

An Insight to Physicochemical Analysis of Hasdeo River Sediments of Chhattisgarh, India

Sadhana Gupta¹, Bhagyashree Deshpande^{1*}, Bhawana Pandey²

¹*School of Sciences, MATS University, Raipur, Chhattisgarh*

²*Dept. of Biotechnology and Microbiology, Bhilai Mahila Mahavidyalaya, Bhilai, Chhattisgarh*

Email: bhagyashree.deshpande851@gmail.com

The present study investigates the physiochemical parameters of sediments collected from different sites of Hasdeo river bank covering Korba and Janjgir -Champa region of Chhattisgarh. The Hasdeo River, a crucial water body, is significantly influenced by industrial, agricultural, and urban activities, leading to potential environmental degradation. Sediment samples were collected from five distinct sites along the riverbank and analyzed for various physiochemical parameters, including pH, temperature, electrical conductivity (EC), organic matter content, organic carbon, total nitrogen, total potassium, phosphorus, and alkalinity. The study also assessed the presence of heavy metals such as iron (Fe), lead (Pb), manganese (Mn), copper (Cu), zinc (Zn), chromium (Cr), cadmium (Cd), mercury (Hg), nickel (Ni), molybdenum (Mo), and aluminum (Al) to determine the extent of contamination. Results indicated spatial variations in sediment composition, with certain locations exhibiting higher concentrations of pollutants due to industrial effluents, mining activities, and anthropogenic influences. The pH values suggested slightly acidic to near-neutral conditions, while elevated organic matter and heavy metal concentrations at downstream sites highlighted increased contamination levels. The findings underscore the need for continuous monitoring and implementation of pollution control measures to mitigate environmental risks. This study provides valuable insights into the river's sediment quality, contributing to future research and environmental management strategies aimed at preserving the ecological balance of the Hasdeo River. The assessment of physiochemical properties and heavy metal contamination serves as a baseline for policymakers and environmentalists to develop sustainable water resource management plans for the region.

Keywords: River sediments, Heavy Metal Contamination, Industrial Pollution, Environmental Monitoring, Water Pollution, Anthropogenic Impact.

1. Introduction

Rivers are dynamic ecosystems that play a vital role in supporting biodiversity, regulating hydrological cycles, and providing essential resources for human activities such as agriculture, industry, and domestic use (Bhaskar et al., 2020). However, increasing anthropogenic activities, including industrialization, mining, and urbanization, have significantly impacted river systems, leading to deterioration of water and sediment quality (Vaishnav et al., 2014).

Among the major concerns is the contamination of river sediments, which act as both a sink and a secondary source of pollutants, particularly heavy metals and industrial effluents (Bhaskar and Yadav, 2019). Assessing the physicochemical characteristics of river sediments is crucial for understanding the extent of pollution, sediment composition, and its potential impact on aquatic life and human health (Bhaskar and Dixit, 2017). The Hasdeo River, an important tributary of the Mahanadi River, flows through Korba, Chhattisgarh, a region known for its extensive coal mining, thermal power plants, and industrial activities (Sahu, 2005). The Sarvmangla region, located near Korba, is particularly vulnerable to pollutant accumulation due to its proximity to industrial zones and human settlements. The discharge of untreated industrial effluents, coal washery waste, mining residues, and domestic sewage into the river has raised concerns about the sediment quality and environmental health of the Hasdeo River (Bhaskar and Dixit, 2015). Since sediments serve as long-term reservoirs for organic and inorganic pollutants, their analysis provides valuable insights into historical and ongoing contamination trends. The physicochemical properties of river sediments, including pH, organic matter content, grain size distribution, electrical conductivity, and heavy metal concentration, influence sediment stability, pollutant bioavailability, and nutrient cycling (Verma et al., 2016; Rajwade and Deshpande, 2023; Dewangan et al., 2024). Heavy metals such as iron (Fe), lead (Pb), manganese (Mn), cadmium (Cd), and arsenic (As) are of particular concern due to their non-biodegradable nature, persistence in the environment (Rajwade and Deshpande, 2024; Dewangan et al., 2023) and potential toxicity to aquatic organisms and humans (Verma and Verma, 2019). Variations in temperature, pH, and redox potential can lead to the remobilization of these metals, affecting water quality and aquatic biodiversity (Verma et al., 2017; Verma and Verma, 2018).

This study aims to conduct a comprehensive analysis of the physicochemical characteristics of Hasdeo River sediments near the Sarvmangla region in Korba, with the following objectives: To assess basic sediment parameters such as pH, organic matter, electrical conductivity. The findings of this study will contribute to a better understanding of sediment pollution levels in the Hasdeo River and provide baseline data for future environmental monitoring and remediation strategies. Given the importance of the Hasdeo River as a water source for local communities, it is crucial to assess and mitigate contamination risks to ensure the sustainable management of riverine ecosystems.

