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The negative effects of heavy metals in sandy soil and methods for reducing their damage "The soil of the Libyan Kufra Oasis as a model"

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Abstract:
The current research seeks to identify the most important negative effects of heavy metals (organic/inorganic) that are saturated with the sandy soil in the Libyan Kufra Oasis, and to provide proposals and solutions to reduce their harm to the soil, humans, animals, and plants. The quantitative approach was relied upon in analyzing the study samples that were brought from three different areas of the Kufra Oasis, including typical agricultural production projects. After subjecting the samples to quantitative analysis through chemical analysis, we arrived at results including: Chemical analysis of samples from the three areas in the study resulted in the percentages of heavy metals in the sandy soil of the oasis as follows: mercury with a total average of (133.22) per million, and cadmium with a total average of (0.91) per million. Arsenic has a total average of (0.128) per million, chromium has a total average of (120.44) per million, thallium has a total average of (0.522) per million, lead has a total average of (60.11) per million, and molybdenum has a total average of (0.0041) per million. Nickel has a total average of (64.11) per million, copper has a total average of (3.45) per million, and zinc has a total average of (366.11) per million. It turned out that most of these rates are higher than the normal rate approved by the World Health Organization, which has serious effects on soil, plants, and human and animal health.

Keywords: Heavy Metals, Sandy Soil, Quantitative Analysis, Soil Contamination, Chemical Analysis.

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التأثيرات السلبية للمعادن الثقيلة في التربة الرملية وطرق الحد من أضرارها "تربة واحة الكفرة الليبية نموذجاً"

الملخص:
يسعى البحث الحالي إلى التعرف على أهم الآثار السلبية للمعادن الثقيلة (العضوية/غير العضوية) المشبعة بالتربة الرملية في واحة الكفرة الليبية، وتقديم مقترحات وحلول للحد من أضرارها على التربة والإنسان والحيوان والنباتات. وتم الاعتماد على المنهج الكمي في تحليل عينات الدراسة التي تم جلبها من ثلاث مناطق مختلفة من واحة الكفرة، بما في ذلك مشاريع الإنتاج الزراعي النموذجية. وبعد إخضاع العينات للتحليل الكمي من خلال التحليل الكيميائي توصلنا إلى نتائج منها: أسفر التحليل الكيميائي للعينات من المناطق الثلاث في الدراسة عن نسب المعادن الثقيلة في التربة الرملية للواحة كما يلي: الزئبق بمتوسط إجمالي. بنسبة (133.22) في المليون، والكادميوم بمتوسط إجمالي (0.91) في المليون. الزرنيخ بمتوسط إجمالي (0.128) في المليون، والكروم بمتوسط إجمالي (120.44) في المليون، والثاليوم بمتوسط إجمالي (0.522) في المليون، والرصاص بمتوسط إجمالي (60.11) في المليون، والموليبدينوم بمتوسط إجمالي قدره (0.0041) لكل مليون. النيكل بمتوسط إجمالي (64.11) في المليون،

والنحاس بمتوسط إجمالي (3.45) في المليون، والزنك بمتوسط إجمالي (366.11) في المليون. وتبين أن معظم هذه المعدلات أعلى من المعدل الطبيعي الذي أقرته منظمة الصحة العالمية، مما له آثار خطيرة على التربة والنبات وصحة الإنسان والحيوان.

الكلمات المفتاحية: المعادن الثقيلة، التربة الرملية، التحليل الكمي، تلوث التربة، التحليل الكيميائي.

Introduction:

There are multiple types of soil on the surface of the Earth (clay, calcareous, silt, loam, peat moss, sandy), and each type has its own characteristics, components, mineral elements, and the crops that suit it. Sandy soil is widespread in the Arab world. It is light brown in color, and its grains are large and loose. It does not retain water due to the large size of its grains and their disintegration. The most important climatic conditions that help its existence are the hot and dry climate for a long period of the year with strong winds. Sandy soil consists of rock particles that have been exposed to weathering factors, and is usually formed as a result of the collapse or fragmentation of granite, limestone, or quartz rocks. It is considered one of the poorest types of soil for agriculture, as it is difficult for plants to grow in it **(Abdel-Baqi, 2005, p:63).**

Sandy soil is exposed to pollution, through the entry of foreign materials into the soil, which leads to a change in the chemical and physical composition of the soil. These materials are called soil pollutants, and they may be pesticides, chemical fertilizers, acid rain, or waste (industrial - domestic - radioactive, etc.). And other reasons. **(Salloum, 2010, p. 345)**

Among the pollutants that are extremely dangerous to sandy soil are heavy metals, both organic and inorganic. What increases the danger of these metals in the environment is the inability to decompose them by bacteria and other natural processes, in addition to their stability, which enables them to spread over long distances from their sites of origin or sources.

Perhaps the most dangerous thing about them is due to the tendency of some of them to bioaccumulate in the tissues and organs of living organisms in the aquatic or terrestrial environment. Some heavy metals have radioactive properties, that is, they act as radioactive isotopes, so these metals will carry double risks to the environment in terms of being toxic and radioactive at the same time, as is the case with radioactive zinc 65 and uranium 235. Sandy soil may be infected with metal contamination. Heavy metals, such as lead, mercury, and cadmium, reach the soil with waste that is buried in the soil, or with polluted irrigation water, or as a result of the fallout of compounds suspended in the air of these metals. These metals are highly toxic, and are highly concentrated in the tissues of plants and fruits, where they in turn are transmitted through. Human food chain**.** **(Al-Saadi, 2008, p. 424).**

Material and methods:

The theoretical framework of the study:

- **Basic search terms:**

1) Sandy soil "desert environment":

Soil consisting of large particles. It is called light soil because it is easy to hoe or dig in all weather conditions. Due to the small percentage of water that this dust can hold, it dries quickly. It is one of the poor soils because its grains do not contain exchange sites for electrolytes. These types of soils need large amounts of organic materials in order to improve their condition, level of fertility, and ability to retain water**.(Al-Khatib,2007,p:16)**

