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An investigation of the effects of untreated waste water containing elements on the soil of the Khabat region in Erbil, Iraq.

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ABSTRACT

Wastewater contains a high amount of toxic metal substances (cadmium, chromium, lead, copper and cobalt) which have a negative effect on the soil and plants.

This study was conducted to determine the effect of untreated sewage seepage into the main sewers of Khabat region and on the chemical and physical properties of the soil. The concentration of some heavy metals cadmium(Cd)- copper(Cu)- lead(Pb) - chromium –(Cr)- cobalt(Co) was also estimated, as well as soil electrical conductivity (EC), total dissolved salts (TDS), and total hardness (TH). Soil samples were taken on depth ranges from 10-15 cm. Compared to control samples, which were taken 200 m length from the main stream and were not affected by untreated sewage,Soil samples near the main stream contain much higher concentrations of elements cadmium (Cd), copper (Cu), lead (Pb), chromium (Cr), and cobalt (Co).

The concentration of these elements in the soil increased with the increase in the percentage of dissolved salts, which in turn led to an increase in the soil's hardness and overall conductivity. This indicates that the soil near the main stream is contaminated: which fundamentally affects the flora and fauna of the area. The study recommended a solution to the problem of the location of sewage in the Khabat area, not throwing untreated water directly into the ground to prevent pollution and groundwater access, and making efforts to use this water after treatment for various purposes.

Introduction:

Elements are natural components of the Earth's crust, and some of them are biologically important and exist in very low concentrations and play an important role in human health. [1].

Soil pollution refers to conditions that affect the soil and alter its natural, chemical, or biological attributes and properties in a way that negatively impacts the people, animals, and plants that live on its surface. Any physical or chemical alteration to the ground that prevents its usage can also be referred to as soil contamination [2].

Proper reuse of wastewater is an environmental protection measure, and it is better than discharging treated wastewater to surface water.

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Because this measure saves large amounts of fresh water currently used for irrigation purposes, to meet the growing needs for fresh water in the cities of developing countries. It is also noted that the strategic importance of managing and using municipal wastewater reclaimed for agricultural uses has increased in regions of the world with limited water resources. The reuse of wastewater has two main purposes: the first is that it improves the environment by reducing the quantities of waste (treated or untreated) that are discharged into waterways and the second Preserving water resources by reducing the demand for fresh water extraction [3].

The hydraulic conductivity, infiltration rate, water retention, and organic carbon of soil are all impacted by wastewater. Additionally, wastewater enhances the situation's micronutrients, microbial population, and accessible elements (N, P, and K). Cadmium, chromium, lead, copper and cobalt all of which are harmful to plants and the soil. When harmful metal concentrations exceed allowable limits, water poses a risk to both human and animal life [4].

The haphazard and unplanned use of treated and untreated wastewater has negative impacts on the environment that are significant and destructive to the soil, agricultural crops, surface and ground water, human health. It accumulates in the soil and then is transmitted through the food chain to plants, animals and humans, causing serious diseases and leading to significant changes in the physicochemical properties of the soil [5].

A review of scientific sources showed that treated water has many benefits, including preserving the environment by treating this water and returning it to nature again. It also works to sustain agriculture, as treated water is used to irrigate crops and green spaces. It is another source of irrigation water for most agricultural crops. In different regions of the world [6]. Sewage water, or known as black water, is considered one of the most serious public health problems in most third world countries, because most of these countries do not have an integrated sewage network. Rather, in some cities there is no sewage system, as is the case in the Khabat region, where most residential neighborhoods lack new sewage systems in the area are connected to sewage networks. Also, there is no treatment and reuse of sewage water in a drainage place in the area, as its water leaks without treatment outside a place towards the nearby farms and forests.

2 - Materials and Methods:

The region of Khabat is located at a distance of 37 km west of Erbil Governorate, and its center is on the public road that extends between Erbil and Mosul, between longitudes (35:43˚) and (07:44˚) west and (53:35˚) and (34:36˚)(Figure 1). The samples were taken near the sewage location, which is located about 2 km south of Khabat region.

