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CENTRAL ASIAN STUDIES

Analysis of Heavy Metals in Soil and Vegetation Near Fuel Filling Stations in Thi-Qar Governorate

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Abstract: This study assesses the ecological situation near fuel filling stations in Thi-Qar Governorate by analyzing the alteration of heavy metals in soil and vegetation. The objective is to evaluate the environmental status of the area, considering heavy metal accumulation as an indicator of soil pollution and the impact of plants on fuel pollutants. Research methods include the measurement of heavy metals using an atomic absorption device and calculation of total soil and plant pollution factors. Results indicate high concentrations of lead (Pb) in soil samples from stations 1 and 2, with significant differences observed ($p < 0.05$). However, concentrations of other heavy metals (Cu, Zn, Cd) remained within permissible limits. The study highlights the role of soil and root systems in heavy metal accumulation and the potential impact on the food chain due to combined air and soil pollution near fuel filling stations.

Keywords: heavy metals, soil, vegetation, fuel filling stations, Thi-Qar governorate

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1. Introduction

The soil is an independent natural-historical bio-bone body, a component and main functional part of the biosphere, the area of the spread of life on Earth. It is significantly different from the air and water parts of the geoxymic landscape by its depositing properties. Pollutants that get into the soil remain in it for decades, possibly longer, then pollute the air, water, accumulate in plants, pass through the trophic chain into animal organisms. Xenobiotics in the form of the smallest dust-like particles can enter the human body not only through the trophic chain, but also directly from the soil into the human organism, bypassing plants. At the same time, pollutants cause the same diseases as those caused by food. With this intake of xentobiotics, diseases manifest in a shorter period of time. The air movement easily lifts dust particles and disperses them to a considerable distance from the source of pollution. This process is especially enhanced if the soil is not covered with vegetation. At present, soils of technogenic and even natural, biogenic landscapes are subject to a wide range of substances, in quantities far exceeding their natural content.

Heavy metals have also been detected in the soil [1]. The accumulation of heavy metals by plants growing on contaminated soils is largely dependent on the level of contamination of the latter. However, a strong direct correlation between these indicators is not always found, as the flow of heavy metals from soil to plants is determined not only by the gross content, but also by the content in the soil of the mobile form. The latter is related to the chemical composition of technogenic emissions, soil protective (buffer) capabilities and so on [2,3]. Heavy metals can enter the plant in two ways: from the soil and from the atmosphere. Most of the heavy metals enter the plant as a result of adsorption by the roots from the soil solution in the form of a surface film, which they are then mobilized by the plants. The literature notes the ability of iron, lead, cadmium and zinc to accumulate in the free space of the root in significant quantities.

Heavy metals are placed in the following order: Cd>Cu>Ni>Pb>Cr. When entering plants, competitive, additive and synergistic interaction takes place between different trace elements. Thus, with an increase in the zinc content, the content of calcium, strontium and cobalt decreases, and the concentration of potassium, copper, lead increases [4,5,6]. A certain amount of heavy metals enter plants through the leaves from the atmosphere. The penetration speed is influenced by the thickness of the cuticle. The amount of heavy metals that accumulate on the plate depends on its cutting, the presence of resin, wax. It is likely that the metals are fixed in the wax plate and are not washed with water, so that a significant portion is in a passive state and does not wash or move to other organs and tissues [7].

Because of their tenacity and propensity to contaminate surface and groundwater, hydrocarbons and fuel are considered environmental noxities. The use of petroleum and petrochemical compounds to pollute the environment has garnered a lot of attention in recent decades. The number of automobiles and machinery vehicles on the road has led to a rise in the consumption of motor oil. One of the main issues now is oil spills into the environment. Hydrocarbons from used motor oils, such as diesel or gasoline, can damage the environment [8].

Numerous processes involved in petroleum exploration, production, and transportation have the potential to impact the environment. Leaking subsurface storage tanks are a common source of contamination [9]. The chemical makeup of soil, in particular its metal content, is crucial to the ecosystem because high concentrations of hazardous metals can lower soil fertility, increase input into the food chain, accumulate toxic metals in food items, and eventually jeopardize human health. Metals are naturally occurring in the crust of the earth, and their environmental concentrations might vary geographically depending on the region. According to Khlifi and Hamza-Chaffai [10], the qualities of the metal control how it is distributed in the environment and have an impact on environmental parameters.

Individuals who reside in industrial cities are especially vulnerable to the deteriorating environmental conditions that can cause health issues for them. Natural cycles have an impact on urban surroundings, changing the air, water, and soil and returning their waste products back to the ecosystem as annoyances. The primary sources of pollution are oil and debris washed into water bodies, car emissions, organic matter originating from plants and animals, sewage effluents from industries, and odors from vehicles. The petroleum and diesel vending industry has attracted a lot of investors recently, which has led to the unchecked growth of service stations and oil filling stations. The environmental impact assessment procedure is not completed by some of these filling and service stations for financial, political, or bureaucratic reasons. Therefore, because of incorrect station placement, inappropriate use of storage tanks or materials, and improper handling of fuel during delivery, significant.