2) Soil contamination:

Soil is exposed to pollution when its atoms or grains come into contact with a substance or substances in unusually high quantities or concentrations, causing a threat to the health of humans, animals, and plants. Soil pollution leads to the contamination of agricultural crops, which leads to harm to the health of the person who feeds on them directly, and through Transfer of pollutants to animal products such as milk, eggs, and meat. There are many sources of soil pollution, including the atmosphere, hydrosphere, and biosphere, including humans and their activities. **(Al-Faouri and Al-Harout, 2009, p. 143)**

3) Heavy metals in soil:

Heavy metals mean all metals whose density exceeds 5 g/cm3, and anything less than that is called light metals. **(Al-Saadi, 2008, p. 423)**

Inorganic heavy metals are those compounds that may lack carbon and hydrogen atoms. They include raw materials such as iron metal, copper metal, coal (carbon), and similar materials that can be prepared in the laboratory, such as potassium nitrate, table salt, and iron carbide. Inorganic elements are not biodegradable, and do not react in the same way with living organisms as organic substances do. Minerals and inorganic compounds include minerals, salts, mineral compounds, acids, bases, and other inorganic substances that do not contain carbon. **(Al-Khatib, 2007, p. 32)**

➢ **Mineral elements in sandy soil:**

Sandy soil contains 70% of its weight sand, its grains are individual, loose, and composed of primary silicate minerals, especially quartz minerals (quartz-feldspar). In addition to carbonate minerals, especially calcite (calcium carbonate). The minerals hematite and limonite give their predominant colors of red and yellow, as a natural result of them containing iron in their composition. Color shades vary based on the degree of concentration of the iron content in them. It is worth noting that these types of minerals are often found in the Arabian Desert, specifically in most Egyptian deserts. Primary silicate minerals, such as feldspars, hurtland, and micates, are present in sand, but they often tend to disappear as they move toward silt grains**. (Food and Agriculture Organization ,2018).**

➢ **Reasons for the contamination of sandy soil in the Kufra Oasis with heavy metals:**

Through a field study of the human factors surrounding the Kufra Oasis, the researchers in the current study found a set of reasons that lead to the contamination of the sandy soil in the oasis with heavy metals, whether organic or inorganic. These factors and reasons are concentrated in the following:

- Throwing waste that comes from household waste or commercial and industrial activities.
- Throwing waste that contains high amounts of metals.
- Chemical fertilizers, animal manure, and pesticides are widely used in agriculture.
- The oasis and the city are distinguished by the large number of fuel stations (gasoline and diesel) that are larger than all of Libya (because it is a border area), and the resulting waste.
- Waste paint of all kinds containing lead.
- Petrochemical spills and accidental leaks.

➢ **Damage caused by heavy metals in sandy soil:**

Heavy metals are dangerous because they tend to bioaccumulate. Accumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the concentration of the chemical in the environment. Compounds that accumulate in living organisms any time they are ingested and stored very quickly.Among the heavy metals that have an effect on plants, humans, and animals, antimony is the metal that is used in the antimony trioxide compound and flame retardants. It can also be found in batteries, colored materials, ceramics and glass. Exposure to high levels of antimony for short periods of time causes nausea, vomiting, and diarrhea. There is little information about the effects of long-term exposure to antimony, but it is suspected to be a carcinogen. Cadmium also derives its chemical toxicological properties from its similarity to zinc, an essential micronutrient for plants, animals and humans. In humans, prolonged exposure leads to kidney failure. Long exposure leads to obstructive pulmonary disease, which has been linked to lung cancer.

Chromium is also used in metal alloys and pigments for paints, cement, paper, rubber, and other materials. Low exposure can cause skin irritation and ulceration. In the long term it can cause kidney failure and liver damage, and also damage circulatory and nerve tissue. Copper is an essential substance for human life, but in high doses it can cause anemia, liver and kidney damage, and irritation of the stomach and intestines. Mercury is a toxic substance that has no known function in human physiology, biochemistry, or does not occur naturally in living organisms. Inorganic mercury poisoning is associated with tremors, gingivitis, psychological changes and/or alterations, along with spontaneous abortion and congenital malformations. Exposure of the human body to excessive amounts of nickel also causes any health problems, and in the long-term exposure can cause a decrease in body weight, heart and liver damage, and skin irritation. Exposure of humans and animals to large amounts of selenium can cause nervous system damage, fatigue, and irritability. Selenium accumulates in living tissue .**(Islam, 2006, p. 137-138)**

The practical aspect of the study:

➢ **methodology:**

❖ The method used in the current study is: quantitative analysis method. This method helps in knowing the amount or percentage of inorganic elements or heavy metals present in the sandy soil samples that will be analyzed. In the current study, soil samples from the Kufra Oasis in Libya were brought from different regions at a depth of 60 cm. Chemical analysis will be performed: to measure the quantities and percentages of heavy metals (organic - inorganic).

➢ **Search samples:**

1) The Kufra project area for palm and olive cultivation: samples from (north - central - south) the region.



2) <u>The Kufra Agricultural Production Project area: samples from (east - central - west) the region.</u>



<u>3) Al-Sarir Agricultural Production Project Area:</u> Samples from (north - center - south) of the region.



procedures:

1) Controls for drawing study samples:

- Ensure that the soil from which samples will be drawn is completely dry.
- Avoid storing the extracted soil samples for long periods, as storage causes the samples to lose organic matter and lead to a change in soil chemistry.
- Drawing sample sites evenly covering all areas.
- Pay attention to removing the surface layer of soil before collecting samples, removing 15 cm of the surface crust.
- The samples are dried by exposing them to sunlight.
- then placed in an electric oven at a temperature of 60 degrees Celsius for an hour.
- The soil is ground, then passed through a 2 mm sieve.
- Expediting the conduct of tests in the laboratory using precise instruments and adjusting them before conducting the test.

