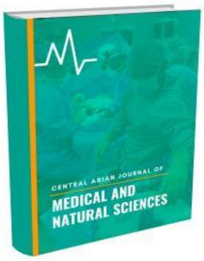

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Article

Investigating the Concentration of Heavy Elements in Soils from Thi-Qar Governorate

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Abstract: Heavy metals are widely recognized as environmental contaminants owing to their toxicity, enduring presence in the environment, and ability to accumulate in living organisms. These metals originate from natural sources such as the breakdown of rocks containing metal deposits and volcanic eruptions. However, human activities such as transportation, waste management, industrial development, and various social and agricultural practices greatly contribute to environmental pollution and affect the overall global ecosystem. Heavy metals (HMs) are among the most dangerous toxicants because they enter the soil via multiple mechanisms and accumulate in the food chain. Toxic metal pollution has increased dramatically from the beginning of the industrial revolution. This study was conducted to determine the levels of contamination of the soil of Thi Qar Governorate, located in southern Iraq, with heavy metals including lead, cadmium, Zinc, and copper during September and October for the years 2023-2024. The study contained modelling and analysis of nine soil samples from the Eredo, Al-Husaynat, Al-Arja, Al-Khamisiya Al-Bathaa, Suq Al-Shuyoukh, Al-Shatrah, Al-Rifai, and Al-Chibaish districts. The heavy metal measurement levels were in the following range: Pb (73 -2.5 ppm), Cd (13.3-0.016 ppm), Zn (42-8.1 ppm), and Cu (26-4 ppm). The concentration of the metals in the soil samples varied according to the following trend: Pb>Zn>Cu>Cd. The findings indicated that the soil in the Eredo area, Al-Arja, and Al-Husaynat districts is contaminated with lead and cadmium, exceeding the globally permitted limits for uncontaminated soil.

Keywords: heavy metals, soil pollution, anthropogenic activities

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1. Introduction

Heavy metals can also be referred to as any metallic chemical element with a relatively high density that is hazardous or poisonous in low concentrations. These heavy metals are the result of several sources of environmental contamination. Environmental contamination caused by heavy metals, as well as health consequences, are among the top causes of concern worldwide [1].

Heavy metal pollution is the excessive deposition of harmful heavy metals in soil induced by human activity. Heavy metals in soil include biologically hazardous metals such as mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), and arsenic (As). Other heavy metals with biological toxicity include zinc (Zn), copper (Cu), nickel (Ni), stannum (Sn), and vanadium (V), among others. In recent years, with the expansion of the global economy, both the type and content of heavy metals in the soil produced by human activities have continuously increased, resulting in the degradation of the environment [2 - 8]. However, heavy metals such as lead, cadmium, and mercury are harmful to living beings in both high and low amounts. They contribute to metabolic anomalies in organisms, particularly consumers of food from plants and other crops cultivated on contaminated soil [9].

The ecosystem and living things are seriously endangered by heavy metals. The food chain has the potential to enhance it. Remediation becomes challenging after heavy metal pollution occurs in the soil. From a few to several hundred years, heavy metals can spend a significant amount of time in the soil [10]. According to [11], heavy metal accumulation in the soil's surface layers might hurt sensitive plants that grow in the soil. When these harmful heavy metals migrate into groundwater or are absorbed by plants and animals, heavy metal-contaminated soil hurts the ecosystem as a whole. Translocation and bioaccumulation can pose a serious threat to ecosystems. When contaminated soils are utilized for crop production, heavy metals have the potential to be harmful to humans, animals, and crop plants. The biosphere's heavy metal pollution as a result of intensive farming and other human activities presents significant challenges to the safe use of agricultural land [12].

2. Materials and Methods

Soil samples were collected from various regions in Thi-Qar Governorate (the center of the governorate, as well as several districts). These samples were collected from the soil surface after removing any debris, within a depth range of 0-10 cm. The soil samples were then sieved to remove unwanted impurities, followed by drying at a temperature of 100°C for two hours using a laboratory oven with a temperature range of 0-250°C. The dried samples were finely ground into a powder. A sieve with a diameter of 0.063 mm was used to obtain pure soil samples free from impurities. The sensitive balance was used to weigh the soil samples for measuring the concentrations of heavy elements.

The concentrations of heavy elements in the selected soil samples were calculated using the Jackson method [13]. To ensure accurate representation, approximately 1 gm of each sample was taken after the modelling process and the samples were crushed. Following this, the samples underwent a series of stages for geochemical analysis.