2. Materials and Method

2.1. Study area

The study area in southern of Iraq extends from the Al-Shatra district center to the the Nasiriyah District. Four stations were selected in the southern part of Thi-Qar Governorate to carry out the current study as shown in Fig. 1.

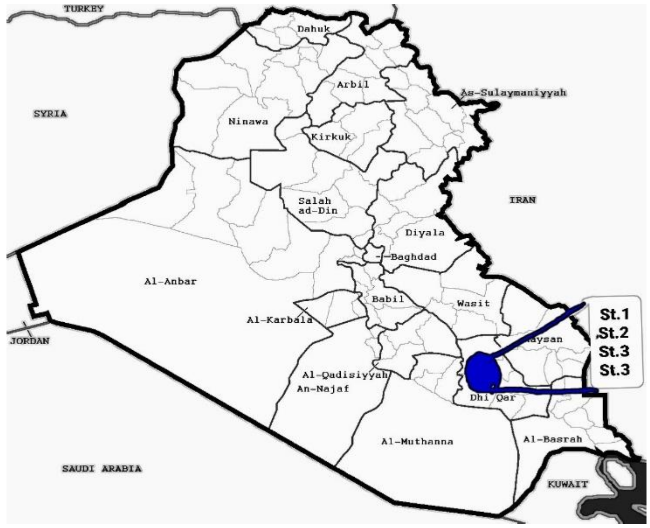

Figure 1. The studied stations within Thi-Qar Governorate

The first station is located inside the Al-Shatra district center. The second station is situated near the industrial district in the Al-Shatra district, on the main road. The third station is in the Al-Gharraf district on the main road. The fourth station is in the Nasiriyah District, at the entrance to Nasiriyah, near the modern village.

2.2. Sampling

Soil and plant samples were collected from four stations in the study area, starting from the Autumn of 2022 until the summer of 2023. Soil sampling in the study area was carried out using a soil reed drill to a depth of 25 cm. At least 500 grams of soil was taken from each site.

The plant samples were collected by hand after being washed in water to get rid of suspended materials and were stored in plastic bags until arriving at the laboratory.

2.3. Recovery of trace elements in sediment

It followed the method by Yi et al. [11] where sediment samples dried at 60 m temperature for 48 hours after removing the solid parts and other dirt, grinded a ceramic balloon and then passed through a plastic palm with a breakout of its openings (63) micron, then took 1 mg from the sample and placed in Baker Villon, added 6 m of the addictive acid mixture at 1:1 and the concentrated nitric, then placed on a hot plate at 80 m, until reaching the pre-drought stage, and then added 4 m of concentrated perchlork acid at 1:1 and placed on the hot plate at 80 m until reaching the pre-drought stage, and then melted the sample with 20 ml of hydrochloric acid (0.5) caliberate, then filtered the model and placed in clean plastic bottles with a 25 m and full-sized 25 m cover by distilled ion-free water.

2.4. Recovery of trace elements in plants

The trace elements in the plants were extracted according to the method by Barman et. al. [12], with 1 mg of each sample grinded, dry and made of a plastic palm with a 40-m micron diameter, added (5 m) of acid mixture made up of nitric acid and concentrated perchlork acid of 4:1 respectively, left the sample for 30 minutes, then placed the mixture on a 60-mm hot plate until the solution became saline, then moved the rotor content after being nominated to a clean 25-millimeter plastic bottle, supplemented by ion-free distillation water.

2.5. Quantifying the amount of metal

The concentration of heavy metals in the specimens was measured using a flame atomic absorption spectrophotometer apparatus. The samples were taken for each element after the calibration graphs were made, and the concentration result is displayed in the tables.

2.6. Statistical Analysis

The results were statistically analysed according to the statistical system (SPSS-10).

3. Results and Discussion

The results of the current study showed the presence of trace elements in the soil for lead, cadmium, zinc and copper, and the highest recorded values were in station 2 (590, 17.1, 60.3 and 134.3) µg/g dry weight, respectively, (Table 1- 4). The order of the abundance of the elements was as follows: Pb > Cu> Cd> Zn. Plants are also the most sensitive to environmental diversity by virtue of their high sensitivity to the toxicity of trace elements, and are effective as the first stage in the food chain that works to accumulate pollutants compared to organisms that live at higher trophic levels [7], and as a result of the accumulation of elements within Plant tissues give a clearer picture of pollution than when relying on other measurements [13].

The current study showed lower concentrations of trace elements in the aquatic plants studied than in the concentrations of trace elements in the soil. Dirilgen [14] pointed out that trace elements in natural systems are not prepared for absorption by plants in a free form, but rather in dissolved complexes. This depends on the physical and chemical conditions of the surroundings, which makes a strong impact on the processes related to the absorption of element ions. Naaz & Pandy [15] confirmed that the high concentrations of these elements in plant tissues is the result of increased absorption from the external environment in accordance with the physical and chemical properties of those environment.