Twelve soil samples (4×**3**) were collected, the method reported by the researcher **[7]** was followed as follows:

- The first site denoted by the symbol A, and these samples are taken directly from the edge.
- The second site, symbolized by the symbol B, is 10 meters away from the stream.
- The third site, symbolized by the symbol C, is 30 meters away from the stream.
- The fourth site, which is symbolized by the symbol D, is called Al Shahed, and is 200 meters away from the stream.

Three duplicate samples were taken from each site, samples were taken at a depth of 10-15 cm and soil samples were placed directly in clean plastic bags **(**Figure **2)**.

It was examined in the central laboratory of the College of Agriculture and Forestry, University of Mosul.

The soil extract:

Have been added in 50 mg of soil distilled water with shaking for a quarter of an hour or making an extract 1:1 and filter with filter paper.

A certain amount of the above extract was taken and Cadmium, chromium, lead, copper and cobalt were measured by washing method as mentioned in the ICARDA method (soil and sample analysis).

Electrical conductivity (EC) measurement was performed with EC meter, the device was immersed inside the above extractor and a reading was taken.

pH measurement (the degree of reactivity of the soil).

Using a pH meter, the device was immersed in the above extract and a reading was taken.

Preparation of soil solution for heavy elements determination (cadmium ,copper, lead, chromium, cobalt):

The concentration of the heavy elements in the soil extract was measured in mg/L units according to the spectroscopic method [8] using a flame atomic absorption device.

Determination of total hardship:

The total hardness of the samples was estimated in mg/L according to the method of [9].

Determination of electrical conductivity:

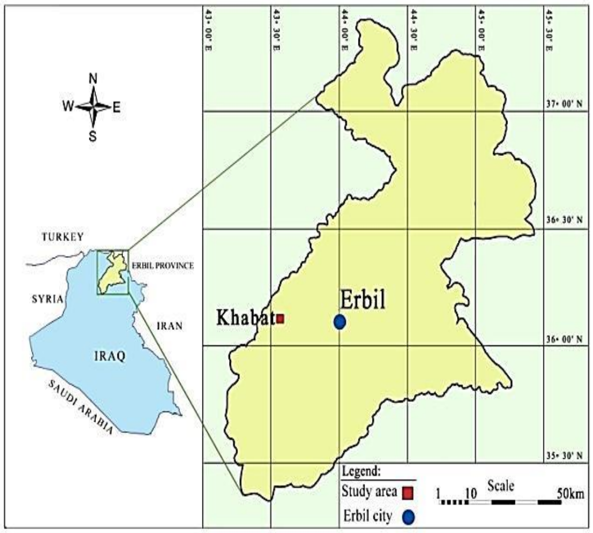
The electrical conductivity (Ems/cm) of the samples was measured by a device model (multi 340i) from the German company WTW according to the method [9]**.**

Determination of the amount of dissolved salts:

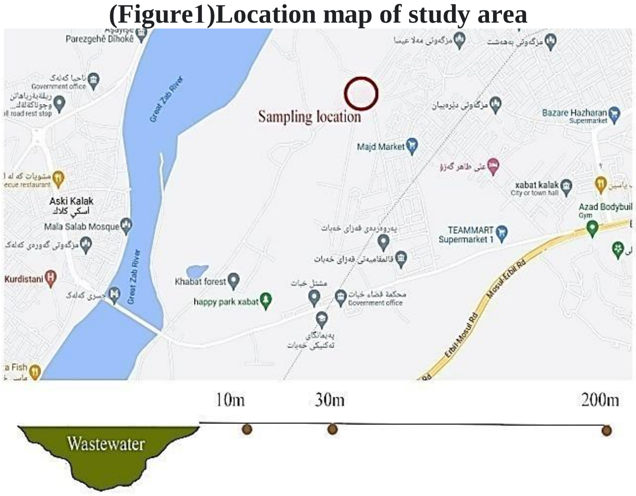
The amount of dissolved salts in the soil extract was estimated according to the method of [10].

pH measurement:

A weight of 10 gm was taken from each soil sample and 20 cm 3 of distilled water was added to it, then the suspension was shaken to prepare the water extract, where the pH was measured using a pH meter.. [10].



(Figure1)Location map of study area



(Figure2) Sampling point

Statistical analysis:

The results were analyzed statistically using the CRD statistical program and (Duncan^{a,b}) the test was used. (In the analysis of variance at the probability level) P <0.01.