2) Bringing samples:
Samples are taken from the mentioned areas, after ensuring that there is no moisture in the withdrawal areas. The withdrawal is done at a depth of 60 cm after removing the surface layer (15 cm). Avoid areas of moisture or leakage. Soil samples are placed in polyethylene bags. Samples were collected as follows:

1) The Kufra project area for palm and olive cultivation.
2) The Kufra Agricultural Production Project area.
3) Al-Sarir Agricultural Production Project Area.

3) Conduct quantitative analysis of sandy soil particles to measure the percentages of heavy metals:

Conducting quantitative analysis to measure basin and salinity ratios, as well as measuring the amounts of heavy metals (organic - inorganic) in sandy soil samples in the Kufra Oasis areas in Libya from the aforementioned sample sites. **Chemical analysis of study samples.**

A chemical analysis experiment was conducted on the soil that was brought and prepared for analysis. These samples were taken from different locations in the three study areas, with the aim of measuring the following elements and minerals:

1) Measurement (**Degree of acidity - salinity)**

A) Degree of acidity:

Table (1) Results of quantitative (chemical) analysis of sandy soil samples in the three study areas to Degree of acidity (pH)

Degree of acidity	Samples of "the Kufra project area for palm and olive cultivation"
5.4	North region sample
5.8	Central region sample
6.7	South region sample
6.97	**Average degree of acidity**
Degree of acidity	**Samples of "The Kufra Agricultural Production Project area"**
5.82	East region sample.
6.25	Central region sample
7.28	West region sample.
6.45	**Average degree of acidity**
Degree of acidity	**Samples of" Al-Sarir Agricultural Production Project Area"**
4.85	North region sample
5.23	Central region sample
5.94	South region sample
5.34	**Average degree of acidity**
6.25	**General average acidity level"**

It is clear from the results of the quantitative (chemical) analysis of samples from the three regions in the study that the general average pH is (6.25) . The highest sites in terms of pH were in the western side of the Kufra production project area (7.28). The lowest pH was in the northern location of the Kufra area for palm and olive production and cultivation (5.4), which is the same area that had the highest overall average pH in its three locations (6.97). In general, the acidity level in these areas does not pose any harm to the cultivation and germination of fruit trees and seasonal crops, as all pH levels are less than (7).

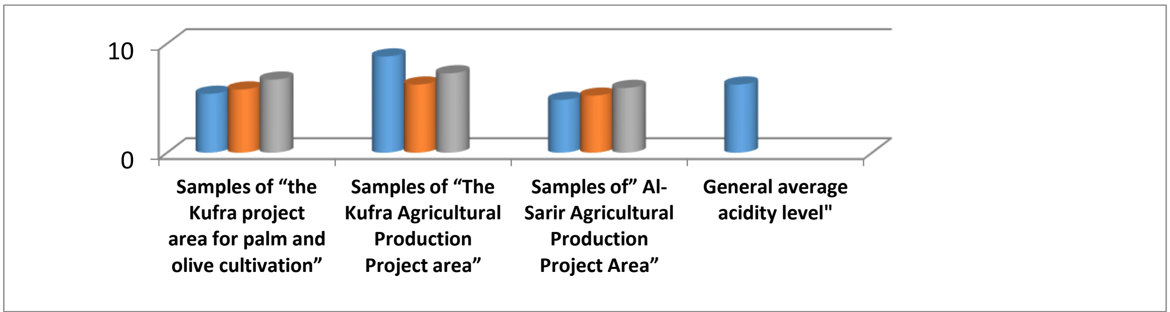

Figure (1) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of their degree of acidity.

B) Salinity ratios:

Table (2) Quantitative (chemical) analysis of samples from the three regions, to measure salinity levels.

Salinity ratios	Samples of "the Kufra project area for palm and olive cultivation"
% 0.276	North region sample
% 0.294	Central region sample
% 0.311	South region sample
% 0.294	**Average degree of acidity**
Salinity ratios	**Samples of "The Kufra Agricultural Production Project area"**
% 0.355	East region sample.
% 0.318	Central region sample
% 0.412	West region sample.
% 0.362	**Average degree of acidity**
Salinity ratios	**Samples of" Al-Sarir Agricultural Production Project Area"**
% 0.427	North region sample
% 0.408	Central region sample
% 0.392	South region sample
% 0.409	**Average degree of acidity**
% 0.355	**General salinity ratios**

It is clear from the quantitative (chemical) analysis of samples from the three study areas that the general salinity percentage in the sandy soil is (0.355%), which is less than (0.4%) and is thus within the range of medium salinity levels. The location in the western region of the Kufra production project area had the highest percentage of salinity (0.412%), while the location with the lowest percentage of salinity was the northern location of the Kufra project for palm and olive cultivation (0.2.76%). The highest average salinity levels were in the Sarir Production Project (0.409%). All of the previous salinity levels are relatively lower than the high levels of salinity, which range between (0.4% - 0.8%). This allows for the cultivation of mango, palm trees, wheat, alfalfa, barley, and watermelon, and there are no accumulated salt deposits in those areas.

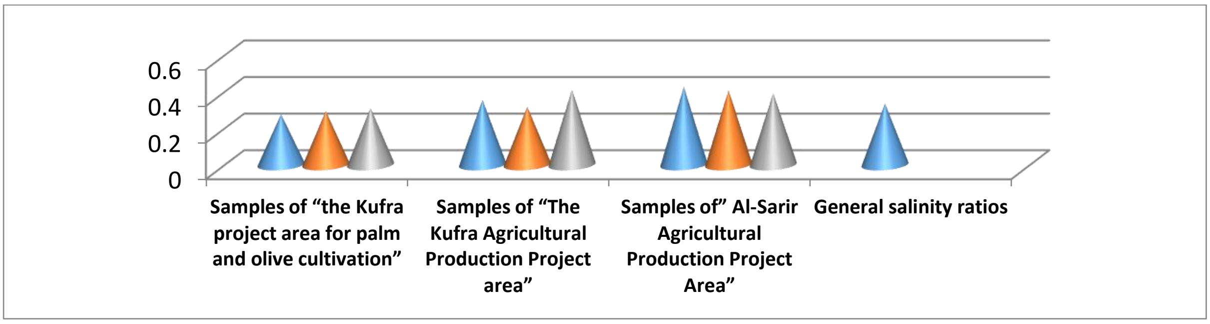

Figure (2) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of salinity levels.