Table 1. Pb concentration in the soil near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	355	360	349	353
Winter	580	590	575	576
Spring	389	399	382	385
Summer	500	560	508	554

Table 2. Cd concentration in the soil near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	7.8	8.9	6.2	6.3
Winter	7.0	7.1	5.4	5.9
Spring	13.1	13.3	11.0	12.1
Summer	17.0	17.1	16.0	16.9

Table 3. Zn concentration in the soil near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	32.1	33.0	31.8	31.9
Winter	24.2	25.6	23.8	23.9
Spring	40.6	40.8	35.3	35.3
Summer	60.1	60.3	57.1	57.1

Table 4. Zn concentration in the soil near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	75.6	76.9	74.2	74.4
Winter	66.8	67.7	60.0	61.0
Spring	130.1	134.3	129.0	129.8
Summer	99.2	99.6	98.9	98.9

With the exception of lead, all of the obtained amounts displayed in Tables 1-4 are below the typical shale concentrations [16,17,18]. From the aforementioned Tables, it is clear that Pb concentrations in all fuel stations during the winter and in station 2 during the summer are significantly higher than the average concentration in earth shale, whereas Cd, Zn, and Cu concentrations are roughly very low.

The five heavy metals that have been measured highlight the fact that lead has higher values than what should be found in typical sedimentary earth shale soils.

Tables (1- 4) make it abundantly evident that the levels of pollution of the elements under study in the soils, with the exception of Pb, are all below the average shale concentration. This may be related to the use of leaded fuel, which can result in serious pollution issues when released from generator exhaust system and automobiles. It can also be related to the pollution caused by fuel station spills and leaks, which can have an impact on the nearby soil in the studied areas [19].

Analysis of the data provided revealed the following pattern: the further the location of the station from which the plant was taken is from the fuel fill stations, the lower the content of heavy metals.

Table 5. Pb concentration in the shoot system of plant near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	53.7	53.7	52.2	52.2
Winter	82.6	83.8	80.3	80.5
Spring	55.2	56.1	54.5	54.6
Summer	63.1	65.9	61.1	62.2

Table 6. Cd concentration in the shoot system of plant near fuel filling stations (µg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	5.7	5.7	4.8	4.8
Winter	4.7	4.7	3.9	3.9
Spring	5.9	5.9	4.8	4.8
Summer	7.8	7.9	6.9	6.9

Table 7. Zn concentration in the shoot system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	20.3	20.3	19.7	19.7
Winter	20.5	20.5	19.8	19.9
Spring	21.6	21.6	20.1	20.2
Summer	23.9	22.9	21.9	21.9

Table 8. Cu concentration in the shoot system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	37.9	37.9	35.1	36.2
Winter	39.4	39.4	38.4	38.5
Spring	43.8	43.1	41.1	41.2
Summer	41.8	41.9	40.6	40.7

The root system, shoot system, and soil all have the highest rates of pollution, particularly in the winter for lead (Pb) and only in the summer for zinc, copper, and lead (Cd). Through the food chain, there was pollution with a concentration of lead (pb) higher than other metals. The decrease in pollutant concentration indicates a drop in metal concentration in the shoot system relative to the soil (Table 1-12).

Table 9. Pb concentration in the root system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	47.1	47.3	35.5	46.2
Winter	78.1	79.1	70.0	71.1
Spring	47.6	49.5	47.3	47.4
Summer	58.5	58.5	54.6	55.5

Table 10. Cd concentration in the root system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	3.8	4.6	1.9	2.0
Winter	3.7	4.5	1.9	1.9
Spring	4.8	5.8	2.7	2.9
Summer	4.9	5.9	2.8	2.9

Table 11. Zn concentration in the root system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	19.6	20.1	15.7	17.6
Winter	19.5	20.1	15.5	17.5
Spring	20.6	21.7	16.1	18.0
Summer	20.9	21.8	16.2	18.1

Table 12. Cu concentration in the root system of plant near fuel filling stations (μg/g)

Season	Station 1	Station 2	Station 3	Station 4
Autumn	36.8	36.9	31.1	32.0
Winter	36.8	36.9	30.0	31.1
Spring	38.9	38.9	32.7	34.0
Summer	37.1	37.3	32.6	33.1

A comparison of data on the content of heavy metals in vegetation indicates that for the same heavy metals in vegetation from all stations are not exceeded, with the exception of lead, where high concentrations were observed in plants.

Mays & Edwards [20], Ye et. al. [21], and Oudeh et. al. [22] showed that higher plants vary in the amount and locations of their storage of trace elements, and the amount of available metal, as well as the form in which it is found, also plays a role in the variation. Also, the absorbed percentage of trace elements may be affected by the depth of the soil surface in which they grow, and plants tolerate wide ranges of concentrations of these elements as a result of their possession of mechanisms to accumulate them within their tissues [23,24], or because they contain different resistance mechanisms to the concentrations High levels of these elements make them inactive within gaps through a bioaccumulation mechanism [25,26].

4. Conclusion

As a result of the study, the influence of fuel fill stations on the condition of vegetation was revealed. This studied showed the level of heavy metals significantly not exceeds the maximum permissible concentration with the exception of lead significantly exceeds the maximum permissible concentration. This fact indicates the polluting impact of fuel fill station on the environment.

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