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Measurement the Effectiveness of Radiation and Physiochemical Properties of Soils Selected from Diwaniya City, Iraq

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Abstract: ***The natural radiation of soil samples in the Aaldewanah city, Heavy metals (HMs), and physiochemical parameters of twenty different public sites. The results showed that values of activity concentrations of 238U and 40K were lesser than level of (MCL) proposed by United States Environmental Protection Agency (USEPA) But 32Th is slightly higher than the limit values because of the global nature of the soil Jalogih. The average values of the Radium equivalent activity and annual effective dose were less than the world average, the heist external and internal, hazard and gamma activity concentration index were lower than unity. Hydrogen ion concentration (pH), Electrical conductivity (EC), Salinity (Sal.), and heavy metals (HMs); Cr, Co, Cu, Mn, Zn, Cd, and Pb for the soils under study has been examined. The results showed a great variation among the analyzed samples with respect to their physical and chemical parameters. However, most values were higher the maximum permissible levels recommended by world health organization (WHO).***

Keywords: Gamma ray spectrometry, Na (Tl) detector, Raeq activities and annual effective dose, Heav metals (HMs), physiochemical parameters, Aaldewanah city.

1. Introduction

Soil radionuclide activity concentration is one of the main determinants of the natural background radiation [1] Over 60 radionuclides can be found in nature and they can be placed in three general categories, primordial, Cosmo genic and human produced. Radionuclides are found naturally, there is no where on earth that we not find natural radioactivity [2] Uranium and thorium are common natural radio elements. These radionuclides are present in soil in varying concentrations related to the nature of the parent rocks during soil genesis.[3]. Natural Occurring Radioactive Materials (NORM) are Known to be present in rocks and soil.The natural radionuclides of concern are mainly of 238U, 232Th or its progenies and 40K. Most of the radioisotopes are alpha emitters, so when they are ingested or inhaled, they contribute significantly to the radiation dose that people receive on the other hand, taking into account that uranium and thorium are always present in soil, their gamma radiation causes external exposures with the consequent absorbed doses [4].There are many heavy metals in our environment both naturally and from pollution. The term “heavy metal” applies to a group of metals with similar chemical properties. Some of these, including copper, iron and zinc, play important roles in our bodies. Others have no known benefit for health Examples of these are lead, which is found in paint in old homes as well as many other sources; arsenic, which can be found in well water and wood products; and mercury, which can build up in fish that we eat. At very high levels, most heavy metals can cause health problems. Luckily, this is very uncommon. For more information on particular heavy metals [5, 6]. A physical property of a pure substance is anything that can be observed without changing the identity of the substance. The obervations usually consist of some type of numerical measurement, although sometimes there is a more qualitative (non-numerical) description of the property. There are many physical properties and each textbook will have a different list of examples. Here are some of the more common ones:, melting point, electrical conductivity color density, boiling point, thermal conductivity odor hardness, There are others which are not mentioned as often. Examples include refractive index, atomic radius, ductility ionization energy, allotropes malleability[7].

Chemical properties describe the way a substance may change or react to form other substances example the salinity of the soil and the electrical conductivity and the acid function and total soluble salts and the type of soil texture and its impact on the environment 8].

2. Material and Methods

2.1 Study Area

Al Diwaniyah is the capital city of Iraq's Al-Qādisiyyah Governorate. In 2013, its population was estimated at 440, 927. The area around Al Diwaniyah city, which is well irrigated from the nearby Euphrates River, is often considered to be one on the most fertile parts of Iraq, and is heavily cultivated. The town is located on the main rail transport corridor between Baghdad and Basra.For birdwatchers; Al-Diwaniyah is a city with a rich bird list, as the city has a wide range of biodiversity. Al-Qadisiyah consists of vast agricultural areas, wetlands, arid zones, and semi-desert areas.The town is the site of a tire manufacturing

plant that once provided tires for much of Iraq. The plant is currently active; Al-Diwaniyah is the headquarters of the Iraqi Army's 8th Division (Iraq).

