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Assessment of radioactivity levels and its associated radiological hazards in soil of Babylon governorate middle of Iraq

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Abstract. The paper included a radial map of the study area for the first time in Iraq thirty-one samples of the soil in Babylon governorate were used for the purpose of measurement the radiation Pollution in the region. used γ -ray spectrometer NaI(Tl) detector technique for the purpose of measurement the concentration of natural radionuclides of ^{238}U , ^{232}Th , ^{235}U and ^{40}K we found (397.230 \pm 3.802 Bq/kg to 244.511 \pm 2.983Bq/kg) for ^{40}K (37.091 \pm 1.005 Bq/kg to 1.879 \pm 0.226 Bq/kg) for ^{238}U ,from (30.971 \pm 0.814 Bq/kg to 0.192 \pm 0.064 Bq/kg) for ^{232}Th and (1.709 \pm 0.280 Bq/kg to 0.086 \pm 0.063)Bq/kg for ^{235}U .The radiological hazards due to natural radionuclides content calculated such as gamma dos rate (AD), radium equivalent activity, annual effective does equivalent (AEDE) ranged between (0.4498 Bq/kg to 0.121 Bq/kg). The results obtained in this research were consistent with global results, the concentration of natural radionuclides in soil samples were within the worldwide value reported by UNSCEAR 2008 .

1.Introduction

Radiation pollution is a type of physical pollution hazardous material means leakage of radioactive materials into a component environment water, soil, air and others. Radioactive material is divided the first type is radiation electromagnetic nature, such as gamma rays and x-rays commonly used in scientific uses, for this type of material highly radioactive ability to penetrate body tissues for a long distance. The second type is radiation of a particle-like nature alpha and beta rays, and for this type of radioactive material has less ability to penetrate the human body of the first type, only to inhalation dust containing alpha-ray or beta-ray radiation can cause serious damage to the cells that absorb it. pollution is considered radiation is one of the most dangerous types of environmental pollution when material reaches radiation to the cells of the body causing damage to the phenomenon. The structural and functional changes caused by ionizing radiation in tissues and organs leave a living creature in the organism with a intensity that depends on its strength and its impact on the organism and on physical chemical and biological factors. ways to enter radiation into the body either by inhaling the air



contaminated with radiation, swallowing radioactive materials due to contamination of the hands, through wounds or by irradiation of the skin[1].

Several local and global studies have been conducted to measure the concentration of radionuclides of ^{238}U , ^{232}Th , ^{235}U and ^{40}K found in soil from these studies, F.S. Erees et al. in 2006 studied natural radionuclide specific activity of surface soils at 64 locations in central Manisa (Turkey) were measured using NaI(Tl) (ORTEC). The natural gamma radioactivity of the terrestrial radionuclides in soil samples and the gamma-absorbed dose rates of these radionuclides in air were calculated and it has been found to be within the permissible limit[2]. Al-Hamarneh and Awed Allah M. I. in 2009 studied the natural radionuclide. Concentrations in surface soil samples and radiation hazard assessment of the highlands of northern Jordan using NaI(Tl) detector. The average concentrations of radionuclides ^{238}U , ^{232}Th and ^{40}K were 42.5, 49.9 and 291.1 Bq/kg respectively. the total average of the absorbed dose rate in the study areas is found to be 51.5 nGy/h, whereas the annual effective dose equivalent has an average value of 63.2 $\mu\text{Sv/y}$ [3].

The objective of this study is to estimate the level of effectiveness concentrations th quality of natural radionuclides of thorium(^{232}Th) uranium (^{238}U) potassium(^{40}K) and uranium (^{235}U) sampling soil from different locations of the city Babylon central Iraq. In order to assess the level of radiation background that arises and mapping of radiation to the area studied work to be part of the radiation map of the province Babylon, and integrated with current and future studies, as well as calculating the value of the radium equivalent and dose-absorbed ratio in air and dose effective annual internal and external impact on health, then compare the results obtained for the.

2. Area of study

The location of the province of Babylon in the central part of Iraq in the center of the sedimentary plain between the latitude of (32.6 and 33.8) north and longitude (43.57 and 44.12) east to include the area between the western plateau in the north-west and south-west to mid-distance between the Tigris and Euphrates rivers at the eastern estuary project takes the shape of the triangle located corner of the 106 km north of the south and the width of the irregular maximum 84 kilometers east-west (see figure1). The area under study according to buday and jasm (1987) lies in the Mesopotamia zone quaternary deposits comprised of Pleistocene and recent deposits covered almost the region ,in the studied area, injana formation (upper miocene age) and dibdibba formatio (Upper Miocene Early Pleistocene)were found to extend over a wide area as an erosional surface[4,5].