This involved digesting the samples by adding specific amounts of hydrochloric acid (HC1) and concentrated nitric acid (HNO_3), followed by placing the samples in a sand bath. The sample was cooled to laboratory temperature, and HCL was added. It was then heated in a sand bath until dry. Afterwards, a quantity of HCL and hot distilled water were added to wash the sides of the beaker with the dissolved sample. The mixture was heated to boiling point, then filtered through filter paper (number 42) and transferred to a volumetric flask with a capacity of 100 ml. The insoluble residue was washed with distilled water, and the wash water was added to the flask to complete the volume to 100 ml. The samples were then sent for analysis using the atomic absorption spectrophotometer at the construction laboratory of the Technical Institute Shatrah.

3. Results and Discussion

Table 1 and Figure 1-4 reflect the findings of the HM levels in the study area examined. According to Table 1, the concentrations of heavy elements (lead, cadmium, Zinc, and copper) were calculated in the soil of some areas in the center of the province (Al-Nasiriya district) covering all four directions of the district, and random soil samples were taken, with one sample from each of Al-Bathaa, Suq Al-Shuyoukh, Al-Shatrah, Al-Rafai, and Al-Chibaish Districts. From the obtained results, it was found that the Eredo, Al-Husaynat, and Al-Arja districts had the highest concentration of lead, reaching (73,61,49) ppm, respectively, while the Al-Rafai district had the lowest concentration of lead, reaching 2.5 ppm. This concentration has been exceeded in the Eredo district, which is a residential area characterized by heavy traffic and the resulting lead pollution from fuel combustion in the surrounding environment [14]. As for the Al-Husaynat and Al-Arja areas, which are agricultural regions, they suffer from heavy traffic in the Al-Husaynat area and the presence of a large public sewage pumping station that contaminates the area with leaked sewage water. This water contains high concentrations of heavy metals resulting from various human activities as well as the use of chemical fertilizers and pesticides in agricultural areas which contain heavy elements as components additionally the main slaughterhouse in the city is located in the Al-Houston at area and its waste from animal slaughter affects the soil [15].

The Arja district has the highest concentration of cadmium reaching 13.3 ppm while the Al-Rafai area had a lowest concentration reaching 0.016 ppm. the concentration of cadmium also exceeds the natural average rates in the above-mentioned areas, compared to the current soil study rates in the Al-Arja and Eredo districts, which are non-polluted and have an average cadmium concentration of 0.06 ppm [16]. These areas are characterised by heavy traffic which causes significant pollution due to the burning of vehicle fuel and the damage and corrosion of tires spread in most areas. The areas also suffer from poor health and environmental services, direct discharge of sewage water into the soil, accumulation of household waste and garbage in the widespread use of household waste and garbage, and the widespread use of power generators, especially in residential neighborhoods.

Cadmium is one of the byproducts of burning generator fuel as well as rubber tyres, plastics, and paints, as it is used to stabilize plastic materials [17]. The study has shown an increase in the concentrations of lead and cadmium elements at the soil surface samples from the districts of Eredo, Al-Husaynat and Al-Arja when compared to the global average concentration of lead and cadmium in unpolluted soil. The global average concentration of lead in unpolluted soil is 10 ppm [16]. However, the concentrations of other elements in the remaining areas did not exceed the permissible limits. A large share of general cadmium pollution is caused by dumping and incinerating cadmium-polluted waste [18].

The Eredo area had the highest concentration of Zn, reaching 42 ppm. The increase in the concentration of zinc in the same areas that have experienced an increase in the concentrations of lead and cadmium is because zinc is not available in isolation but rather found in combination with other elements. It is more common in areas that suffer from poor health and environmental services, high human activities, as well as the discharge of sewage into the soil and groundwater and the accumulation of waste and household garbage, most of which contain zinc [19]. The Arja area had the highest concentration of copper, reaching 26 ppm, while the Al-Khamisiyah area had the lowest concentration, reaching 14 ppm. The Al-Khamisiya district is characterized by its extensive spaces that were previously used for military purposes. Military units were heavily deployed in these areas until 2003, when most of the military remnants, including war ammunition and military waste such as the remnants of the American bombings and the detonation of a large number of bombs and shells, were buried. Improper disposal of these wastes leads to their mixing and interaction with the soil, resulting in the presence of heavy elements such as Zn, Mn, Pb, Ni, Cu, Co, and Cd, which increases the pollution levels of these elements in the area [20]. The soil undergoes continuous alteration of heavy metals distribution as a result of various soil processes, all of which are affected by environmental factors. The act of dumping and incinerating cadmium-polluted waste is responsible for a significant portion of the overall cadmium pollution [18]. The study areas in Thi-Qar Governorate have not exceeded the permissible levels of Zinc (50 ppm) and copper (30 ppm) in uncontaminated soil [16].