2. Materials and Methods

Study Area

Hasdeo, a tributary of Mahanadi River Pathar in the valley of Chota Nagpur from hill region of a Deogarh, district Korba, Chhattisgarh and passes through Korba, Janjgir- Champa district and joined in Mahanadi river. Captive power plant of BALCO (Bharat Aluminium Company Limited), coal mines, CSEB, SECL, Gopal explosive factory, and number of thermal power plant are situated along the side of river. These power plants discharge their effluent in river body which leads to increase in pollution load in river water (Figure 1).

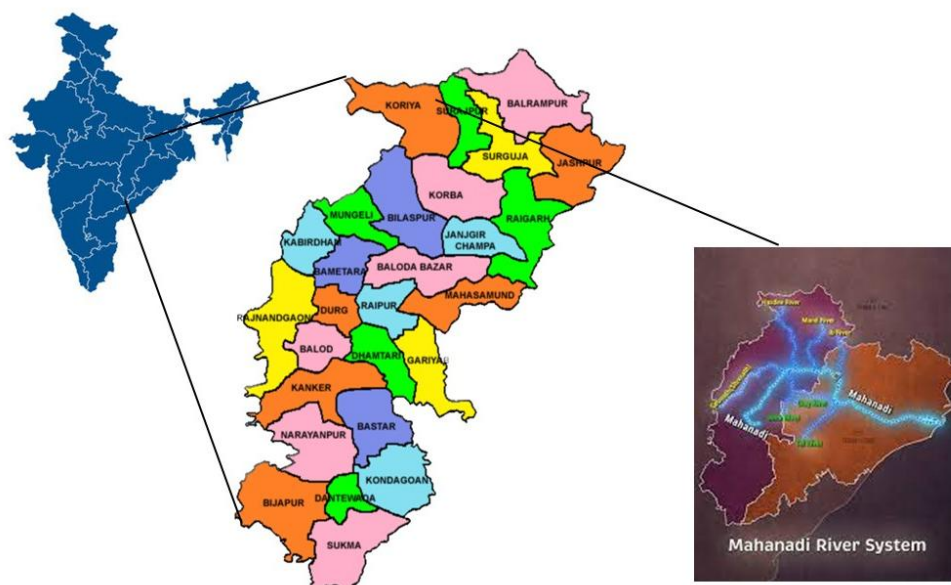


Figure 1: Sample collection site

Selection of Sampling Sites

Samples was collected from five different site of Hasdeo river bank covering Korba and Janjgir Champa region (Chhattisgarh). The sampling site (SS) was (SS- 1) Swarmangla, (SS- 2) Deori, (SS- 3) Kudri- barrage, (SS- 4) Champa, (SS- 5) Pithampur which are surrounded by BALCO, NTPC, SECL Coal crusher plant, GBR Energy, Shanti GD Ispat and power plant Manikpur coal mine (SECL), Prakash iron and steel industry, Mahindra power Ltd respectively (Figure 2).



Figure 2: Sample collection site

Collection and Processing of Samples

River sediment soil samples was collected from sampling sites using clean shovel at the depth of 15 cm around the sampling area in a clean and polythene bag. Collected samples was brought in laboratory and was processed under aseptic condition and stored in refrigerator at

4°C for the further investigation (Carter & Gregorich, 2007).

Physicochemical Analysis of the Collected Samples

Physicochemical parameters of the samples like soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), phosphorus (P), potassium (K) will be determined by standard methods described by APHA, 2017.

pH and Electric Conductivity (Rhoades, 1984)

20g of soil was taken in a 100ml beaker and added 50ml distilled water. The suspension was stirred at regular intervals for about one hour. The pH of soil suspension (1:2.5) was recorded using systronics pH meter 362. After recording soil pH, soil suspension was allowed to settle soil at the bottom of beaker, electrical conductivity was determined in soil water suspension (1:2.5) by direct reading on conductivity meter, 304 (make - Systronics).

Determination of Organic Carbon

Soil passed through 0.5mm sieve are estimated by Walkley-Black method using 1N potassium bichromate ($K_2Cr_2O_7$) as oxidizing agent and 0.5N Ammonium iron (II) sulphate [$Fe(NH_4SO_4)$]. The organic carbon obtained is multiplied by factor 1.724 to get organic carbon (Jackson, 1973).

