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Assessment of Heavy Metal Contamination in the Diwaniyah River: Tracing Industrial and Municipal Effluent Sources

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Abstract: ***This study investigates the contamination of heavy metals in the Diwaniyah River due to industrial and sewage discharge. The levels of lead (Pb), cadmium (Cd), zinc (Zn), and chromium (Cr) were analyzed to determine the extent of pollution. The study found that zinc recorded the highest concentration at 0.1141 mg/L, followed by chromium (0.0508 mg/L), lead (0.0244 mg/L), and cadmium (0.0117 mg/L). Statistical analysis using SPSS revealed that Al - Hamza Al - Sharqi District exhibited the highest levels of contamination. The findings highlight the urgent need for pollution control measures to mitigate heavy metal accumulation in water sources.***

Keywords: Heavy metals, River contamination, Environmental pollution, Diwaniyah River, Water pollution

1. Introduction

River pollution is a major environmental concern. Increasing water pollution not only leads to the deterioration of water quality, but also impacts human health, the balance of aquatic ecosystems, economic development, and social prosperity [1].

The matter has become more complicated with the development of various industries and technologies and the production of chemical waste, toxins, and environmentally hazardous waste, in addition to the massive expansion in the use of pesticides, disinfectants, sterilization materials, and the disposal of sewage and industrial water, and the random spread of service workshops. All of these activities pollute water sources, especially rivers, ponds, canals, and inland lakes, with various pollutants, including toxic metals [2].

Heavy metals are dangerous pollutants that enter freshwater environments and cause an imbalance in the ecosystem [3]. This is directly or indirectly reflected on the individual [4]. Heavy metals are among the most common environmental pollutants, and their presence in the aquatic ecosystem indicates the existence of natural and human sources [5]. Some of them are harmful even in low concentrations and represent dangerous environmental pollutants as they are non - biodegradable and remain suspended or partially dissolved in the water column. They enter the body through food, water, or air and accumulate over time, causing various damages to organisms [6].

And which can have a serious impact on plant and animal life [7]. Pollution of ecosystems with heavy metals has become a common environmental problem around the world. River and stream water is often polluted with heavy metals from various sources that may be natural, resulting from the weathering of rocks and soil and volcanic activities, or from anthropogenic resulting from the disposal of urban waste, in addition to drifts, atmospheric deposition, drainage ,domestic and industrial waste [8].

Sources of heavy metals in the aquatic environment Natural resources including rock and soil erosion, and reach the aquatic environment where they are dissolved or suspended in rainwater that drifts on the surface of the earth [9]. Anthropogenic resources ,heavy metals vary widely in their chemical properties and are widely used in electronics, machinery and high - tech applications. Major sources of their pollution include mining waste, waste chimney leaks, municipal sewage, urban runoff, industrial wastewater, especially from the electroplating and electronics industries, and automobile exhaust. With increasing generation of metals from technologies activities, the problem of waste disposal has become of utmost importance [10].

Heavy elements are distributed in water between the dissolved and particulate phases, and they can be adsorbed on the surfaces of suspended materials and bottom sediments. All of these cases can be repeated in the river environment and are affected to varying degrees by the physical and chemical properties and biomass within the water body. Thus, they play an important role in regulating and distributing the concentration of these elements, their circulation and their transfer between the layers of water [11].

The subject of this paper is to examine the water of the Diwaniyah River based on samples collected in 2024 in the Diwaniyah Governorate, one of the governorates of southern Iraq within the governorates of the Middle Euphrates.

Among previous studies: [12] on the Karun River in Iran, they found that the concentrations of nickel, chromium and copper were during the winter season (110.7 - 69.3 ,118.3 - 1.7 ,70.3 - 5.5) µg/L respectively ,and during the spring 60.7 - 41.0 ,19.8 - 0.7 ,28.7 - 0.5) µg/L they pointed out that this river is home to several factories, including dye factories, steel factories, and a paper factory, which discharge their waste into the river.