3-Result and discussion:

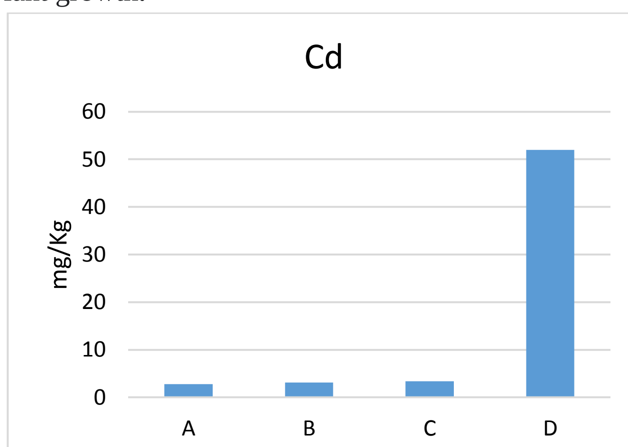
3.1 cadmium (Cd),copper(Cu), lead (Pb), chromium (Cr) and cobalt(Co)**:**

Figures 3 to 7 show changes of heavy elements in soil at different distances from the pollution basin. Close examination of these numbers shows an increasing pattern for cadmium and cobalt, and a decreasing pattern for copper and lead, while chromium indicates a clear trend of irregular concentration.

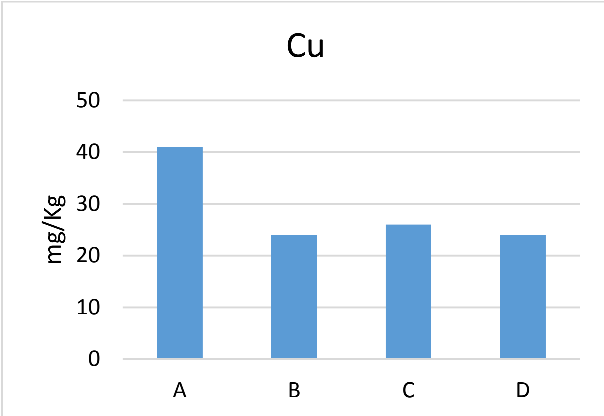
The percentage of cadmium decreased from the river bank and increased in soil samples at distances of 10, 30 and 200 meters, which is more than the permissible limit. The copper concentration was high from the river bank and decreased from the other distance. An increase in lead concentration from the river bank and a decrease at the other distance, more than the permissible limit. A decrease in the concentration of cobalt from the river bank, and a slight increase in other distances, and less than the permissible limit. Chromium shows a clear trend of non-uniform concentration. [11]

Except Cu,Pb are more concentrated in samples taken near the stream, and the ratio increases from the river bank to soil samples taken at these distances. This is consistent with a study [2] .

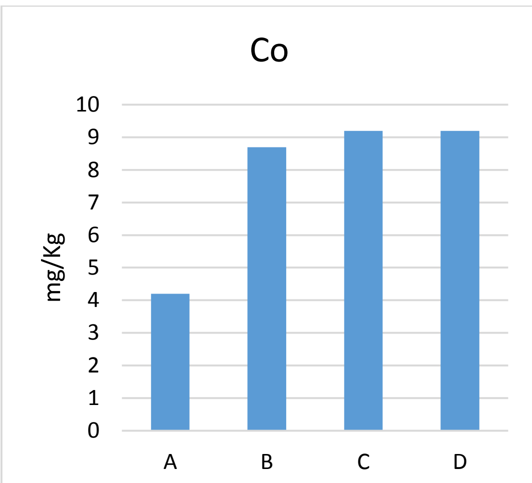
This trend of soil moving away from the contaminated water source can be attributed to dilution of the contaminant. Staying away from a contaminated water source helps reduce the concentration of contaminants, including cadmium, copper, lead, chromium and cobalt, in the surrounding soil. By moving away from the source of contamination, the soil is less likely to receive high levels of these elements, mitigating potentially harmful effects on soil health and plant growth**.**