Procedure: 1g of soil sample was taken in 500ml of conical flask and added 10ml of 1N $K_2Cr_2O_7$. To this added 20ml of conc. sulfuric acid (H_2SO_4) and left the solution for 10 minutes. Then mixed 200ml of distilled water and 5ml of ortho phosphoric acid (H_3PO_4) and added a pinch of [1-2g of NaF (sodium fluoride)]. Added 3 drops of di phenyl amine [$(C_6H_5)_2NH$] and titrated with 0.5N $Fe(NH_4SO_4)$ until the colour change from blackish to bluish green and noted the reading at end point.

$$\% \text{ Organic carbon} = \left\{ 10 - (T. R. \times \frac{\text{Volume of } K_2Cr_2O_7}{\text{Blank reading}}) \right\} \times \frac{0.003 \times 100}{\text{Weight of soil sample}}$$

T. R. = Titration reading of the sample

Determination of Available Nitrogen

It was estimated by simple titration method. 10g of 2.5% sodium hydroxide (NaOH) is taken in Kjeldahl apparatus (make – Pelican KelplusDistyl EMBA) for the distillation and absorb in boric acid (H_3BO_3) and finally titrated with 0.1N H_2SO_4 (Chopra and Kanwar, 1976). Procedure: 10g of soil sample was taken in round bottom flask and added 100ml of 2.5% NaOH and 100ml of 0.32% $KMnO_4$ (potassium permanganate). Kept this solution in a burner for about 25 min. Connect the round bottom flask with the condenser and react the condensed material with 10ml of boric acid until the colour of red litmus paper changes from blue and noted the reading of end point of burette.

$$\text{Nitrogen \%} = (T - B) \times N \times \frac{1.4}{\text{Weight of soil (g)}}$$

T = Titration reading of the sample; B = Titration reading of the blank

Determination of Available Phosphorus

25g of soil and pinch of charcoal were extracted by 0.5N NaHCO₃ (sodium bicarbonate) (Olsen's extract) than shake for 1 hr, filtered and blue color was developed (blue color method) and read in UV/VIS spectrophotometer (make – Shimadzu UV-2450) using 660nm wavelength (Black, 1965).

Procedure: 1.5g of soil sample was taken and added 50ml of NaHCO₃ solution add pinch of activated charcoal in it. Shake it for 1 hr and filtered. Took 5ml of filtrate in 50ml volumetric flask and add 2-3 drops of 2-4 nitro phenol indicators to appear yellow color. Added 4N HCl (Hydrochloric acid) drop by drop to adjust the pH of the solution until solution becomes colorless. Then added 10ml of ammonium molybdate [(NH₄)₆Mo₇O₂₄.4H₂O] 0.5ml of stannous chloride (SnCl₂) and make up the volume up to 50ml. Reading of this solution was taken on UV/VIS spectrophotometer using 660nm wavelength (Black, 1965).

$$P \text{ in ppm} = \frac{GR \times SPR \times \text{Volume of NaHCO}_3 \times \text{Total volume made}}{\text{Weight of extract taken} \times \text{soil taken}}$$

$$P \text{ in ppm} = \frac{GR \times SPR \times 50 \times 50\text{ml}}{5\text{ml} \times 2.5\text{g}}$$

$$P \text{ in Kg/ha} = SPR \times 1315$$

GR = Graph reading; SPR = Spectrophotometer reading

Determination of Available Potassium

5.0g of soil was abstracted by 25ml 1N ammonium acetate (C₂H₃O₂NH₄) (pH 7.0) and shake for 5 to 10 min. by shaker. Filter with ordinary filter paper and took readings of extract with the help of flame-photometer (make – Systronics 130) (Black, 1965).

Procedure: For preparing 100ppm stock solution of potassium, 0.1907g potassium chloride (KCl) is dissolved in 1 liter of distilled water. Solution of different concentrations viz. 50, 40, 30, 20 and 10ppm were prepared by dilution method and prepared a graph for estimation of these elements. 5g of samples were added with 25ml of C₂H₃O₂NH₄ are shaking well with the help of shaker for 10 to 15 min. After shaking, filtered the solution in 50ml beaker and analyzed by a flame-photometer.

$$\text{K in Kg/ha} = \frac{\text{GR} \times \text{FPR} \times \text{Volume of ammonium acetate} \times 2.5}{\text{Weight of soil sample}}$$

R = Graph reading; FPR = Flame photometer reading

3. Result and Discussion

Collection of Sample

Samples collected from five different site of Hasdeo river bank covering Korba and Janjgir-Champa region (Chhattisgarh).

1. S- 1 Swarmangla
2. S 2 Deori
3. S- 3 Kudri- barrage
4. S- 4 Champa
5. S- 5 Pithampur

Samples were collected from five distinct sites along the Hasdeo River bank, spanning the Korba and Janjgir-Champa regions in Chhattisgarh. These sites included Swarmangla (S-1), representing the upstream area, and Deori (S-2), located further downstream. Another sampling point, Kudri-Barrage (S-3), was selected to assess the river's condition near the barrage area, which may experience variations due to water flow regulation. The fourth site, Champa (S-4), represents a key location near an urban settlement that could be influenced by anthropogenic activities. Finally, Pithampur (S-5), a downstream location, was chosen to capture the river's state as it flows through the region.