3. Materials and methods

3.1. Sample collection

Samples of soil were collected at a depth of 15 cm within randomly distributed. The study area was divided administratively so that the samples were collected from the districts and areas of the governorate under study each about 1.00 kg were neatly packed in well-labelled polyethylene bags properly sealed and transported to the radiation laboratory that were sifted and removed the impurities and then dried samples and stored for 30 days obtain the radiation balance. GIS 9.3(Geographic Information System) used to plot and deduced the spatial distribution of the radiation efficiency values of national radiological devise and also to plot the other radiological parameters.

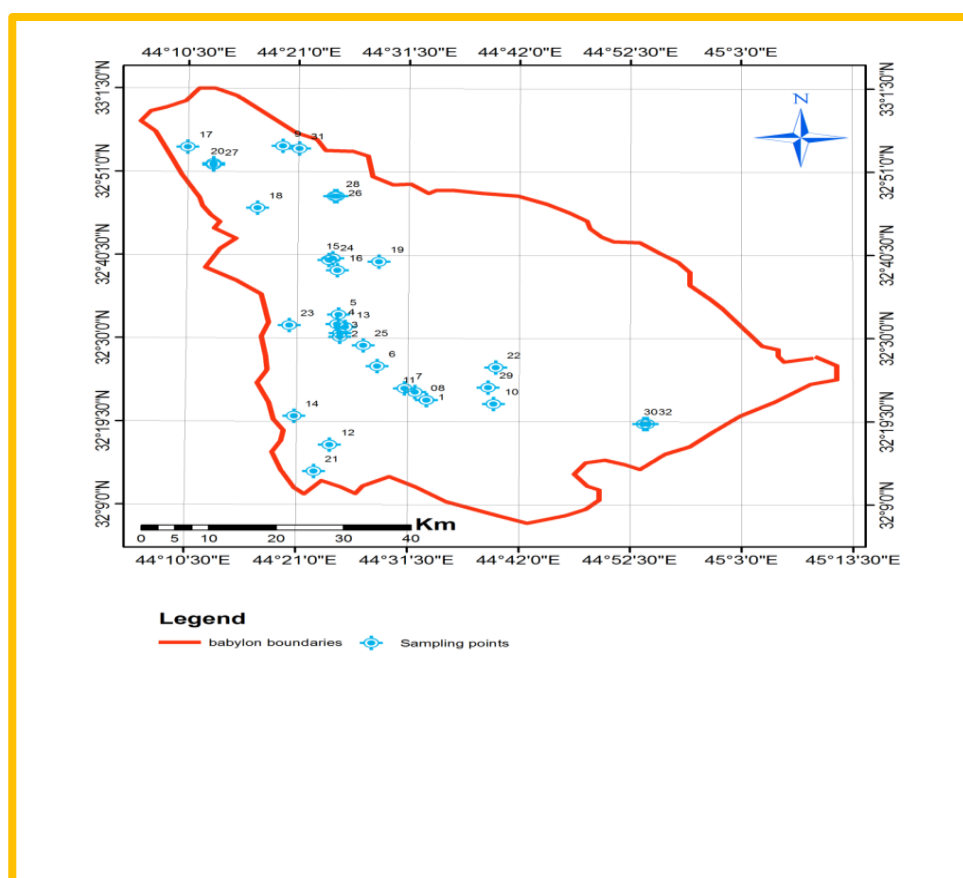


Figure1. study area (sampling points)

3.2. System used for measurements

Activity concentrations of the natural radionuclides of ^{232}Th (^{208}Tl), ^{238}U (^{214}Bi), (^{40}K) and (^{235}U) were measured using NaI(Tl) γ -ray spectrometer of (3"×3") crystal dimension, supplied by (Alpha Spectra, Inc.-12I12/3 coupled with a multi-channel analyzer (MCA) ORTEC–Digi Base with range of 4096 channel joined with ADC (Analog to Digital Convertor) unit, through interface, the spectral data was converted directly to the PC of the laboratory introduced using (Maestro-32) software. Measurements were made to check the background level of radioactivity in the laboratory the γ -ray photo peaks corresponding to 1460 Mev of ^{40}K , 1764Mev for ^{238}U and 2505kev of ^{232}Th . The detector was maintained in a vertical position and shielded by ORTEC cylindrical chamber ,the shielding consists of two parts the upper one is composed of lead 5cm thick and 20 cm long surrounding the crystal with a cover that is 5cm thick and has a diameter of 22 cm. The energy calibration is relationship between the number of channels and the energy absorbed in the detector. The energy calibration of the NaI(Tl) spectroscopy system is established by measuring the position of selected full-energy gamma-ray peaks with large peak-height to background ratios, and whose energies are known precisely[6].