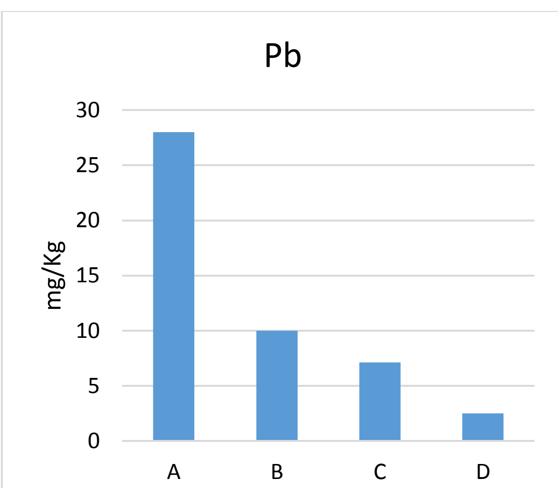
(Figure3)Concentration of cadmium (mg/ kg) in soil



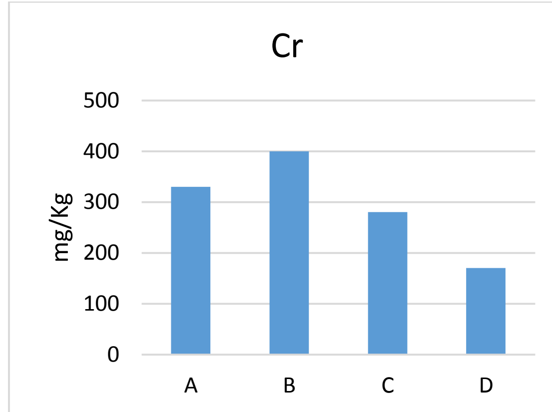
(**Figure4)** Concentration of copper(mg/ kg) in soil



(Figure5) Concentration of lead (mg/ kg) in soil



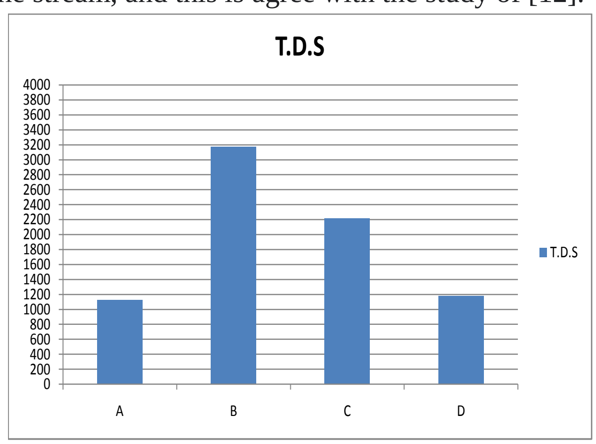
(Figure 6) Concentration of cobalt (mg/ kg) in soil



(Figure 7) Concentration of chromium(mg/ kg) in soil

3.2 Total dissolved solid (TDS):

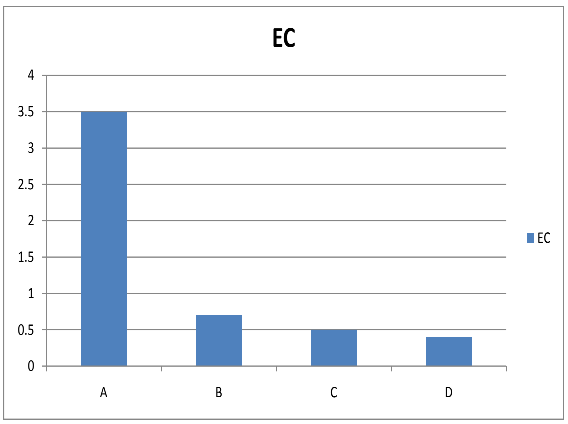
From the results of the TDS in Figure (8), the concentration of total dissolved solid (TDS) in the soil samples near and affected by the sewage plant was high and ranged between 1130- (ppm) 3170. As for the control samples, the concentration (ppm) of total dissolved solid was 1880. The statistical analysis also showed that there is a significant difference between the control sample D and the samples close to the source of pollution (A, B), and the large difference between the control samples and the samples close to the main stream in the concentrations of total dissolved solid (TDS) An indication of contamination of the soil near the stream, and this is agree with the study of [12].