C) Measuring the proportions of heavy metals (organic and inorganic):

To measure the percentages of heavy metals in the sandy soil of the Kufra Oasis through chemical analysis, some solutions were used, including dissolving 1.97 grams of Acetic acid Penta Triamine Diethylene and 1.1 grams of calcium chloride $CaCl_2$ dissolved in distilled water. Then a 14.92 grams of amine triethanol in distilled water. Mix the entire volume to a liter with distilled water

The two solutions together. After that, 10 grams of dry soil were mixed, and 20 ml of the two solutions were added. Then shake for two hours using a shaking device. The solution is then filtered using filter paper. The filtrate is then used to measure the concentrations of elements and minerals using an Atomic Sequential Flame Atomic Absorption Device.AA240FS-Absorption.

Table (3) shows the quantitative (chemical) measurement of samples from the three study areas in terms of the percentages of organic and inorganic heavy metals per (ppm).

General average	**Samples of" Al-Sarir Agricultural Production Project Area"**			**Samples of "The Kufra Agricultural Production Project area"**			**Samples of "the Kufra project area for palm and olive cultivation"**			**Organic and inorganic heavy metals.**	**M.S**
	South	Centre	North	West	Centre	East	South	Centre	North		
133.22	153	127	104	123	107	180	165	130	110	**Mercury**	Hg
0.91	0.3	0.3	0.4	0.5	0.6	0.8	1.7	1.6	2.0	**Cadmium**	Cd
0.128	0.13	0.14	0.16	0.12	0.17	0.13	0.11	0.10	0.09	**Arsenic**	As
120.44	112	127	134	98	110	108	125	130	140	**chrome**	Cr
0.522	0.6	0.5	0.7	0.4	0.6	0.7	0.5	0.3	0.4	**Thallium**	Ti
60.11	38	49	33	47	77	92	58	68	79	**Lead**	Pb
0.0041	0.003	0.005	0.004	0.006	0.005	0.004	0.002	0.003	0.005	**Molybdenum**	Mo
64.11	71	63	51	68	77	73	62	57	55	**Nickel**	Ni
3.45	3.1	3.9	4	2.6	3.6	3.9	2.8	4	3.2	**Copper**	Cu
366.11	385	361	295	372	380	365	344	253	270	**Zinc**	Zn

Through the results of quantitative (chemical) analysis of the three study samples, in all locations, with regard to the percentages of heavy metals (organic and inorganic), the following becomes clear:

1) Mercury.

The results of the chemical analysis of soil samples from the three study areas resulted in a total average of (133.22) per million, and this percentage exceeds the normal rate allowed in soil by the World Health Organization, which it set at (100) per million. In general, all percentages exceed this permissible rate, in all three areas under study, and the highest percentage (180) per million came in the eastern part of the Kufra agricultural production project area. While the lowest percentage of mercury was in the central part of the same region and amounted to (107) parts per million. It can be said that increasing the level of mercury in the soil beyond the normal limit may lead to serious harm to plants, animals and humans, such as harmful effects on the nervous and digestive systems, the immune system, the lungs and the kidneys. And it may be fatal. Inorganic mercury salts are corrosive to the skin, eyes, and digestive system, and may cause kidney toxicity if ingested.

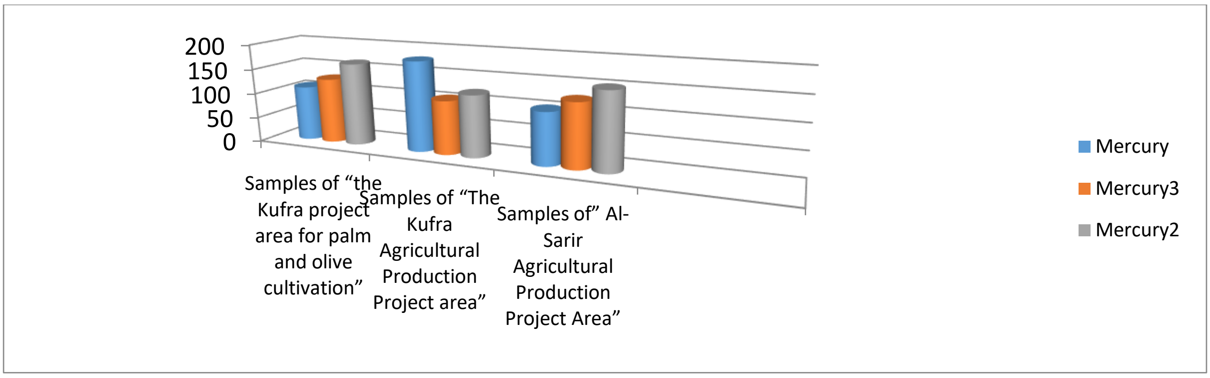

Figure (3) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of mercury percentages.

2) Cadmium.

The results of the chemical analysis of soil samples from the three study areas resulted in an overall average of (0.91) per million, and this percentage is less than the normal rate allowed in soil by the World Health Organization, which it set at (2.0) per million. In general, all percentages are less than the permissible rate in the three areas under study, and the highest percentage (180) per million came in the northern part of the Kufra project area for palm and olive cultivation. While the lowest percentage of cadmium was in the central and southern part of the Sarir agricultural production project area, where it reached (0.3) per million, and this may be due to the study areas not being exposed to waste and leaks of materials or products containing Cadmium.