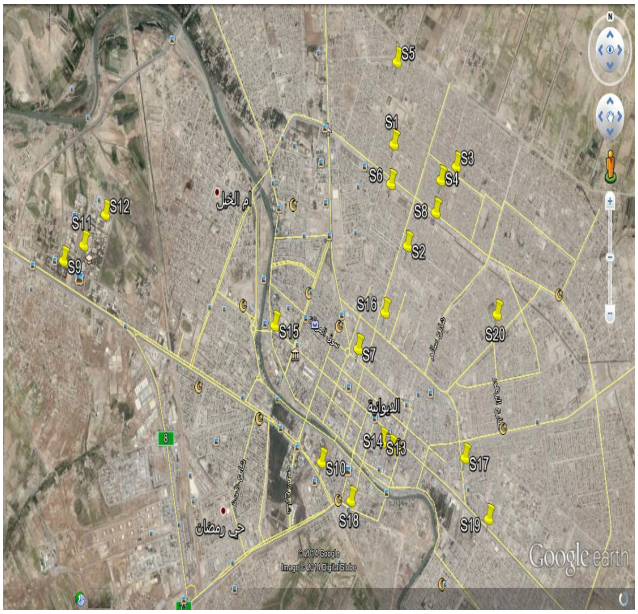

Figure 1: determine Location of sample in Diwaniya City by using GPS.

2.2 Sample Analyses

The soil samples measured at (5-20) cm depth level were collected from sampling points located at religious and historical places. The location of the samples is shown on table (1) and figure (1) after collection, samples are crushed into fine powder by grinder, and fine quality of the sample is obtained using scientific sieve. before measurement samples are dried in an oven at a temperature of 60 Cº for 72 h, each sample is packed and sealed in an airtight PVC container and kept for about (6) weeks period to allow radioactive equilibrium among. To measured the specific activity we used NaI(Tl) a system which consist of a scintillation detector NaI(Tl) of (3"×3") crystal dimension, supplied by (Alpha Spectra, (Inc), and measured Heavy metals (HMs) by Flame Atomic Absorption Spectrophotometer 6300AA - Shimadzu, Japan. and measured The Hydrogen Ion Concentration (pH), Salinity (Sal)by Multi meter, Digital Inolab 720, WTW – Germany, Electrical Conductivity (EC)by E.C.-meter, Digital multi meter Model 340i/SET, WTW – Germany, of soil samples.

The specific activity of each radionuclide is calculated using the following equation [9].

$$A = \frac{N_{net}}{\varepsilon . I_{\gamma} . m . t} \pm \frac{\sqrt{N_{net}}}{\varepsilon . I_{\gamma} . m . t} [Bq.kg^{-1}] \quad \ldots\ldots\ldots (1)$$

Where N_{net} is the net count (area under the specified energy peak after back ground subtraction) in (c/s), $\sqrt{N_{net}}$ is the random error in (c/s), ε is the efficiency of the detector, Iγ is the transition probability of the emitted gamma ray, t is the time (in sec)for spectrum collected and m is the sample weight (in kg).

3. Result and Discussion

3.1 Specific Activity

The specific activity values of 238U, 232Th and 40K radionuclide s for 20 soil sample are tabulated in table (1) and Figure (2). It has been found to lie in the range of (6.80 ± 1.98;S4 to 35.57 ± 4.31;S5) Bq/kg with an average of 21.97 ± 3.30 Bq/kg, from (5.29 ± 1.87;S20 to 39.68 ± 5.12;S16) Bq/kg with an average 22.78 ± 3.75Bq/kg and (103.14 ± 4.73;S14 to 162.64 ± 5.94;S13) Bq/kg with an average 127.12 ± 3.56 Bq/kg for 238U, 232Th and 40K respectively. The result shows that all values of 238U, and 40K specific activity for all soil sample are in the worldwide average (35Bq/kg for 238U, 30 Bq/kg for 232Th and 400 Bq/kg for 40K) [10]. But 232Th is slightly higher than the limit because of the global nature of the soil Jalogih.