(**Figure 8**) Total dissolved salts (mg/L) TDS

3.3 Soil electrical conductivity EC:

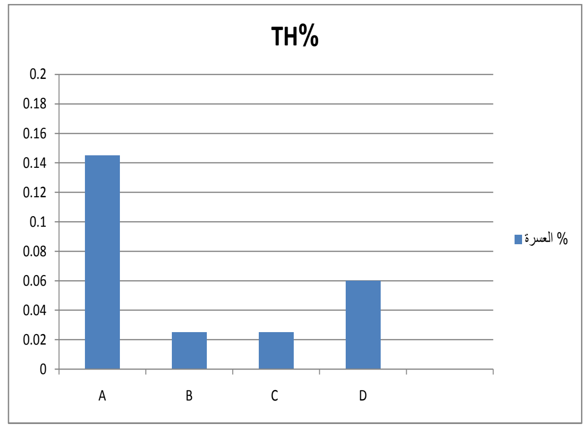
The electrical value is directly proportional to the total amount of dissolved sludge, and according to the following Figure 9 in soil samples from the main (ms / cm),In contrast to the control samples, which were 0.40 (ms/cm) with weak conductivity because they contained low concentration of total dissolved solid (TDS), and this was confirmed by statistical analysis, which showed a significant difference between the control sample D and samples close to the source of pollution. (B, C) This is in agreement with the study [13] and the study [14**]** .The decrease in EC in some soils, especially on the riverside, may be due to flooding of fields. When the fields are constantly flooded, there is a downward movement of water to the lower horizons and soluble salts also move into these waters, which leads to lower EC [12] .The high EC of some soils irrigated with wastewater can be attributed to the large amount of ionic substances and soluble salts, due to the salt content of the local wastewater [15**].**



(**Figure 9**) Soil electrical conductivity (EC) ms/cm

3.4 Total hardness TH:

The results demonstrated a statistically significant increase in the concentration of total hardness in samples near the source of pollution, which ranged from0.145-0.025 compared to the control sample far from the source of pollution, which was 0.06, as shown in Figure No. (10). Due to the high concentration of chloride ions, calcium, and magnesium in the soil close to the source of the pollution, where the total hardness increases with the concentration of these elements, as shown in Figure No. (3- 4 - 5), there is a significant difference between the control sample D and the sample close to the source of pollution (C), and this is considered a natural result [13**]** .



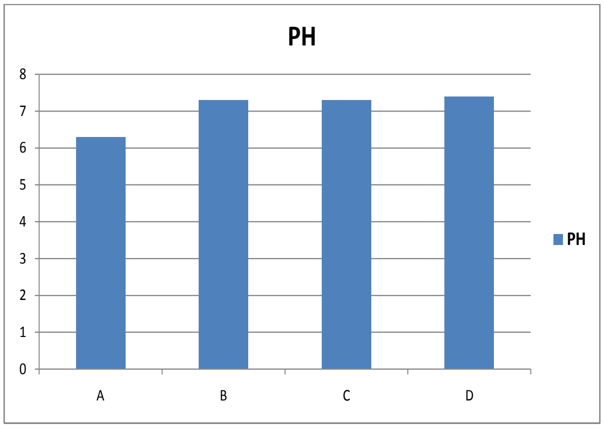
(**Figure 10**) Total hardness (mg/I) of soil

3.5 pH:

The difference in soil pH can be attributed to various factors such as the filtration action of water, the nature of the soil, and the mechanical composition. Soil acidity varies from one type to another and sometimes depending on the location of the soil. From the pH results Figure (11),Edge and near main stream samples have an range pH between: 7.3 and 6.3.

Soil near the main stream is considered to have low acidity. Since the soil's pH in the control samples was 7.4, it is considered to be just very little alkaline. The findings of the soil analysis make it abundantly evident that the average pH in the polluted soil is lower than the average determined in the uncontaminated soil, and the increase in pH is due to neutral.

This is in agreement with **[14],** but statistical analysis shows that there are significant differences between the control sample and samples taken close to the source of pollution. According to [16**]**, the pH balance in some types of soil irrigated with wastewater may be caused by the breakdown of organic matter and the creation of organic acids [17**]**. [18**]**. Due to the substantial salt content of wastewater, pH values are higher **[19]**.