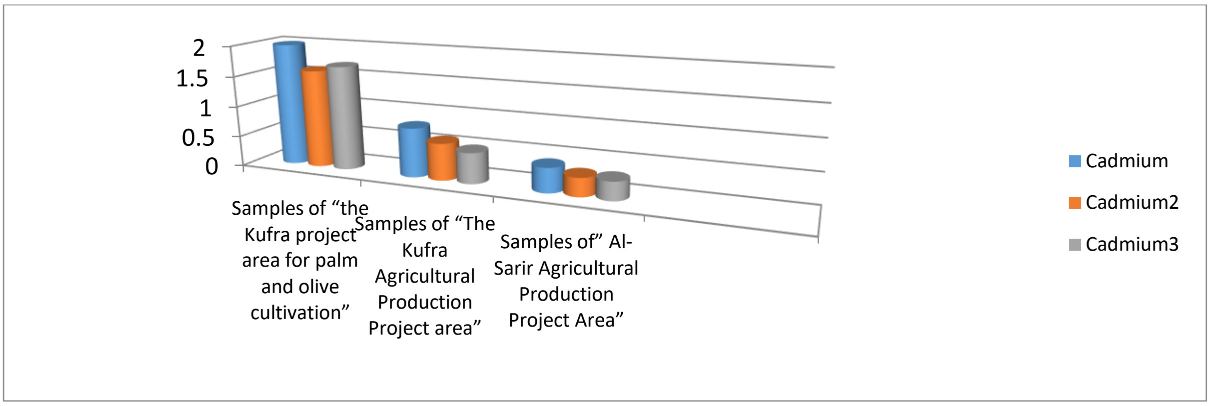

Figure (4) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of cadmium percentages.

3) Arsenic.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (0.128) per million, and this percentage is higher than the normal rate allowed in soil by the World Health Organization, which was set by (0.10) per million. In general, all percentages are higher than the permissible rate, in all three areas subject to the study, and the highest percentage (0.17) per million came in the central part of the "Al-Kafra Agricultural Production Project Area." While the lowest percentage of arsenic metal occurred in the northern part in the "Al-Kufra Project Area for Palm and Olive Cultivation," and amounted to (0.09) per million, and it causes an increase in arsenic in the soil beyond the normal limit that can lead to severe harm to humans, such as cancer and skin lesions. It is also associated with cardiovascular disease and diabetes. A link has been found between exposure in the womb and early childhood to negative effects on cognitive development and increased mortality among young people.

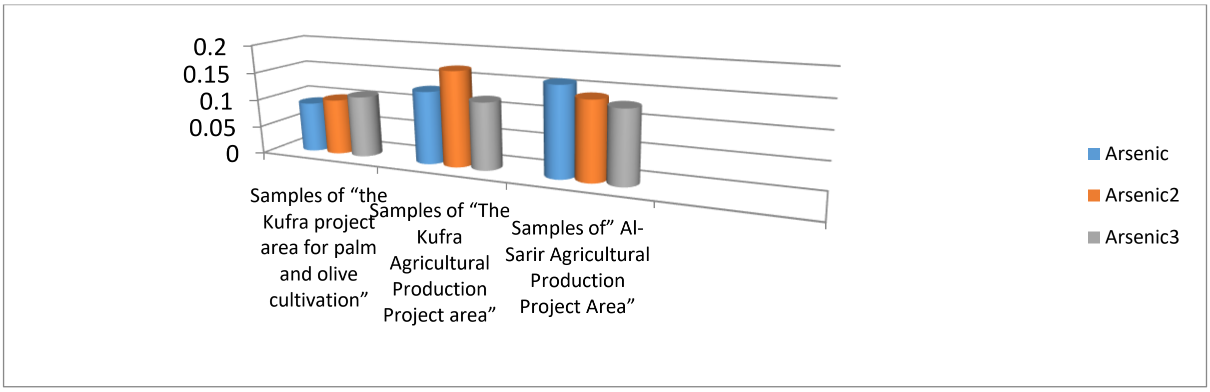

Figure (5) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of arsenic levels.

4) Chrome.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (120.44) per million, and this percentage is higher than the normal rate allowed in soil by the World Health Organization, which set it as (100) per million. In general, all percentages are higher than the permissible rate, in all three areas subject to the study, and the highest percentage (140) per million came in the northern part of the "Al-Kafra Palm and Olive Plantation Project Area." While the lowest percentage of chromium metal occurred in the western part in the "Al-Kafra Agricultural Production Project Area," reaching (98) per million, and it causes an increase in chromium in the soil beyond the normal limit and can lead to irritation, ulcers in the stomach and intestines, and anemia. In addition to problems with semen and reproductive system.

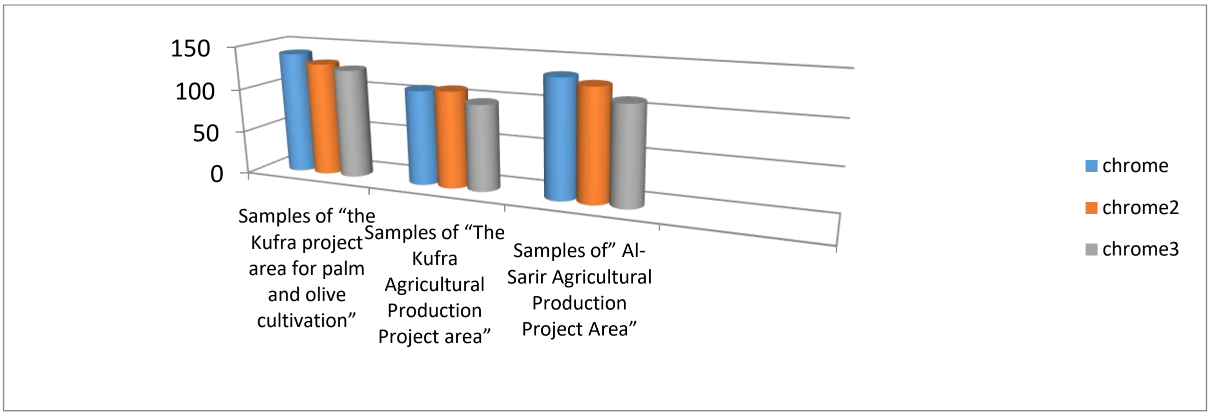

Figure (6) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of chromium percentages.