Physiochemical Analysis of Hasdeo River Sediments

The table 1 provides detailed insights into the physicochemical and nutrient parameters of water samples collected from five different sites (S-1 to S-5) along the Hasdeo River bank, covering the Korba and Janjgir-Champa regions. The water samples varied in color, reflecting different environmental and pollutant conditions. At S-1 (Swarmangla), the water appeared blackish, indicating high organic load or possible contamination. S-2 (Deori), S-4 (Champa), and S-5 (Pithampur) exhibited muddy water, suggesting sedimentation or soil erosion. S-3 (Kudri-barrage) had a brownish tint, possibly due to suspended particles or organic material in the water near the barrage. Similar observations have been made by researchers such as Gupta et al. (2013), who reported blackish water in areas with high organic pollution. The muddy water observed at S-2, S-4, and S-5 is often linked to soil erosion and sedimentation, which are prevalent in agricultural regions where land disturbance and runoff increase sediment transport into rivers (Hossain et al., 2015).

The pH values across the sites ranged from slightly acidic at S-1 (5.86 ± 0.01) to near neutral at the other sites. The acidic pH at S-1 may be attributed to the high organic load, which can lower pH through the release of organic acids during decomposition (Tebbutt, 1998). S-2 and

S-4, with pH values closer to neutral, reflect a less acidic environment, likely influenced by buffering capacity due to higher alkalinity at these sites (West et al., 2006). The variation in alkalinity, ranging from 72 ± 1.41 mg/L at S-2 to 106 ± 0 mg/L at S-4, further supports this interpretation. Higher alkalinity at S-4 suggests a stronger buffering capacity, which can help neutralize acids and stabilize the pH (Zhou et al., 2014).

Temperature variations across the sites ranged from $20.66 \pm 0.47^\circ\text{C}$ at S-1 to $24.66 \pm 0.94^\circ\text{C}$ at S-5. Warmer temperatures at S-5 could be due to anthropogenic influences such as nearby industrial activities or reduced flow velocity downstream, as warmer water temperatures are commonly observed in such environments (Chakrabarti et al., 2002). The higher temperature at S-5 may also influence the solubility and reactivity of substances in the water, affecting nutrient cycling and microbial activity.

EC values at S-2 and S-4 were the highest (1665.66 ± 0.47 $\mu\text{moh/cm}$ and 1600 ± 0.95 $\mu\text{moh/cm}$, respectively), reflecting elevated ion concentrations in these areas, likely due to agricultural runoff and industrial discharges. The EC at S-3 was the lowest (1231 ± 0 $\mu\text{moh/cm}$), which might suggest lower dissolved ion content, possibly due to limited runoff or water dilution effects from upstream conditions (Rhoades, 1984).

The highest organic matter content at S-1 ($0.66 \pm 0.94\%$) is consistent with the observed blackish water, likely due to contamination from organic waste or industrial effluents. High organic content can contribute to eutrophication, leading to oxygen depletion in aquatic ecosystems (Boyd & Tucker, 2014). Conversely, the lower organic content at S-4 ($0.279 \pm 0.81\%$) might indicate better water quality or higher decomposition rates of organic material. Organic carbon, another critical parameter, was also highest at S-2 (25.53 ± 0.41 g/kg) and lowest at S-1 (17.90 ± 0.21 g/kg), with the former reflecting higher biological activity or agricultural inputs.

Total nitrogen content was highest at S-5 (1.63 ± 0.20 g/kg) and lowest at S-4 (1.06 ± 0.68 g/kg). Elevated nitrogen levels at S-5 could be attributed to agricultural or domestic runoff, while lower levels at S-4 suggest less nitrogen input or faster utilization. This elevation in nitrogen is consistent with findings from Maiti et al. (2013), who noted similar trends in rivers impacted by agricultural runoff. Potassium content ranged from 20.66 ± 0.47 g/kg at S-3 to 28.33 ± 0.94 g/kg at S-5, reflecting nutrient variability. Potassium is an essential plant nutrient, and its higher levels at S-5 may indicate agricultural contributions. Potassium is an essential nutrient for plants, and higher concentrations are typically associated with areas of intense agricultural activity (Singh & Dwivedi, 2011). Phosphorus levels were relatively low across all sites, ranging from 0.047 ± 0.13 mg/L at S-5 to 0.055 ± 0.11 mg/L at S-3. Phosphorus is a key nutrient for aquatic ecosystems, and its low concentration may limit algal growth but also indicates minimal pollution from fertilizers or detergents. Low phosphorus levels suggest limited eutrophication potential, possibly due to the limited use of phosphorus-based fertilizers in the surrounding areas or effective uptake by aquatic plants (Sharma et al., 2005). Overall, the parameters provide a comprehensive understanding of the water quality and ecological conditions of the Hasdeo River, highlighting site-specific variations influenced by natural and anthropogenic factors.

