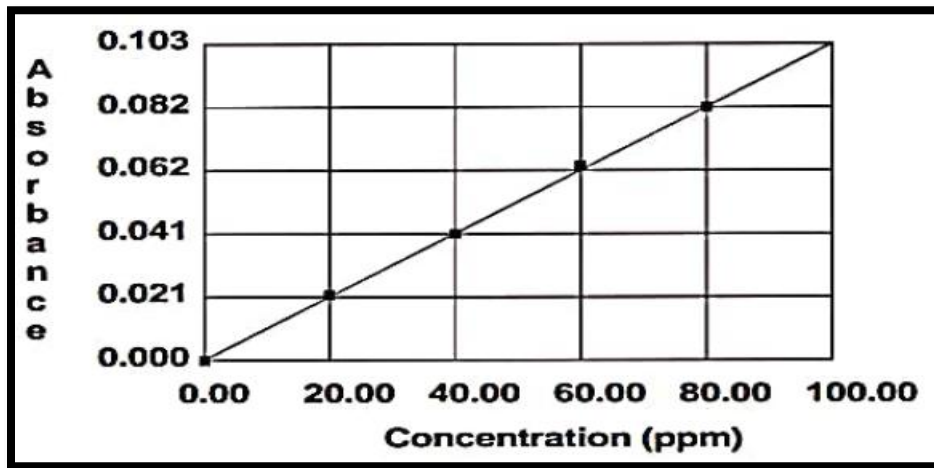


Figure 2: Linear graph conc. of Lead

Table 5: Iron Conc. of sample

S.No	Sample ID	Conc (PPM)	Conc.(%)
1	Sample 1	2.353	0.002
2	Sample 2	0.000	0.000
3	Sample 3	1.176	0.001

Table 6: Absorbance data of Iron

Concentration (ppm)	Absorbance
0.000	0.000
2.000	0.016
4.000	0.030
6.000	0.045
8.000	0.062

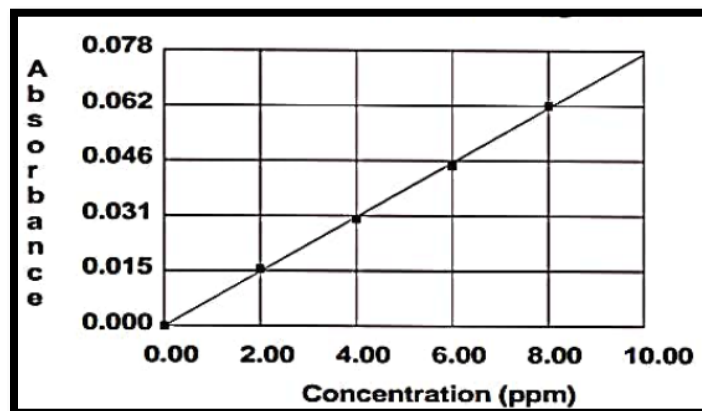


Figure 3: Linear graph Conc. of Iron

Table 7: Manganese Conc. of sample

S.No	Sample ID	Conc(PPM)	Conc(%)
1	Sample 1	1.038	0.0001
2	Sample 2	0.278	0.0000
3	Sample 3	0.785	0.0001

Table 8: Absorbance data of manganese

Concentration (ppm)	Absorbance
0.000	0.000
2.000	0.027
4.000	0.059
6.000	0.093
8.000	0.125

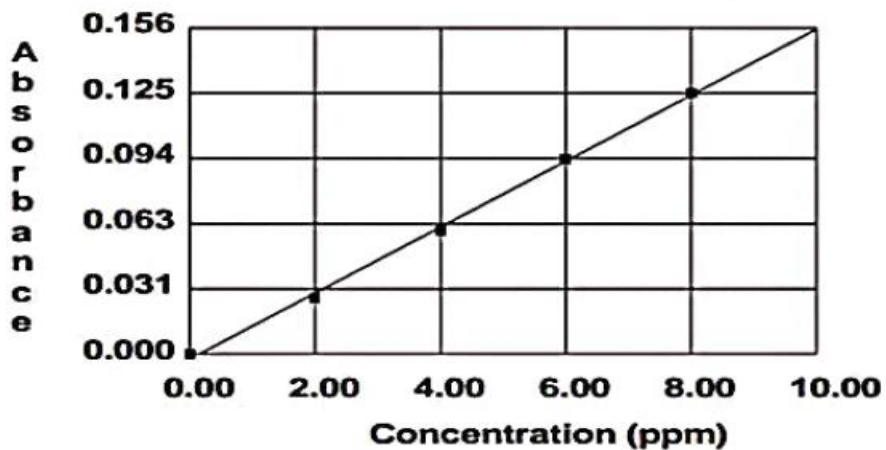


Figure 4: Linear graph conc. of Manganese

Table 9: Zinc Conc. of sample

S.No	Sample ID	Conc (PPM)	Conc (%)
1	Sample 1	0.416	0.0000
2	Sample 2	0.185	0.0000
3	Sample 3	0.185	0.0000

Table 10: Absorbance data of Zinc

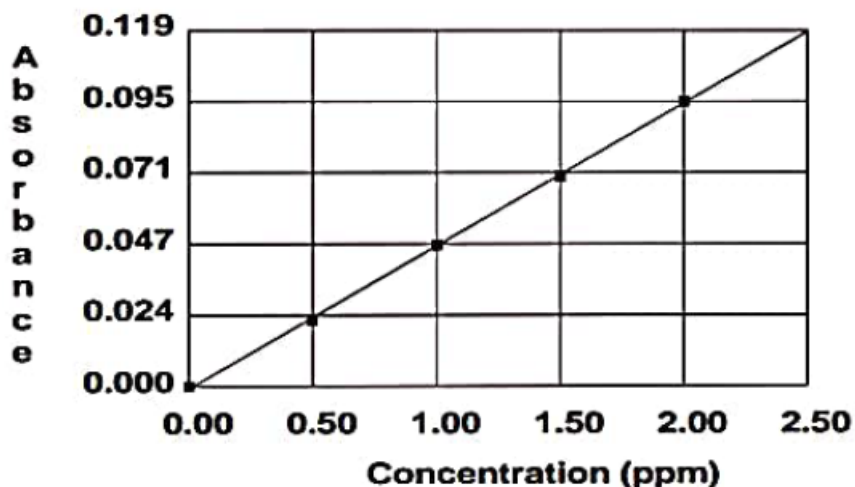


Figure 5: Linear graph conc. of zinc

CONCLUSION

The study on heavy metal contamination in the Hasdeo River within the Champa industrial area of Chhattisgarh reveals significant insights into the environmental impact of industrial activities. The analysis demonstrates specific heavy metals, particularly Pb and Fe, are influenced by industrial proximity, reinforcing the need for regulatory monitoring of these sites to manage industrial effluents and protect river ecosystems. The findings underscore the importance of continuous monitoring and stricter regulation of industrial discharges to mitigate heavy metal contamination in the Hasdeo River. Implementing effective wastewater treatment protocols and conducting periodic health risk assessments are essential to protect both the ecosystem and communities relying on this vital water resource. Methods such as phytoremediation and advanced water treatment technologies should be considered to mitigate existing pollution levels. The Hasdeo River’s contamination highlights a critical need for integrated water management policies and sustainable industrial practices to restore and preserve the river's ecological balance for future generations.

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