5) Thallium.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (0.522) per million, and this percentage is slightly higher than the normal rate allowed in soil by the World Health Organization, which set it as (0.5) per million. In general, there is a discrepancy in the percentages of thallium above the permissible rate, between low and high depending on the sampled areas, and the highest percentage (0.7) per million occurred in the eastern part of the Kufra agricultural production project area. While the lowest percentage of thallium metal occurred in the central part of the Kufra project for palm and olive cultivation, reaching (0.3) per million. Excess thallium in the soil beyond the normal limit causes poisoning through ingestion, inhalation, or absorption through the skin.

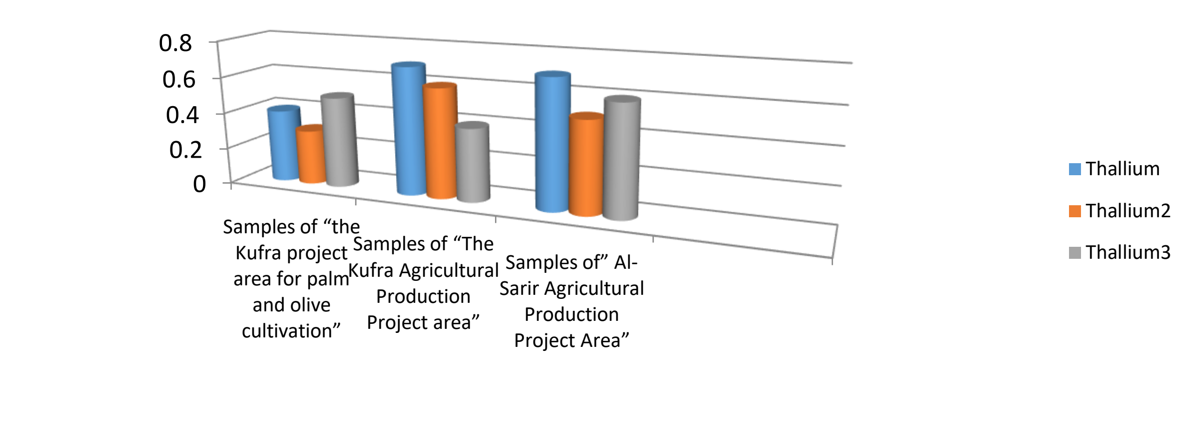

Figure (7) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of thallium percentages.

6) Lead.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (60.11) per million, and this percentage is higher than the normal rate allowed in soil by the World Health Organization, which determined it to be between (14-40) per million. In general, there is a variation in lead percentages above the permissible rate, between low and high depending on the sampled areas, and the highest percentage (79) per million occurred in the northern part of the "Al-Kufra Palm and Olive Planting Project Area." While the lowest percentage of lead was in the northern part, in the Sarir project area for agricultural production, and amounted to (33) per million, and it causes an increase in lead in the soil beyond the normal limit. Even a small amount of lead can cause serious health problems. Children under 6 years of age are particularly vulnerable to lead poisoning, which can severely affect mental and physical development. Lead poisoning at high levels may lead to death.

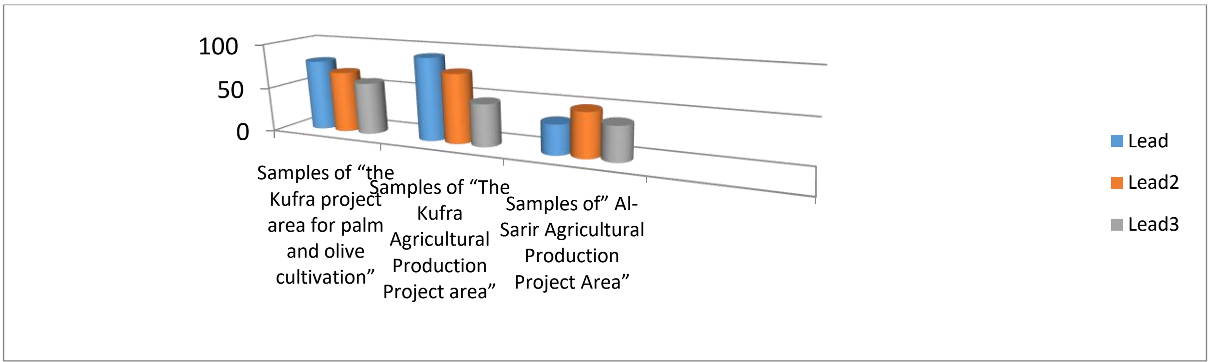

Figure (8) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of lead percentages.

7) Molybdenum.

The results of the chemical analysis of soil samples from the three study areas resulted in an overall average of (0.0041) per million, and this percentage is consistent with the normal rate allowed in soil by the World Health Organization, which it specified as (0.002-0.005) per million. In general, all percentages are less than the permissible rate in the three areas under study, and the highest percentage (0.006) per million came in the western part of the Kufra agricultural production project area." This may be due to the study areas not being exposed to waste and leakages of materials or products Contains molybdenum.