The radium equivalent activities was calculated and listed in table (1).Ra eq values vary from (26.71 ± 3.72;S20 to 91.63 ± 11.23;S16) Bq/ kg with average value of (64.33 ± 8.94) Bq/kg. It can seen be that the Ra eq values for all samples are lower than the recommended value 370 Bq/ kg[11]. Gamma Dose Rate (D) range from (12.89 ± 2.23;S40 to 42.79 ± 4.92;S16) nGy/h with average (20.691) nGy/h. the Indoor Annual Effective Dose rang are from (0.0632±0.0109;S40 to 0.2099±0.0241;S16)(mSv/y) with average 0.1468±0.0198 (mSv/y)and Outdoor Annual Effective Dose rang are from (0.01581±0.0027;S40 to 0.05248±0.0060;S16)(mSv/y) with average 0.0367±0.0049 (mSv/y) all the soil samples have the annual effective dose less than the world average [17, 18], Representative level index (Iγr) range from (0.198945;S20 to 0.654073;S16) with average 0.458991, External hazard index (Hex) range from (0.072169;S20 to 0.247468;S16) with average 0.173759 and Internal hazard index (Hin) range from (0.019677;S20 to 0.042002;S16) with average 0.033098. External and internal hazard and gamma activity concentration were lower than unity according to the Radiation Protection 112 [10] as shown in Table (2).

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3.2 Heavy Metals

The study also measure the rate of the concentrations of heavy metals using Atomic Absorption Flame (AAS), including (Zn, Cr, Cd, Co, Cu, Mn, Pb) study showed that the concentration of lead ranged from (2.33 ;S15 to 24.23;S5), and the rate of in total (8.71)ppm. The cadmium concentration of (0.25) ;S4 to 9.78 ;S3) and the average of the year amounted (3.34)ppm, and the concentration of manganese (29.39;S8 to 877.07;S10)ppm and the rate of the year amounted (403.96)ppm, and the concentration of chromium from (6.98;S11 to 76.2;S10) ppm and the average of the year amounted (27.83) ppm, and the concentration of

zinc from (17.9;S5 to 161;S10) ppm and the average of the year amounted (88.76)ppm, and the concentration of cobalt from (3.2 ;S17 to 25.6 ;S9) ppm and the average of the year amounted (36.31) ppm, The concentration of copper (10.37;S9 to 82.03;S14) ppm and the rate reached in (57.64) ppm, As shown in Table(3) and Figure (3). Compared with the global determinants found that most of the concentrations of these elements of the models studied exceeds these limits, except element manganese concentrations were models are within the permissible limits[12].

3.3 Physicochemical Parameters

The study also included measurement of some physicochemical properties of the soil, the function of the hydrogen (pH), which values ranging from (6.78; S18 to 7.55; 18) and the rate reached in (7.11). and electrical conductivity EC values ranging from (3.16;S15 to 8.97;S17) dS / m and the average of the year amounted to (5.92) dS / m. and salinity which values ranging between (1.5 ;S9 to 7.6 ;S17) mM / Cm and the average of the year amounted to (3.98) mM / Cm, As shown in Table(3) and Figure (4) comparing the results of the analyzes physiochemical models studied with the World Health Organization found to be within the limits recommended by the World Health Organization[13, 14].

3.4 Figures and Tables

Table 1: Concentrations of Specific activity, Radium equivalent and Gamma Dose for samples.

Gamma Dose Rate ($nGy.h^{-1}$)	Radium equivalent (Bq/Kg)	(Bq/Kg) Specific activity			S.No.
		^{232}Th	^{238}U	^{40}K	
29.92 ± 4.04	64.33 ± 8.94	22.78 ± 3.75	21.97 ± 3.30	127.12 ± 3.56	Average
42.79 ± 4.92	91.63 ± 11.23	39.68 ± 5.12	35.57 ± 4.31	162.64 ± 5.94	Max.
12.89 ± 2.23	26.71 ± 3.72	5.29 ± 1.87	6.80 ± 1.98	103.14 ± 4.73	Min.

Table 2: Concentrations of Indoor and Outdoor Effective dose rate, Internal and External Hazard Index, Representative level index for samples.

Representative level index (Iγr)	Hazard Index		Effective dose rate $mSv.yr^{-1}$		S.No
	≤Internal (H_{in} 1)	External (H_{ex}≤1)	(Indoor)	(Outdoor)	
0.458991	0.033098	0.173759	0.1468±0.019	0.0367±0.0049	Averag
0.654073	0.042002	0.247468	0.2099±0.024	0.05248±0.006	Max.
0.198945	0.019677	0.072169	0.0632±0.010	0.01581±0.002	Min.

