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Role of Anthropogenic Metal Contamination in Water, Soil Sediment, Flora and Fauna in the Lotic Ecosystem in Subarnarekha River, Jamshedpur (Jharkhand) India

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ABSTRACT

The study showed the effects of anthropogenic metal pollutants on the Subarnarekha River, namely on water, soil sediments, and aquatic biota such as water hyacinth (*Eichhornia crassipes*) and fish species including *Rohu* and *Tilapia*. Heavy metals such as cobalt (Co), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn) were investigated for their presence and bioaccumulation in various environmental matrices. The study conducted a comparative investigation of local, Indian, and worldwide rivers to better understand contamination patterns. Significant metal deposition is indicated by the findings, which may have negative effects on the environment and human health.

Figure : 01 References : 31 Table : 00

KEY WORDS : Anthropogenic, Bioaccumulation, Ecological, *Eichhornia crassipes,* Environmental, Heavy metal

Introduction

Rivers play a vital role in sustaining life by supplying water for domestic, agricultural, and industrial use. However, increased urbanization, industrialization, and deforestation have led to severe pollution in river ecosystems worldwide. Heavy metals, in particular, pose a serious threat due to their non-biodegradable nature, high toxicity, and ability to accumulate in aquatic organisms, leading to severe ecological and human health concerns [1, 2]. Heavy metal pollution in river systems is a significant global environmental issue, impacting water quality, sediment composition, and biodiversity. Studies have reported excessive metal concentrations in major rivers such as the Mississippi (USA), Thames (UK), and Yangtze (China), primarily due to industrial discharge, mining, and urban waste [3, 4]. Similarly, in India, rivers like the Ganga, Yamuna, and Hooghly face severe contamination from chromium (Cr), lead (Pb), nickel (Ni), and cadmium (Cd) due to industrial and municipal waste discharge [5, 6]. The Subarnarekha River, which traverses West Bengal, Odisha, and Jharkhand, has been severely harmed by heavy metal contamination. Millions of people depend on the river for their water supply, but mining operations, uncontrolled waste disposal, and industrial discharge have a negative impact on it [7, 8]. High concentrations of cobalt (Co), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn) have been found in sediment, river water, and aquatic life [9, 10]. The Subarnarekha River's metal poisoning is largely caused by the Jamshedpur area, which is well-known for its substantial industrial presence. Among the biggest polluters, steel mills, mining operations, and chemical manufacturers discharge dangerous metals straight into rivers [11, 12]. Hazards to the environment and human health: Heavy metals impair aquatic organisms' physiological and metabolic processes. Studies indicate that chromium (Cr) and lead (Pb) disrupt cellular metabolism,