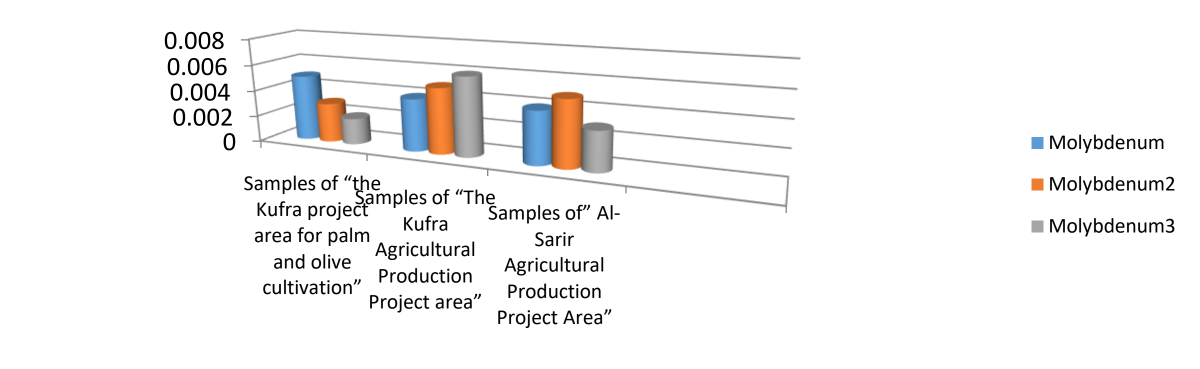

Figure (9) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of Molybdenum percentages.

8) Nickel.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (64.11) per million, and this percentage is higher than the normal rate allowed in soil by the World Health Organization, which set it at between (50) per million. In general, all nickel percentages are higher than the permissible rate, ranging from low to high depending on the sampled areas, and the highest percentage (77) per million came in the central part of the “Kafra Agricultural Production Project area.” While the lowest percentage of nickel metal was in the northern part in the Sarir project area for agricultural production, and amounted to (51) per million, and the increase in nickel in the soil beyond the natural limit causes poisoning of wood trees when the concentration of nickel in the soil increases from (80-100) per Million. Some plants sensitive to nickel, such as tomatoes, may be poisoned if the percentage of nickel exceeds 10 per million.

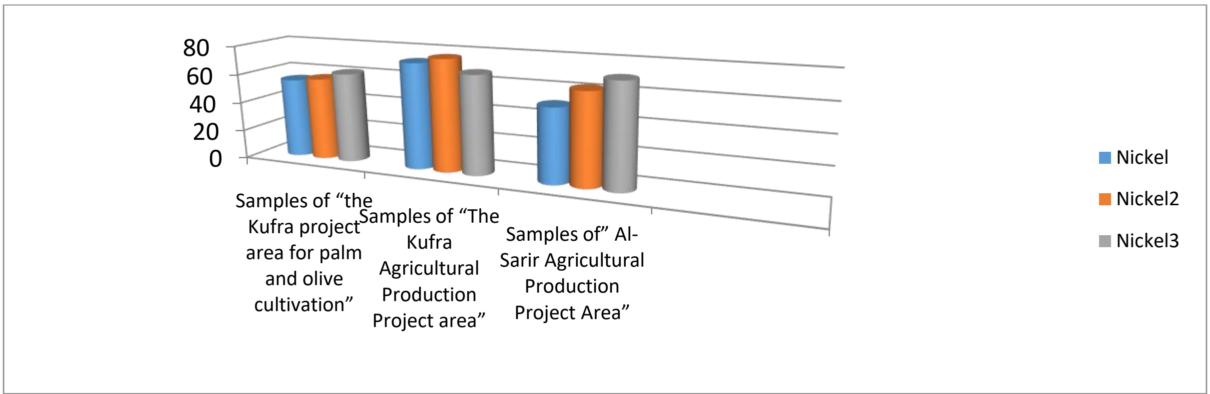

Figure (10) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of Nickel percentages.

9) Copper.

The results of the chemical analysis of soil samples from the three study areas resulted in an overall average of (3.45) per million, and this percentage is consistent with the normal rate allowed in soil by the World Health Organization, which was set by the World Health Organization between (2-4) per million. In general, all percentages are within the normal permissible level in the three areas under study, and the highest percentage (4) per million occurred in the central part of the Kufra project for palm and olive cultivation. This may be due to the study areas not being exposed to waste and leakages of materials or products Contains copper.

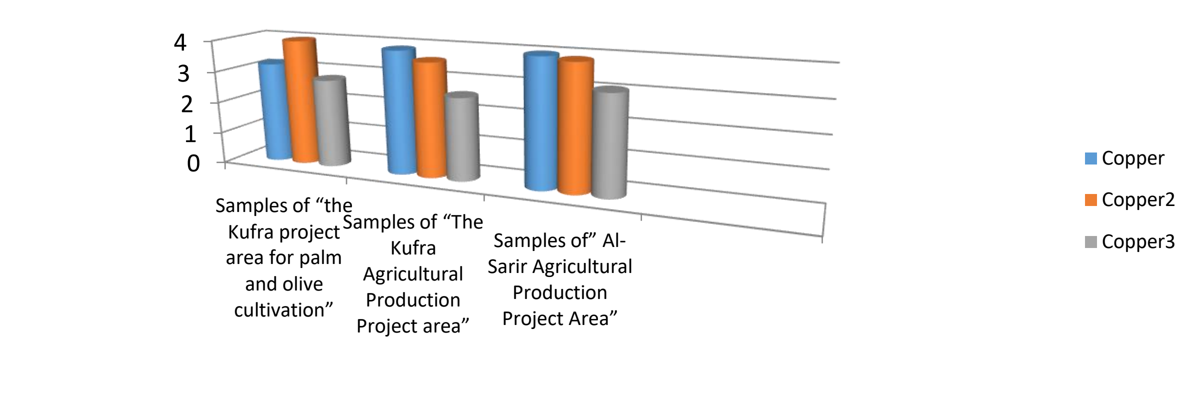

Figure (11) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of copper percentages

10) Zinc.