Table 1. Concentrations of Heavy Metals in the study area

Stations	Pb concentration (ppm)	Cd concentration (ppm)	Zn concentration (ppm)	Cur concentration (ppm)
Eredo	73	9.5	42	21
Al-Husaynat	61	9.4	38	18
Al-Arja	49	13.3	31	26
Al-Khamisiya	33	5.7	34	14
Al-Batha	13	0.02	21	8.4
Suq Al-Shuyoukh	7.1	0.05	13.5	6.85
Shatrah	4.85	11.1	8.1	4
Al-Rifai	2.5	0.016	9.95	5.15

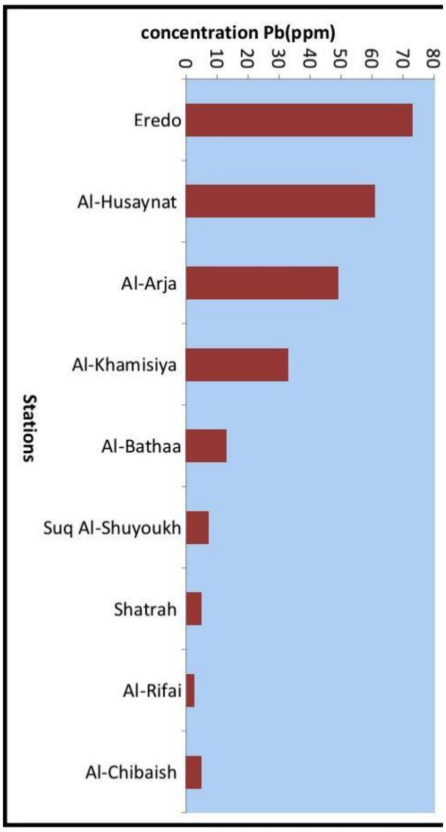

Figure 1. Lead concentration in study stations

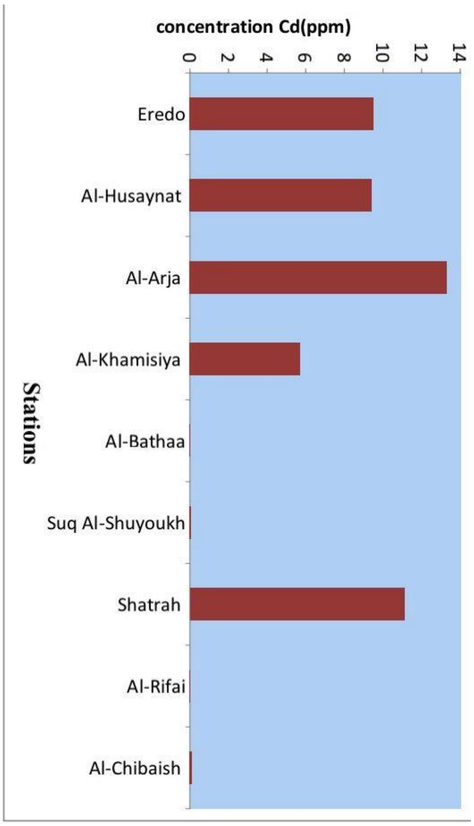

Figure 2. Cadmium concentration in study stations

Mean	Al-Chibaish
27.6	4.95
5.4651	01
24.0944	19.3
12.35	7.75

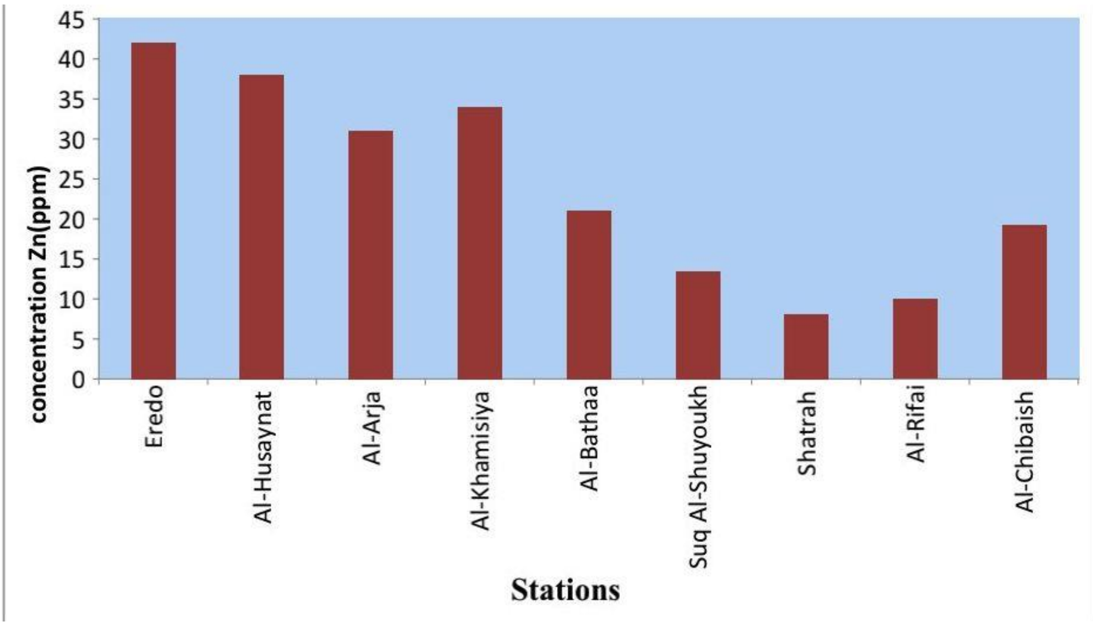

Figure 3. Zinc concentration in study stations

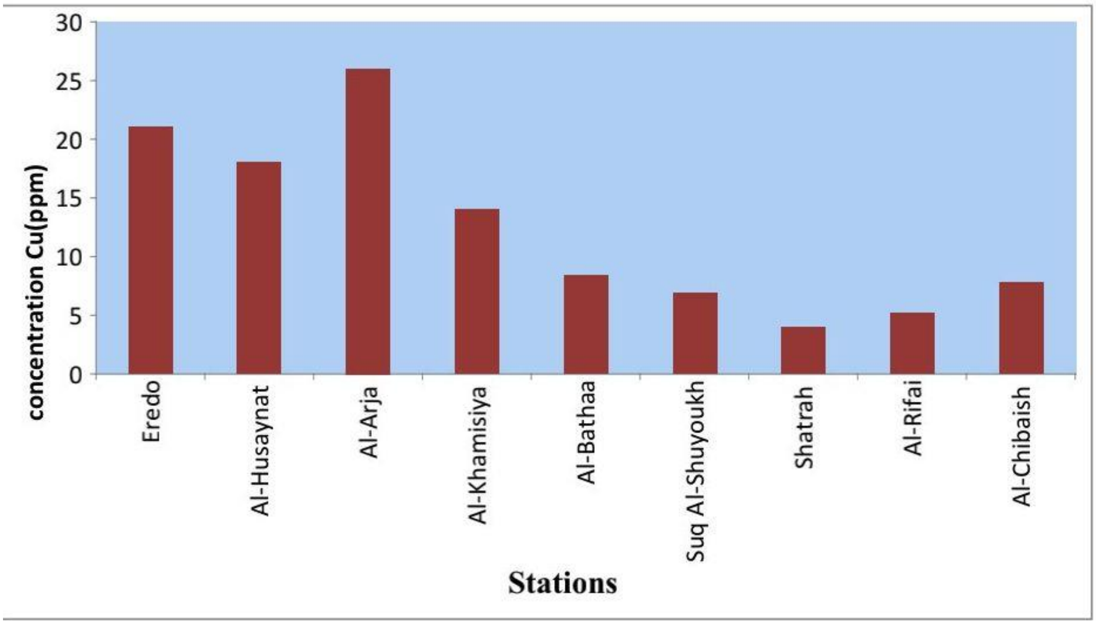

Figure 4. Copper concentration in study stations

4. Conclusion

The current study conducted on soil samples taken from different areas in Thi-Qar. Governorate indicates the presence of high concentrations of heavy metals, such as lead pb and cadmium Cd. In some study areas, the elevated levels of these elements in these areas can be attributed to pollution caused by several factors one factors, the congestion of roads with various modes of transportation where lead is a major pollutant due to the presence of light additives and gasoline used in vehicles. There is also a dent spread of private electric generators in urban areas which also contributes to increased concentrations of heavy metals in the soil. Additionally, various pollutants are directly disposed of in the soil, such as waste, dumping, household, waste and sewage, which contain high concentrations of heavy elements. These pollutants degrade and increase the concentrations of heavy metals in the soil. The results also show that the use of fertilizer and pesticides was a factor in the increased concentrations of heavy elements in agricultural areas in general the study showed that the pollution ratio of lead and cadmium was higher than that of zinc and copper. This increases attributed to the increased fuel emissions, resulting from high traffic density and the spread of private electric generators in all areas.

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