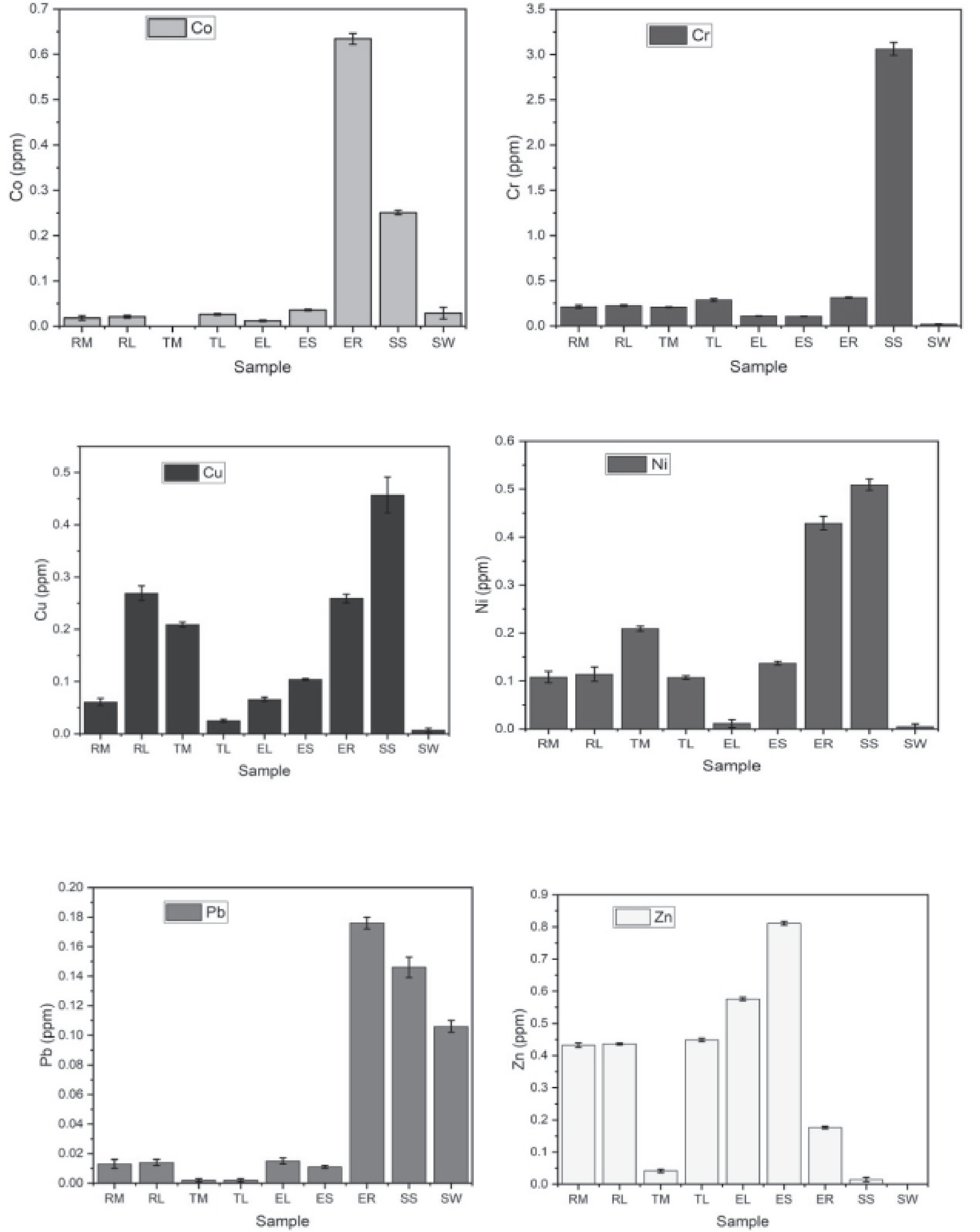

Fig.1: Concentrations of various heavy metals (Co, Cr, Cu, Ni, Pb, and Zn) in samples which were collected from Subarnarekha River, Jamshedpur (Sample nomenclature: RM- Rohu Muscle Tissue, RL- Rohu Liver Tissue, TM- Tilapia Muscle Tissue, EL- *Eichhornia crassipes* Leaf, ES- *Eichhornia crassipes* Stem, ER- *Eichhornia crassipes* Root, SS- Soil Sediment, SW- Surface Water)

reproductive processes, and enzyme activity in fish species such as tilapia and rohu[13, 14]. Aquatic species experience growth retardation and higher mortality rates as a result of oxidative stress and DNA damage was caused by copper (Cu) and nickel (Ni) [15, 16]. Furthermore, individuals who depend on edible fish species as their main source of protein are at serious risk for health problems due to the bioaccumulation and biomagnifications of harmful metals in these species. Developmental defects, renal damage, and neurological diseases have all been related to long-term exposure to lead (Pb) and cadmium (Cd) [17, 18].

The Role of *Eichhornia crassipes* in the Removal of Heavy Metals: Heavy metals from polluted water sources can be absorbed and accumulated by water hyacinth, or *Eichhornia crassipes*. Its rapid growth and potent metal-uptake capabilities make it a viable phytoremediator. More research on safe disposal methods is necessary, nevertheless, as improper removal of plants containing metals might lead to secondary pollution risks [19, 20].

Research and Policy Interventions Are Needed: Immediate action is required in light of the mounting health and environmental issues related to heavy metal pollution. Strict environmental laws, better industrial waste management, and environmentally friendly remediation methods are all examples of strategies that should be implemented [21, 22].In order to restore and protect the river ecology, this study intends to present a thorough analysis of heavy metal contamination in the Subarnarekha River, assess bioaccumulation trends, and suggest sustainable mitigation techniques [23, 24]

Materials and Methods

Sample Collection: Water, soil sediments, aquatic plants (*Eichhornia crassipes*), and fish tissues (Rohu and Tilapia) were all included in the samples that were gathered from several sites along the Subarnarekha River [8, 9].

Heavy Metal Analysis: Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) was used to determine the amounts of metals (Co, Cr, Cu, Ni, Pb, and Zn). Parts per million (ppm) were used to express the results [10, 11].

Statistical Analysis: To investigate the connections between metal bioaccumulation in various environmental matrices, a correlation analysis was carried out. Additionally, a comparison with contamination levels in other river systems in India and around the world was conducted [12, 13].

Observation

Based on the Fig. 1, various observations have been made as follows:

- **Cobalt (Co)** is significant accumulation in *Eichhornia crassipes* roots and soil sediments, indicating strong bioaccumulation potential, similar observation has also been reported elesewhere[14].
- **Chromium (Cr)** levels is the highest in soil sediments, similar observation has also been found previously[15] and pointing towards industrial effluent discharge as a primary source.
- **Copper (Cu)** concentration was highest in soil sediments, affecting aquatic biodiversity, same type of observation was also reported earlier[16].
- **Nickel (Ni)** is significantly present in *Eichhornia crassipes* and soil sediments, confirming ongoing pollution, alike situation was also already reported[17].
- **Lead (Pb)** bioaccumulation in Rohu muscle and *Eichhornia crassipes* highlights risks to the food chain, similar type of surveillance was also seen earlier[18].
- The potential for phytoremediation is shown by the high content of zinc (Zn) in *Eichhornia crassipes* stems; which was previously[19].

Results and Discussion

According to a comparative analysis of Indian and global rivers, Subarnarekha river has pollution patterns similar to the Ganga and Yamuna in India and the Mississippi and Thames internationally [20,21].The study reveals that *Eichhornia crassipes* as a possible metal removal capacity due to its high metal absorption capability. However, concerns about secondary pollution from plant living being that contains metals constrain applicable disposal methods [22, 23]. Entering heavy metals in the living system, like fish species like Rohu and Tilapia raises concerns about possible health issues, particularly for those who depend on these fish for food. Stronger legislation, increased public awareness, and the treatment of industrial effluent are all necessary for the immediate reduction of pollution [24, 25]. Heavy metal contamination in aquatic ecosystems poses severe environmental and health risks, particularly in industrial regions. Studies highlight pollution in global rivers [28] and groundwater near industries[30]. The Mississippi River also faces contamination [31]. Phytoremediation using aquatic plants offers an effective remediation strategy [29]

Conclusions

The findings of this study indicate that the Subarnarekha River is experiencing severe heavy metal contamination, primarily from industrial discharge, mining activities, and urban pollution. Bioaccumulation of these metals in aquatic flora and fauna poses substantial risks to biodiversity and human health.

This study underscores the need for effective pollution control measures, advanced wastewater treatment technologies, and sustainable phytoremediation techniques. Future research should focus on long-term monitoring programs and policy-driven environmental management strategies to ensure the ecological health of the Subarnarekha River [26, 27].

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