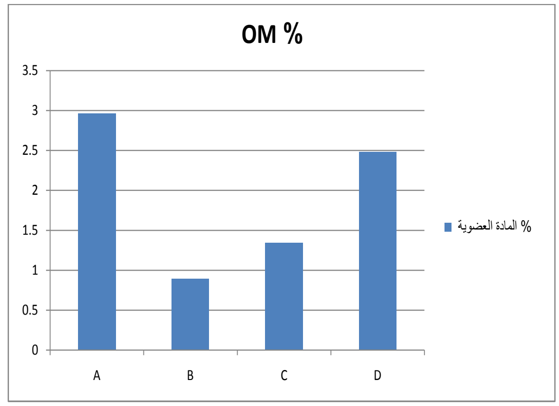
(**Figure11**) Soil pH

3.6- Organic matter:

According to the OM data in Figure 12, there is a higher concentration of these organic matter in the samples taken close to the stream, and the ratio drops as one moves away from the bank to the soil samples by 10 and 30 meters, respectively. 2.96%. The OM rate for the control samples was around 2.48%.Moving away from a source of polluted water can contribute to a decrease in the percentage of soil organic matter for two reasons;

1. Polluted water often carries various contaminants that can deposit on the soil surface or infiltrate into the soil profile. These contaminants can include industrial pollutants, heavy metals, pesticides, or other harmful substances. Deposition of such contaminants can hinder the decomposition and accumulation of organic matter in the soil.
2. Polluted water may contain toxic substances that can directly or indirectly affect soil organisms responsible for the decomposition of organic matter.

It is clear from the results of the soil analysis that the average of OM in the polluted soil is more than the average in the uncontaminated soil.



(**Figure12**) Organic matter percentage (%) in soil.

Reference:

[1] Belaid, N.P., Al-Ahmar, R. A.,&Saleh, H. M. (2019). Estimating the level of lead, cadmium, and iron in soil and ash within some areas of the city of Tripoli, *Journal of Applied Sciences*, No. 120 - 107, First Special Mustafa.

[2] Al-Mansoori, A. M. (2018). Soil Pollution, College of Basic Education, University of Babylon.

[3] Regional Center for Environmental Health Activities Amman, Jordan (2003). Reuse of wastewater in agriculture, a guide for planners. World Health Organization, Regional Office for the Eastern Mediterranean.

[4] Sushil, K. V., Kochar, D. V., &Khokhar, K. (2019). A Review on Influence of Sewage Water on Soil Properties and Microbial Biomass Carbon, Ind. *Journal of Pure Applied Biosciences*, 7(5), 83-90.

[5] Alzoubi, M.M. O.,Jouzdan, A.,Majar, M.N.,Haboub, M., &Hakkoun, H. D. (2014).Treated waste water use in agriculture. General Commission for Scientific Agricultural Research (GCSAR In collaboration with ACSAD and ICBA). Damascus, Syria. Pp 2- 63.

[6] Ali, H. J., Saif, A.,& Al-Khamisi, A. N. (2011), The Use of Tertiary Treated Wastewater in the Production of Forage Crops under the Conditions of the Sultanate of Oman, *The Jordanian Journal of Agricultural Sciences*, Volume 7, Issue pp.

[7] Johnson, L.F.,& Curl, E.A. (1972). Methods for Research on the Ecology of Soil- Borne Plant Pathogens. Burgess Publishing Company, Minneapolis.

[8] AOAC, (1984). Official methods of analysis of the Association of Official Analytical Chemists, 14thedn .AOAC, Washington, DC.

[9] Abbawi, S. A., & Suleiman, M. (1990). Practical Engineering of the Environment, Water Tests, Publications of the Ministry of Higher Education and Scientific Research, University of Mosul, Iraq.

[10] Chaturvedi, R. K.,&Sanka, K. (2006). Laboratory Manual for thePhysico-Chemical Analysis of Soil, Water and Plant, Wildlife Institute of India, Dehradun.

[11] List of standards for heavy metal concentrations recommended by the World Health Organization (2020).

[12] Mehdi, S.M., Abbas, G., Sarfrz, M., Abbas, S.T.,& Hassan, G. (2003). Effect of industrial effluents on mineral nutrition of rice and soil health.*Pakistan Journal of Applied Sciences*, 3(6): 462-473.