Table 1: Physiochemical Analysis of Hasdeo River Sediments

S.No.	Parameters	Samples				
		S-1	S-2	S-3	S-4	S-5
1.	Colour	Blackish	Muddy	Brownish	Muddy	Muddy
2.	pH	5.86±0.01	6.34±0.02	6.44±0.004	6.04±0.009	6.37±0.131
3.	Temp (°C)	20.66±0.47	23.66±1.24	22±0.81	21±0	24.66±0.94
4.	EC (µmoh/cm)	1588.33±0.47	1665.66±0.47	1231±0	1644±0.81	1609±0.47
5.	Organic Matter (%)	0.66±0.94	0.33±0.47	0.550±0	0.279±0.81	0.55±0
6.	Alkaninity (mg/lCaCO ₃)	92.66±1.24	72±1.41	86±1.63	106±0	73±0.81
7.	Organic Carbon g kg ⁻¹	17.90 ±0.21	25.53±0.41	21.8±0.56	23.63±0.04	18.43±0.54
8.	Total Nitrogen (g kg ⁻¹)	1.4±0.08	1.6±0	1.133±0.44	1.06±0.68	1.63±0.20
9.	Total Potassium (g kg ⁻¹)	24.66±0.47	23.66±1.24	20.66±0.47	24±0	28.33±0.94
10.	Phosphorus(mg/l)	0.05±0.47	0.051±0.17	0.055±0.11	0.049±0.27	0.047±0.13

Heavy Metal Analysis of Hasdeo River Sediments

The table 2 outlines the concentration of heavy metals measured at five different sampling sites (S-1 to S-5) along the Hasdeo River. The concentration of iron was highest at S-1 (4.980 ± 0.01 mg/L) and gradually decreased downstream, reaching its lowest value at S-5 (3.84 ± 0.01 mg/L). Elevated iron levels at upstream sites could be attributed to natural mineral deposits, industrial effluents, or runoff from mining areas. Elevated iron concentrations at upstream sites could be attributed to natural mineral deposits, as iron is commonly found in sedimentary rock formations, or anthropogenic sources such as industrial effluents, mining runoff, and wastewater discharge (Chrysafides et al., 2012). The gradual decrease downstream indicates that the river's natural flow likely dilutes the concentration as it moves away from potential sources of contamination. Elevated iron levels are often indicative of poor water quality, as they can impact aquatic ecosystems by altering oxygen dynamics and affecting the health of aquatic organisms (Boulton et al., 2004).

Lead levels ranged from 2.34 ± 0.02 mg/L at S-2 to 2.62 ± 0.04 mg/L at S-1, with minor variations across sites. These values suggest contamination from industrial activities, battery disposal, or vehicular emissions in the region. The presence of lead at these sites is indicative of contamination from industrial activities, such as battery disposal, vehicular emissions, and metal processing (Jain et al., 2015). Lead contamination is particularly concerning due to its toxicity, even at low concentrations, and its long-lasting environmental and health effects, particularly on aquatic organisms and humans (Sadiq, 1992).

Manganese concentrations varied from 1.21 ± 0.008 mg/L at S-3 to 1.62 ± 0.02 mg/L at S-4. Copper was detected in the range of 0.103 ± 0.004 mg/L at S-1 to 0.8 ± 0.09 mg/L at S-5. The gradual increase in copper downstream indicates potential anthropogenic sources, such as

Nanotechnology Perceptions Vol. 20 No. S7 (2024)

industrial effluents, fertilizers, or pesticides. The increase in copper downstream could be linked to industrial effluents, agricultural practices (including the use of fertilizers and pesticides), and the wear of metals from urban infrastructure (Sari et al., 2008). While copper is essential for organisms, it can become toxic when present in excess, especially to aquatic life, impairing growth and reproduction (Boening, 2000).

Manganese is an essential element for both plants and animals, but excessive concentrations can lead to toxicity, particularly in aquatic environments where it can affect the respiration of aquatic organisms (Sanchez et al., 2013). The variation in manganese concentrations suggests that localized sources such as industrial discharges or natural mineral deposits contribute to these elevated levels.

Zinc levels were highest at S-2 (1.20 ± 0.009 mg/L) and lowest at S-1 (0.1 ± 0 mg/L). The elevated levels at S-2 suggest contamination from urban runoff, industrial discharges, or waste disposal practices, reflecting contamination primarily from urban runoff, industrial discharges, and waste disposal practices (Mishra et al., 2016). Zinc, although an essential nutrient, can be toxic at elevated concentrations, particularly in aquatic systems, where it can disrupt the functioning of enzymes and other cellular processes (Balsamo et al., 2013).