The results of the chemical analysis of soil samples from the three areas of the study resulted in an overall average of (366.11) per million, and this percentage is higher than the normal rate allowed in soil by the World Health Organization, which determined it to be between (10-300) per million. In general, the percentages vary with the percentages of zinc above the permissible rate, between low and high according to the sampled areas, and the highest percentage (385) per million came in the southern part of the Sarir project area for agricultural production. While the lowest percentage of zinc metal came in the southern part in the area of the Kufra project for palm and olive cultivation, and amounted to (344) per million, and an increase in zinc in the soil beyond the normal limit causes a person to suffer from nausea, vomiting, stomach pain, diarrhea, and headache. As the human body is exposed to high amounts of zinc over a long period, it may suffer from chronic zinc toxicity, which may lead to low levels of high-density lipoprotein (HDL), or "good" cholesterol - and decreased immune function.

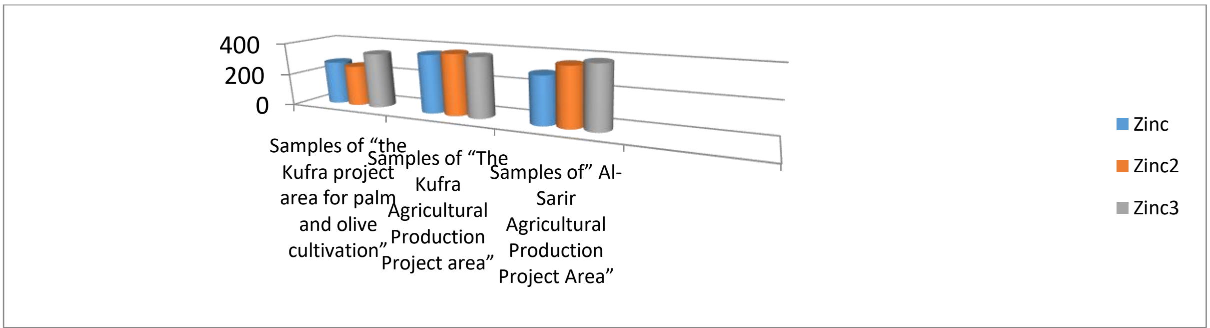

Figure (12) shows the quantitative (chemical) analysis of sandy soil samples in the three study areas in terms of Zinc percentages.

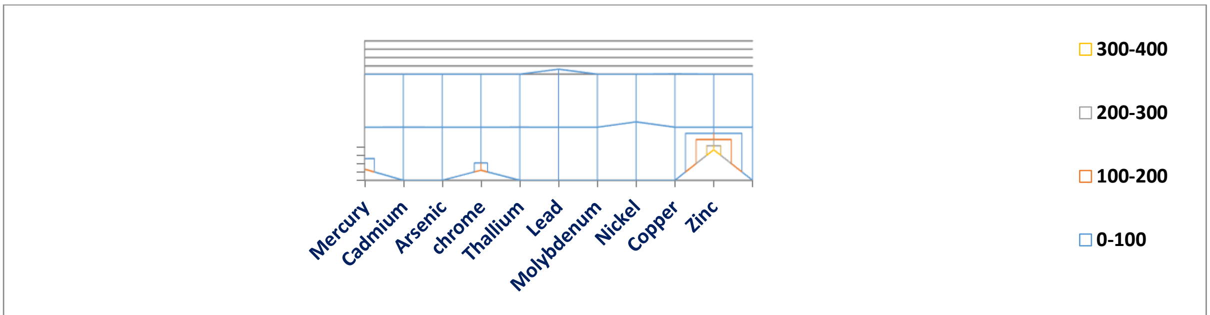

Figure (13) shows the general averages of the percentages of organic and inorganic heavy metals for sandy soil samples in the three study areas, in their different locations, according to what was reported in the quantitative (chemical) analysis.

Recommendations:

Through the results of the study, we present procedural recommendations that will reduce the risks of saturation of the sandy soil in the Kufra Oasis with heavy metals, as follows:

1) It is necessary to carry out chemical treatment of soil areas that are saturated with heavy metals, by adding heavy metal stabilizers.
2) Reducing the dumping of household waste and waste emitted from commercial and industrial activities in areas near agricultural projects in the oasis.
3) The importance of criminalizing the throwing of waste that contains high amounts of metals such as lead, zinc, zinc and copper.
4) Regulating the process of using chemical fertilizers, animal manure and pesticides in agriculture.
5) The necessity of activating control over the waste of gas stations spread throughout the oasis and its affiliated city.
6) Imposing strict laws and deterrent penalties on anyone who throws all types of paint waste containing lead and zinc.
7) Constant monitoring of any activities that result in chemical or petrochemical leaks, to prevent their mixing with the soil.
8) Continuously conduct chemical analysis of the sandy soil in the oasis in all its areas, to ensure that the levels of heavy metals are within normal levels.

References:

1) Abdel-Baqi, Gamal El-Sayed (2005): Development of the desert environment in the Rayan Depression during the last quarter of the twentieth century, publication of the Fifth Conference for the Development of the Egyptian Rural, Faculty of Engineering, Shebin El-Kom University.
2) Al-Khatib, Al-Sayyid Ahmed. (2007): Basics of land fertility and fertilization, Dar Al-Kutub Publishing House,Alexandria - Egypt.
3) Food and Agriculture Organization (2018): Soil Quality Considerations in Selecting Aquaculture Sites, January 17, 2018.
4) hmed Medhat Islam, Pollution is the Problem of the Age, second edition, World of Knowledge series. The National Council for Culture, Arts and Literature - Kuwait, August 2006.
5) Hussein Al-Saadi, Environmental Science, first edition, Al-Yazouri Scientific House, Amman-Jordan, 2008.
6) Muhammad Ghassan Salloum, Dr. Adnan Nizam, Applied Environment and Pollution (Theoretical Part), Damascus University Publications, Faculty of Science, 2010.
7) Wael Al-Faouri, Muhammad Al-Harout, The Environment, Its Protection and Maintenance, first edition, Dar Al-Mahraj for Publishing and Distribution, Amman - Jordan, 2009.