4. Result and discussion

4.1. Activity concentrations of ^{40}K , ^{238}U , ^{232}Th and ^{235}U .

Activity concentrations of samples were determined by the net area under the photo peaks and . The results are tabulated in table 1. calculated by [7] :

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

N: net the net count, ε efficiency of detector, t: time for spectrum, m: weigh of the samples in kg, I_{γ} the transition probability of the emitted gamma ray. and the activity of ^{235}U calculated from [8]:

$$A(^{235}\text{U}) = A(^{238}\text{U})/21.7 \quad (2)$$

4.2. Radium equivalent (Ra_{eq})

this radium equivalent activity defines the relation[9]:

$$Ra_{eq} (Bq / kg) = A_U + 1.43A_{Th} + 0.077A_K \quad (3)$$

5. Radiological hazard parameters

5.1. Absorbed gamma dose rate

The total dose rate in the air at 1m above the ground surface due to uniform of all the ^{238}U , ^{232}Th and ^{40}K in each soil calculated by equation[1]

$$AD(nGy / h) = 0.462A_U + 0.621A_{Th} + 0.0417A_K \quad (4)$$

AD : is the dose rate , AU, ATh and Ak are the concentration of uranium ,thorium and potassium. It reflects the dose received by a person from outdoor radionuclides, the first step to estimate the health risks of radiation. The results of samples from the soil of the area under the study obtained were reported in table 2 .

5.2. Annual Effective Dose Equivalent

Annual estimated average effective dose equivalent received by member was calculated using factor of 0.7 SvGy^{-1} , which was used to convert the absorbed dose rate to human effective dose equivalent with an outdoor of 20 % and 80% for indoor . The annual effective doses equivalent outdoor and indoor calculated using [10]:

$$(AEDE)_{outdoor} = AD (nGh^{-1}) \times 8760 (h.y^{-1}) \times 0.7 \times (103 mSv/nGy109) \times 0.2 \quad (5)$$

$$(AEDE)_{indoor} = AD (nGh^{-1}) \times 8760 (h.y^{-1}) \times 0.7 \times (103 mSv/nGy109) \times 0.8 \quad (6)$$

$$(AEDE)_{outdoor} = AD \times (1.226 \times 10^{-3} mSv.y^{-1}) \quad (7)$$

The result of of the absorbed dose rate (AEDE) given in table 2.

Table1. Activity concentrations for isotopes and Radium Equivalent (Ra_{eq}) in soil.