Understanding the concentration of heavy metals in river water is crucial for public health and environmental conservation. This study provides insight into the levels of pollution in Diwaniyah River, aiding policymakers in developing effective water management strategies.

The objectives of this study were (1) determine the content of heavy elements (cadmium, lead, zinc and chromium) in the water of the Diwaniyah River (2) determine the highest and least abundant elements in the water (3) determine the sites that recorded the highest levels of heavy elements.

2. Materials and Methods

Water sampling

Water samples were collected from three sites: Diwaniyah, Al - Sudair, and Al - Hamza Al - Sharqi, covering different regions of the river. to take water samples that were collected over a period of six months from June to November 2024. Samples were collected once a month, with three replicates for each site. Water samples were collected from the riverbank at a depth of 10 cm, using clean 1 - liter polyethylene containers .then the samples were stored in an ice box with information written for each site, then the samples were transferred to the laboratory for examination using an atomic absorption spectrometer.

Analysis of Sediments Samples

One liter of each sample underwent filtration using Millipore filter paper with a pore size of 0.45 μm. This process was conducted in triplicate for each site. Prior to filtration, the filter paper was thoroughly washed with 0.5 N nitric acid, followed by deionized water, and then dried at a temperature of 60°C for a duration of 12 hours. To preserve the elements in their ionic form, 1.5 ml of concentrated nitric acid was added to each liter of the filtered water samples. Subsequently, 100 ml of the filtered water was evaporated at a temperature of 70°C. Before the drying process was completed, 1 ml of concentrated HNO3 and 10 ml of deionized water were introduced to the evaporated sample to facilitate complete dissolution. The final volume was then adjusted to 25 ml with distilled deionized water and stored in polyethylene bottles until the concentrations of the elemental ions were analyzed using an atomic absorption spectrometer, with results reported in mg/L [13].

3. Results

The study analyzed cadmium, lead, chromium, and zinc concentrations at three locations along the Diwaniyah River. Cadmium concentrations ranged from 0.0002 mg/L as a minimum during the month of June at the second study site to 0.0117 mg/L as a maximum during the month of October at the third study site. Lead values in water ranged from a minimum of 0.0001 mg/L during July at the third study site to a maximum of 0.0244 mg/L during September at the first study site. zinc values in water ranged from a minimum of 0.0056 mg/L during august at the second study site to a maximum of 0.1141 mg/L during June at the third study site. Chromium values in water ranged from a minimum of 0.0020 mg/L during July at the second study site to a maximum of 0.0508 mg/L during July at the third study site.

4. Discussion

The results of the current study showed that the levels of cadmium, lead, zinc, and chromium were higher than the Iraqi standards and those of the World Health Organization. The study observed that cadmium concentrations peaked in November, likely influenced by seasonal temperature variations and lead in September when the temperature was low, Increased rainfall and wet deposition of cadmium from the atmosphere and increased surface runoff carrying cadmium from contaminated soils and industrial areas to rivers . [14] [15] .The reason for its decrease during the summer may be due to the tendency of these elements to bioaccumulate in aquatic plants or aquatic organisms, or the tendency of these elements to be absorbed with sediments or form complexes with organic materials [16]. Meanwhile, zinc and chromium recorded the highest level in June and July when the temperature was high ,due to increased evaporation, which increases the concentration of zinc in the water, and the increased use of fertilizers and pesticides that contain quantities of zinc, which increases its concentration in the soil, and then it seeps into the rivers.

5. Conclusion

This study evaluated the contamination levels of heavy metals in the Diwaniyah River, revealing significant pollution from industrial and sewage sources. Zinc recorded the highest concentration, followed by chromium, lead, and cadmium. The results highlight the need for strict monitoring and regulation of industrial waste disposal in the region. Future research should focus on the long - term ecological impact of heavy metal accumulation in aquatic environments.

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