Chromium concentrations varied significantly, with the highest value recorded at S-4 (0.66 ± 0.04 mg/L) and the lowest at S-3 (0.03 ± 0.13 mg/L). Chromium is commonly associated with industrial activities like tanning, electroplating, or dye manufacturing. Chromium is frequently associated with industrial processes such as tanning, electroplating, and dye manufacturing, and its higher levels at S-4 suggest localized industrial contamination (Banerjee et al., 2011). Chromium, particularly in its hexavalent form (Cr(VI)), is a potent carcinogen and poses significant risks to both aquatic life and humans (Chakrabarti & Chatterjee, 2012).

Cadmium levels ranged from 0.02 ± 0.1 mg/L at S-3 to 1.62 ± 0.02 mg/L at S-4, with high levels at downstream sites suggesting contamination from industrial effluents, phosphate fertilizers, or waste discharge. The higher concentrations at S-4 suggest contamination from industrial effluents, phosphate fertilizers, and waste discharges (Mohan et al., 2016). Cadmium is highly toxic and can accumulate in aquatic organisms, leading to long-term environmental damage and human health risks, particularly through the food chain (Järup, 2003).

Mercury was detected in varying concentrations, with the highest levels at S-3 (0.81 ± 0.008 mg/L) and S-4 (0.8 ± 0.09 mg/L), and the lowest at S-1 (0.21 ± 0.01 mg/L). Mercury contamination may arise from mining activities, industrial discharges, or improper disposal of mercury-containing products. Mercury contamination may arise from mining activities, industrial discharges, or improper disposal of mercury-containing products (Mackay & Kyriakidis, 2010). Even at low concentrations, mercury is highly toxic, particularly in its methylated form, which can accumulate in fish and pose serious health risks to humans and wildlife (Olsson et al., 2000).

Nickel concentrations ranged from 0.14 ± 0.004 mg/L at S-3 to 1.62 ± 0.02 mg/L at S-4 and S-5, indicating potential contamination from electroplating industries, urban runoff, or waste disposal, indicating contamination from electroplating industries, urban runoff, or waste disposal (Singh et al., 2015). While nickel is an essential nutrient in trace amounts, it can be toxic to aquatic organisms at elevated concentrations, impairing the function of various

enzymes and cellular processes (Bhattacharya et al., 2013).

Molybdenum was highest at S-4 (0.8 ± 0.09 mg/L) and lowest at S-2 (0.11 ± 0.004 mg/L). This variability suggests localized sources of contamination, possibly from agricultural or industrial activities, indicating possible localized contamination from agricultural or industrial sources (Medeiros et al., 2008). Molybdenum toxicity is rare but can occur in specific environmental conditions, potentially leading to disruption in the nitrogen cycle in aquatic ecosystems.

Aluminum levels were relatively low at S-1 (0.22 ± 0 mg/L) and increased downstream, peaking at S-4 (1.62 ± 0.02 mg/L) and S-5 (1.55 ± 0.004 mg/L). High aluminum levels are often associated with soil erosion, mining activities, or untreated wastewater discharges (Zhao et al., 2017). Elevated aluminum concentrations can be toxic to aquatic life, particularly in acidic waters, where aluminum becomes more bioavailable (Forstner & Wittmann, 1983).

High aluminum levels may result from soil erosion, mining activities, or untreated wastewater discharge. The data indicates spatial variations in heavy metal concentrations, with downstream sites such as S-4 and S-5 showing higher levels of several metals. This trend suggests cumulative contamination from anthropogenic activities, including industrial effluents, agricultural runoff, and urban waste. Heavy metals like cadmium, lead, and mercury, even at low concentrations, pose significant risks to aquatic ecosystems and human health, highlighting the need for stringent monitoring and mitigation strategies (Verma et al., 2017).

Table 2: Heavy Metal Analysis of Hasdeo River Sediments

Heavy Metals	S-1	S-2	S-3	S-4	S-5
Fe	4.980±0.01	4.76±0.02	4.86±0.02	3.96±0.012	3.84±0.01
Pb	2.62±0.04	2.34±0.02	2.55±0.004	2.42±0.02	2.51±0.004
Mn	1.36±0.047	1.54±0.004	1.21±0.008	1.62±0.02	1.55±0.004
Cu	0.103±0.004	0.20±0.004	0.12±0	0.66±0.04	0.8±0.09
Zn	0.1±0	1.20±0.009	0.86±0.04	0.66±0.04	0.40±0.02
Cr	0.52±0.01	0.60±0.04	0.03±0.13	0.66±0.04	0.2±0.09
Cd	0.66±0.04	0.51±0.004	0.02±0.1	1.62±0.02	1.55±0.004
Hg	0.21±0.01	0.8±0.09	0.81±0.008	0.8±0.09	0.40±0.02
Ni	0.43±0.012	1.03±0.04	0.14±0.004	1.62±0.02	1.55±0.004
Mo	0.40±0.02	0.11±0.004	0.31±0.004	0.8±0.09	0.40±0.02
Al	0.22±0	0.40±0.004	0.75±0.004	1.62±0.02	1.55±0.004