No	Block	Activity concentrations				Ra_{eq} (Bq/kg)
		^{40}K (Bq/kg)	^{238}U (Bq/kg)	^{232}Th (Bq/kg)	^{235}U (Bq/kg)	
1	Al-thoraa 1	269.4±3.1	16.4 ±0.6	4.4±0.3	0.7±0.1	43.5±1.7
2	Al-thoraa 2	327.2±3.4	8.1±0.4	10.1±0.4	0.3±0.1	47.8 ±1.8
3	seanjar	311.1±3.3	20.8±0.7	10.8±0.4	0.9±0.2	60.3±2.0
4	Annana	364.8 ±3.6	35.9±0.9	14.9±0.5	1.6±0.2	85.3±2.2
5	Muammarh	244.5 ±2.9	2.01±0.2	0.1±0.06	0.09±0.06	21.1±0.9
6	buo-ashynawa	312.2 ±3.3	37.09 ±1	0.9±0.06	1.7±0.2	62.4 ±1.5
7	al dabble	317.1 ±3.3	22.7 ±0.7	16.8±0.6	1.04±0.2	71.1±2.1
8	al-garbohyaa	359.5±3.6	14.5 ±0.6	17.9±0.6	0.6±0.1	67.8±2.0
9	Al-hashmaya	293.8±3.2	16.8 ±0.6	8.7±0.4	0.7±0.1	51.9±1.9
10	abrahamya	377.9±3.7	35.9 ±0.9	10.8±0.4	1.6±0.2	80.5±2.1
11	Al-Qasim	274.1 ±3.1	2.4 ±0.9	3.0±0.2	0.1±0.07	22.9±1.8
12	al-jamjma	340.2 ±3.5	20.9 ±0.7	7.4 ±0.3	0.9±0.2	57.8±1.9
13	al-sibhya	316.1 ±3.3	21.5 ±0.7	29.4±0.7	0.9± 0.2	88.07±2.2
14	mahawil	303.7 ±3.3	13.9 ±0.6	25.2±0.7	0.6± 0.1	73.4±2.1
15	Mahawil	349.4±3.5	15.2 ±0.6	30.6±0.8	0.7±0.1	85.9±2.2
16	Sadda	371.1±3.6	11.9±0.5	17.9±0.6	0.5 ±0.1	66.2±2.0
17	Masayab	312.7±3.3	26 ±0.8	11.2±0.4	1.2 ±0.2	66.2±2.0
18	Al-amam	397.2±3.8	32.7 ±0.9	2.7±0.2	1.5 ±0.2	67.2±1.8
19	jarf al -nasser2	372±3.6	5.9 ±0.4	3.9±0.2	0.2 ±0.1	40.1±1.5
20	Alkafel2	326.6 ±3.4	28.7 ±0.8	7.8±0.4	1.3±0.2	65.07±1.9
21	markis2	262.3±3.08	12 ± 0.5	5.4±0.3	0.5±0.1	40.02±1.7
22	Abu Girq	308.4 ±3.3	2 ±0.5	5.1±0.3	0.09 ±0.06	33.2± 1.7
23	mahawil2	288.4±3.2	30.8 ±0.9	26.5 ±0.7	1.4 ±0.2	91.1±2.3
24	markis1	305.1±3.3	2.3 ±0.2	14.8 ±0.5	0.10 ±0.07	47.02±1.7
25	mashrua1	265.9±3.1	17.3 ±0.6	5.7 ±0.3	0.80 ±0.1	46.03±1.8
26	jarf al nasser1	278.9±3.1	1.8 ±0.2	2.6±0.2	0.08 ±0.06	27.1±1.3
27	mashrua2	313.7 ±3.3	18.8±0.7	11.4±0.4	0.8±0.2	59.3±1.9
28	madhativ2	260.3 ±0.002	8.6±0.0008	9.6 ±0.4	0.4 ±0.1	42.5±0.9
29	shomaliya1	318.2 ±3.1	24.9±0.8	2.4 ±0.2	1.1±0.2	53.009±1.7
30	scandaryaa	313.2±3.3 6	22.1 ±0.7	30.9±0.8	1.02±0.2	90.5±2.3
31	shomaliya2	317.1 ±3.3	6.6 ±0.4	7.008 ±0.3	0.3±0.1	41.08±1.6

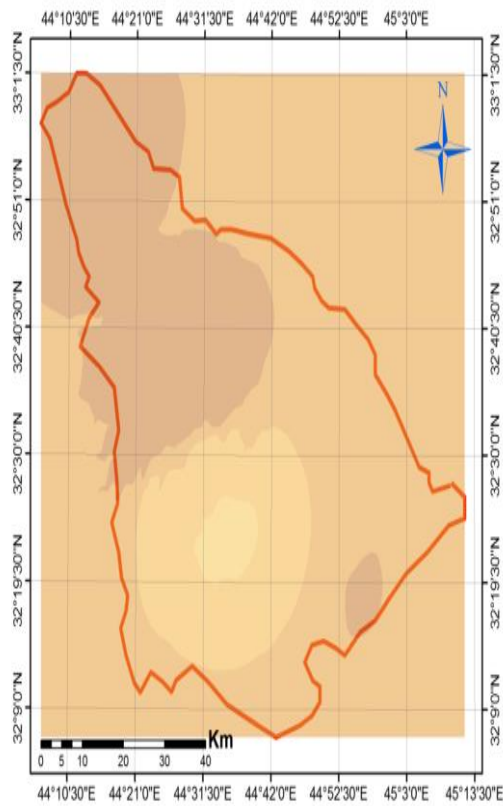


Figure 2. spatial distribution of ^{40}K radioisotope activity concentration found in soil of study area