Table 3: Status of physiochemical parameters and heavy metals in soil samples

Parameters	Average	Max.	Min.
Cr(ppm)	27.83	76.2	6.98
Zn(ppm)	88.76	161.57	17.9
Co(ppm)	12.47	25.6	3.2
Cu(ppm)	36.31	82.03	10.37
Cd(ppm)	3.34	9.87	0.25
Pb(ppm)	8.71	24.23	2.33
Mn(ppm)	403.96	877.07	29.39
Sal(Mm/cm)	3.98	7.6	1.5
E.C.(ds/m)	5.92	8.97	3.16
pH	7.11	7.55	6.78

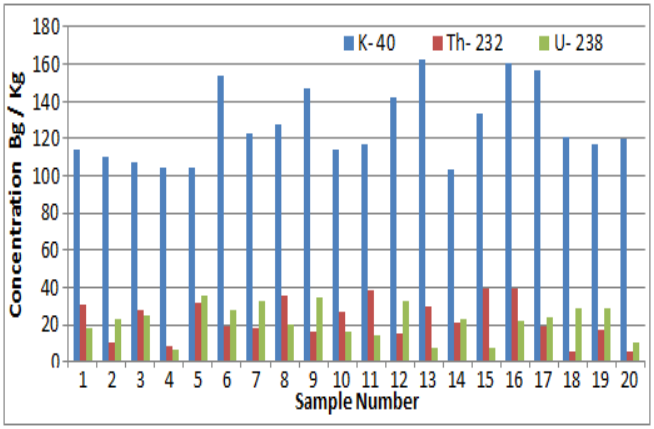

Figure 2: Concentrations of radionuclide for each sample

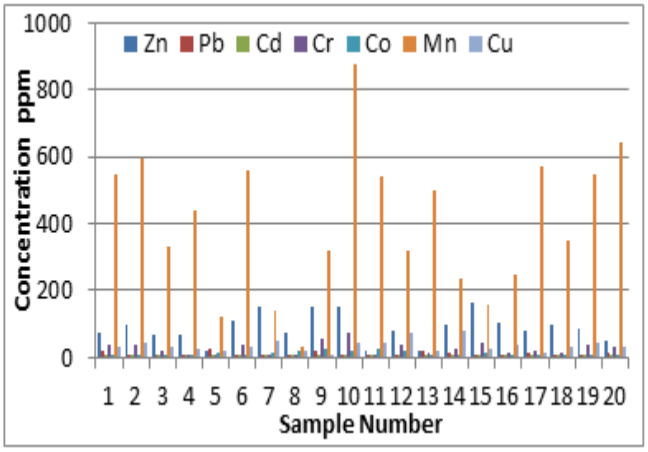

Figure 3: Concentrations of heavy metals in soil samples

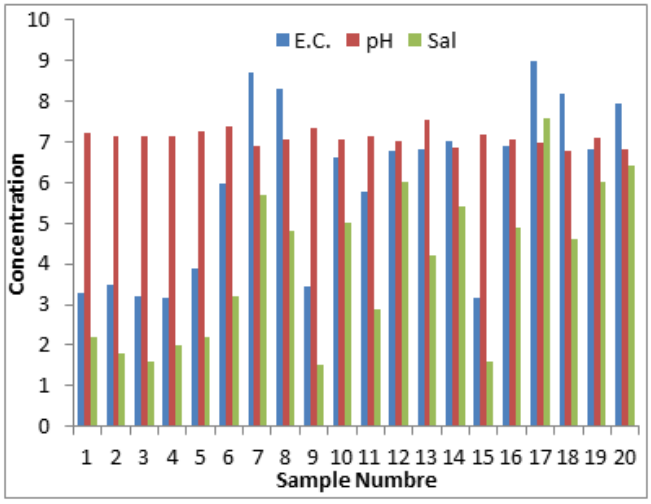

Figure 4: Concentrations of physiochemical parameters in soil samples

4. Conclusions

(1)The activity concentrations of 238U, 232Th and 40K for (20) soil sample from the City of Diwaniya. The activity concentrations were measured using Na (Tl) detection. The value of the Radium equivalent activity and annual effective dose was less than the world average. External and internal hazard and gamma activity concentration (representative level index) indexes were lower than unity.(2) Physiochemical properties than limits recommended WHO guideline values, these refer to inefficiency for drinking water. (3) Concentration of some toxic HMs such as Cr, Cu, Zn, Co, Cd and Pb were higher the maximum permissible levels recommended by world health organization (WHO) for the soil.

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