4. Conclusion

The study of the Hasdeo River sediments provided significant insights into the physiochemical characteristics and heavy metal contamination levels. The findings revealed variations in sediments quality parameters such as pH, temperature, electrical conductivity, organic matter content, and nutrient concentrations across different sampling sites. The presence of heavy metals such as iron, lead, manganese, copper, zinc, chromium, cadmium,

mercury, nickel, molybdenum, and aluminum at varying levels indicates both natural and anthropogenic influences on the river's water quality. Elevated concentrations of metals like iron, lead, and magnese at upstream sites suggest potential sources from industrial discharges, mining activities, and agricultural runoff. The physicochemical analysis demonstrated that some sites exhibited slightly acidic conditions, higher organic matter, and elevated conductivity, signifying pollution input. Heavy metal accumulation, particularly at downstream locations, highlights the cumulative impact of industrial and urban effluents, necessitating stringent environmental monitoring and mitigation measures. The data suggest that the Hasdeo River is under considerable ecological stress due to human activities, emphasizing the urgent need for sustainable management practices to preserve water quality and ecosystem health. The study underscores the necessity for regular assessment and the implementation of effective pollution control strategies to mitigate contamination levels and ensure the long-term sustainability of the river for both ecological and human use.

References

1. American Public Health Association. (2017). Standard methods for the examination of water and wastewater (23rd ed.). Washington, DC: American Public Health Association.
2. Balsamo, M., Bolognese, A., & Berzolari, F. (2013). Zinc contamination in rivers: Effects on aquatic ecosystems and risks for human health. *Environmental Toxicology and Chemistry*, 32(5), 1082–1090.
3. Banerjee, M., Pal, A., & Ghosh, D. (2011). Chromium contamination and its ecological risks in river water: A case study. *Environmental Science & Technology*, 45(9), 3910–3916.
4. Bhakur, K., & Yadav, P. (2019). Heavy metal pollution of River Hasdeo of Chhattisgarh at different places in Korba District. *International Journal of Computer Sciences and Engineering*, 7(3), 63–66.
5. Bhaskar, M., & Dixit, A. K. (2015). Water quality appraisal of Hasdeo River at Korba in Chhattisgarh, India. *International Journal of Scientific Research*, 4(9), 1–3.
6. Bhaskar, M., & Dixit, A. K. (2017). Toxicity evaluation of Hasdeo River water on seed germination and amylase activity in *Vigna radiata* L. *MOJ Toxicology*, 3(7), 161–165.
7. Bhaskar, M., Dixit, A. K., Ojha, K. K., Dubey, S., Singh, A., & Abhishek, A. (2020). The impact of anthropogenic organic and inorganic pollutants on the Hasdeo River water quality in Korba region, Chhattisgarh, India. *Bioinformation*, 16(4), 332–340.
8. Bhattacharya, P., Ghosh, R., & Chatterjee, P. (2013). Nickel contamination in freshwater ecosystems: Environmental and health impacts. *Environmental Monitoring and Assessment*, 185(2), 1029–1037.
9. Black, C. A. (Ed.). (1965). *Methods of soil analysis: Part 1. Physical and mineralogical properties, including statistics of measurement and sampling*. American Society of Agronomy.
10. Boening, D. W. (2000). Ecological effects of metals in the aquatic environment. *Critical Reviews in Environmental Science and Technology*, 30(1), 1–43.
11. Boyd, C. E., & Tucker, C. S. (2014). *Water quality: An introduction*. Springer.
12. Carter, M. R., & Gregorich, E. G. (2007). *Soil sampling and methods of analysis* (2nd ed.). Canadian Journal of Soil Science, 87(1), 1–3.
13. Chakrabarti, R., Kundu, S., & Roy, A. (2002). Temperature and dissolved oxygen dynamics in an industrially affected river. *Environmental Monitoring and Assessment*, 77(1), 89–102.
14. Chakrabarti, S., & Chatterjee, A. (2012). Chromium contamination in river waters: Impacts and risks to human and aquatic health. *Environmental Monitoring and Assessment*, 184(7), 4217–4230.
15. Chrysafides, M., Liu, Y., & Ochoa, D. (2012). The fate of iron in the water column of rivers. *Environmental Chemistry*, 9(5), 253–259.
16. Dewangan S, Mundeja P and Deshpande B (2024) Biological Remediation of Rice Mill Wastewater with *Pichia pastoris*: Optimization Approaches. *Afr.J.Bio.Sc.* 6(1): 601-610.
17. Dewangan S, Mundeja P, Deshpande B and Roy V (2023) Enhanced Physical Method of Remediating Rice Mill Effluent. *International Journal of Applied Engineering & Technology*, 5(2): 410-421.