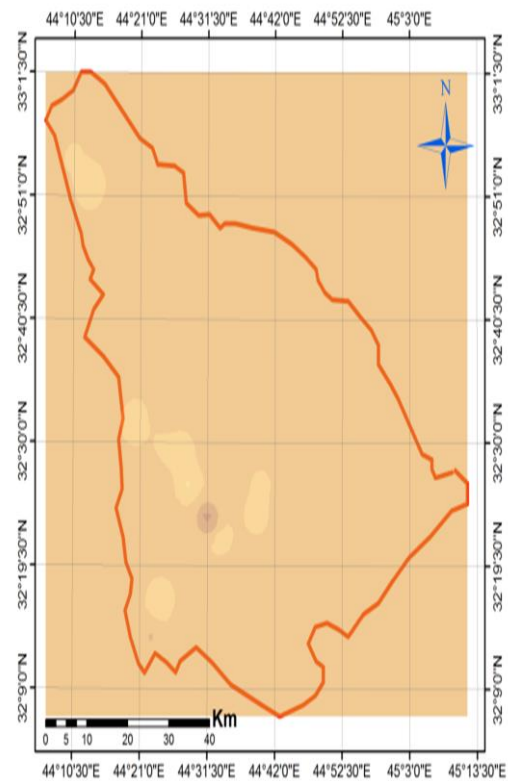


Figure 3. spatial distribution of ^{238}U radioisotope activity concentration found in soil of study area

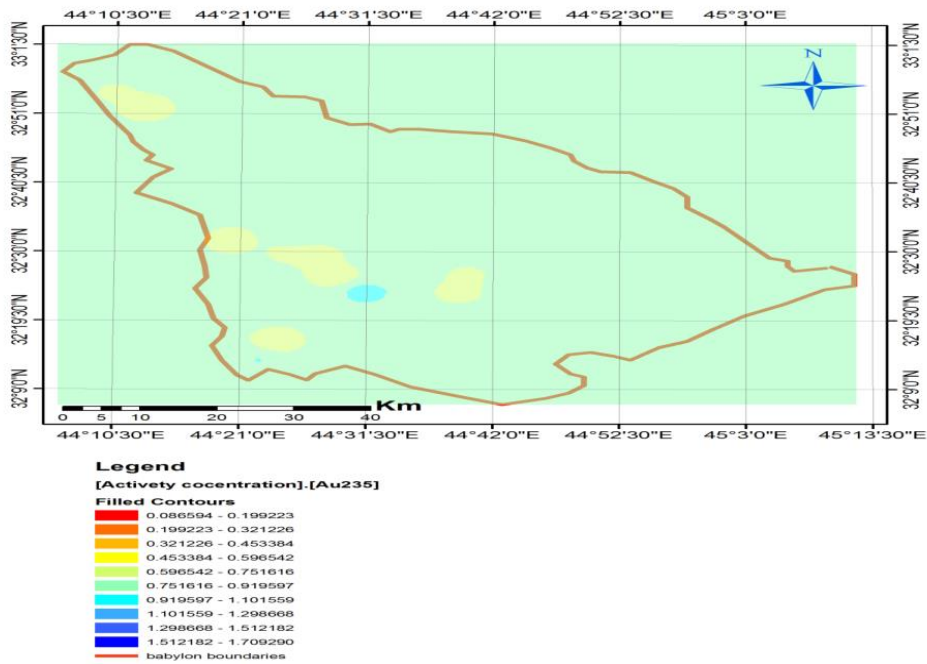


Figure 4. spatial distribution of ²³⁵U radioisotope activity concentration in soil of study area.