[13] Mleitan, A., Hanan, A., Khadija A., &Khawla, A. (2019). Study of the effect of wastewater on some soil properties in the Sasso Valley, *Academic Research Journal*, 174- 82.

[14] Warraq, H.,Abdulaziz, A.,& Salah, M.(2013). The Impact of Wastewater on the Soil in the City of Port Sudan, *Red Sea University Journal*, Third Issue, June.

[15] Mojiri, A.,& Aziz, H.A. (2011). Effects of municipal waste water on Accumulation of heavy metals in soil and wheat (*Triticumaestivum* L.) with two irrigation methods. *Romanian Agricultural Research*. 28: 217-222.

[16] Alghobar, M.A.,&Suresha, S. (2016). Effect of Wastewater Irrigation on Growth and Yield of Rice Crop and Uptake and Accumulation of Nutrient and Heavy Metals in Soil.*Applied Ecology and Environmental Sciences*, (3): 53-60.

[17] Khai, N.M., Tuan, P.T., Vinh, N.C., &Oborn, I. (2008). Effects of using wastewater as nutrient sources on soil chemical properties in peri-urban agricultural systems. V.N.U. *Journal of Earth Science*, 24, 87-95.

[18] Vaseghi, S. M.,Afyuni, H. S., &Mobli,M. (2005). Effect of sewage sludge on some nutrients concentration and soil chemical propertieS. *Journal of Isfahan Water and Wastewater*,53:15-19

[19] Bhat, M.A., Agrawal, H.P., Wani, M.A.,&Wani, J.A. (2011). Long-term Effect of Sewage Water Irrigation on Heavy Metal Accumulation in Soils and Crops .*Journal of the Indian Society of Soil Science*. 59(1): 97-100.

[20] Keys to Soil Taxonomy, 12th edition. (2014). U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC.

دراسة تأثير المياه الصرف الصحي غير المعالجة على عناصر في تربة منطقة خبات في أربيل، العراق.

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الخلاصة :
تحتوي مياه الصرف الصحي على كمية عالية من المواد المعدنية السامة (الكادميوم والكروم والرصاص والنحاس والكوبالت) والتي لها تأثير سلبي على التربة والنباتات.تم اجراء هذه الدراسة لتحديد تأثير تسرب مياه الصرف الصحي غير المعالجة إلى المجاري الرئيسية لمنطقة خبات وعلى الخواص الكيميائية والفيزيائية للتربة. كما تم تقدير تركيز بعض المعادن الثقيلة (Cd) الكادميوم (Cu) – النحاس (Pb) – الرصاص – (Cr) – الكروم (Co) الكوبالت وكذلك التوصيل الكهربائي للتربة (EC) والمواد الصلبة الذائبة الكلية (TDS) والعسرة الكلية (TH). تم أخذ عينات من التربة على عمقي تراوح بين 10-15 سم. بالمقارنة مع عينات المراقبة، التي تم أخذها على بعد 200 متر من المجرى الرئيسي ولم تتأثر بمياه الصرف الصحي غير المعالجة، تغيرات المعادن الثقيلة في التربة على مسافات مختلفة من مصدر التلوث.يظهر الفحص الدقيق وجود نمط متزايد للكادميوم والكوبالت، ونمط متناقص للنحاس والرصاص، بينما يشير الكروم إلى اتجاه واضح غير منتظم للتركيز. ويزداد تركيز هذه العناصر في التربة مع زيادة نسبة الأملاح الذائبة مما يؤدي بدوره إلى زيادة صلابة التربة وموصليتها الكلية. ويشير هذا إلى أن التربة القريبة من المجرى الرئيسي ملوثة، مما يؤثر بشكل أساسي على النباتات والحيوانات في المنطقة. وأوصت الدراسة بإيجاد حل لمشكلة موقع الصرف الصحي في منطقة خبات، وعدم إلقاء المياه غير المعالجة مباشرة في الأرض لمنع التلوث ووصول الملوثات الى المياه الجوفية، وبذلا لجهود لاستخدام هذه المياه بعد معالجتها لأغراض مختلفة.

الكلمات المفتاحية: الصرف الصحي، التلوث، التربة، العناصر الثقيلة.