18. Forstner, U., & Wittmann, G. T. (1983). Metal pollution in the aquatic environment (2nd ed.). Springer.
19. Gauthier, J. M., Armstrong, D., & Link, P. (2013). Toxic effects of heavy metals in freshwater systems. *Ecotoxicology*, 22(7), 1522–1535.
20. Gupta, S. K., Kaur, M., & Yadav, M. (2013). Impact of organic and inorganic pollutants on water quality: A review. *Journal of Environmental Science and Technology*, 6(3), 114–120.
21. Hossain, M. S., Rahman, M. A., & Bhuiyan, M. R. (2015). Soil erosion and sedimentation in river basins: Case study of the Ganges-Brahmaputra-Meghna delta. *Environmental Science & Policy*, 55, 72–81.
22. Jackson, M. L. (1973). Soil chemical analysis: Advanced course (2nd ed.). Madison, WI: University of Wisconsin Press.
23. Jain, C. K., Prakash, S., & Tripathi, S. (2015). Lead contamination in river water and sediments: A case study. *Environmental Pollution*, 201, 92–99.
24. Jarup, L. (2003). Hazards of heavy metal contamination. *British Medical Bulletin*, 68(1), 167–182.
25. Maiti, S. K., Saha, A., & Sengupta, D. (2013). Impact of agricultural runoff on river water quality: A case study from India. *Environmental Monitoring and Assessment*, 185(6), 4931–4943.
26. Rajwade D and Deshpande B (2023) Decolourization of Industrial Dyes Using A White Rot Fungi *Lentinus Edodes*. *International Journal of Applied Engineering & Technology*, 5(2): 468-481.
27. Rajwade D and Deshpande B (2024) Decolourization of Rhodamine B and Remazol Brilliant Blue by crude enzyme extract from *Ganoderma lucidum*. *Afr.J.Bio.Sc.* 6(1): 718-728.
28. Rhoades, J. D. (1984). Electrical conductivity methods for measuring and mapping soil salinity. *Advances in Agronomy*, 37, 85–130.
29. Sahu, B. (2005). Study of some physico-chemical characteristics of Hasdeo River water at Korba. *Nature Environment and Pollution Technology*, 4(4), 633–636.
30. Sharma, S. S., Khanna, M., & Singh, R. (2005). Phosphorus dynamics in river ecosystems: A review. *Water Research*, 39(10), 2205–2216.
31. Singh, M. R., & Dwivedi, S. (2011). Influence of agricultural runoff on nutrient concentrations in the river water: A study on Ganga River. *Environmental Monitoring and Assessment*, 179(1-4), 373–384.
32. Tebbutt, T. H. Y. (1998). Principles of water quality control (5th ed.). Butterworth-Heinemann.
33. Vaishnav, M. M., Hait, M., & Rahangdale, P. K. (2014). Assessment of water pollution of Hasdeo River and its surrounding areas at Janjgir-Champa District (C.G.) India. *International Journal of Advanced Research*, 2(8).
34. Verma P and Verma RK (2018) Qualitative estimation of amylase enzymeactivity of Fungal species isolated from iron ore mined overburden soil. *TropicalPlant Research*, 5(3):396–404.
35. Verma P and Verma RK (2019) Succession of Culturable Microbes on Rhizosphere Soil of Iron Ore Mined Overburden dump in Dalli Rajhara, Durg Chhattisgarh. *Plant Archive*, 19(1): 1179-1189.
36. Verma P, Singh S and Verma RK (2016) Heavy metal biosorption by *Fusarium* strains isolated from iron ore mines overburden soil. *International Journal of Environmental Science and Toxicology Research*, 4(4): 61-69.
37. Verma P, Singh S and Verma RK (2017) Impact of plantation on iron ore mined overburden at Durg in Chhattisgarh (India). *International Research Journal of Environment Science*, 6(1):1-12.
38. West, C. T., Geller, D. E., & Biswas, R. (2006). Water quality and ecosystem services in agricultural rivers. *Environmental Science & Technology*, 40(6), 1690–1699.
39. Zhou, X., Li, X., & Yu, H. (2014). Buffering capacity and nutrient dynamics in freshwater ecosystems: A review. *Environmental Science & Technology*, 48(3), 1123–1135.