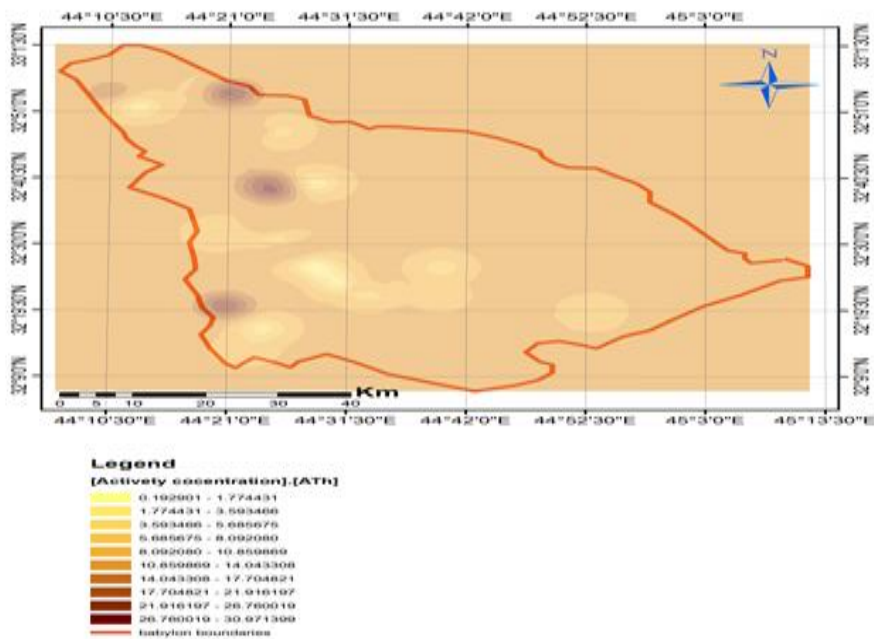


Figure 5. spatial distribution of ²³²Th radioisotope activity concentration found in soil of study.

5.3. Activity Utilization Index (UAI)

The total dose in the air of Babil province resulting from gamma radiation was calculated from the concentrations of the three nuclides ^{238}U , ^{232}Th , and ^{40}K , respectively calculated from the formula[11]:

$$\text{AUI} = A_{\text{U}} / 50\text{Bq/kg} \times f_{\text{U}} + A_{\text{Th}} / 50\text{Bq/kg} \times f_{\text{Th}} + A_{\text{K}} / 500\text{Bq/kg} \times f_{\text{K}}. \quad (8)$$

f_{K} , f_{U} and f_{Th} fractional contribution total dose rate of three radionuclides in soil samples.

5.4. Annual Gonadal Dose Equivalent (AGDE)

Including the dose received by organs such as the bone marrow and bone cells calculated from equation[12]:

$$\text{AGDE (mSv/y)} = 3.09A(\text{U}) + 4.14 A(\text{Th}) + 0.314A(\text{K}) \quad (9)$$

5.5. Hazard indices

5.5.1. Hazard indices for external radiation gamma (H_{ex} & I_{γ})

The external gamma radiation H_{ex} dose from soil as given below [13]:

$$H_{\text{ex}} = A(\text{U})/370 + A(\text{Th})/259 + A(\text{K})/4810 \leq 1 \quad (10)$$

Another factor depend on the activity concentrations of the three radionuclides ^{238}U , ^{232}Th and ^{40}K called the representative level index (I_{γ}) defined by the following equation[14]:

$$I_{\gamma} = 1/150 \times A(\text{U}) + 1/100 \times A(\text{Th}) + 1/1500 \times A(\text{K}) \quad (11)$$

5.5.2. Internal hazard index (H_{in})

Many of the radioactive materials decay naturally and when these materials decay produces external radiation field which exposed humans. In terms of dose, the principal primordial radionuclides are ^{232}Th , ^{226}Ra and ^{40}K . Thorium and uranium head series of radionuclides that produce significant human exposure, The value of this index must be less than unity for the radiation hazard to be negligible; H_{ex} equal to unity corresponds to the upper limit of Ra_{eq} (370Bq/kg). It is possible to calculate the internal exposure to radon resulting from alpha rays, which causes cancer, through which to know the short life span of the and it is series; given below[15]:

$$H_{\text{in}} = A(\text{U})/185 + A(\text{Th})/259 + A(\text{K})/4810 \leq 1 \quad (12)$$

Table2. The Air-absorbed dose rates ,and associated Annual effective dose.

No	Block	absorbed dose <i>nSv/h</i>		Annual effective dose <i>mSv.y⁻¹</i>	
		indoor	outdoor	indoor	outdoor
1	Al-thoraa 1	21.064 ±2.175	41.839 ±7.375	0.025 ± 0.071	0.205 ±
2	Al-thoraa 2	23.295 ±1.732	45.201± 7.601	0.028 ±0.074	0.221 ±0.032
3	seanjar	29.361 ±2.485	56.370± 9.259	0.036 ±0.078	0.276 ±0.036
4	Ananh	41.072 ±3.143	79.034 ±11.312	0.050 ±0.084	0.387 ±
5	Al-Muammarh	11.246 ±0.842	21.871± 3.055	0.013 ±0.053	0.107 ±0.022
6	Al-buo-	30.713 ±2.883	60.403 ±8.077	0.037 ±0.068	0.296 ±0.038
7	al dabla	34.150 ±2.618	65.093 ±10.339	0.041 ± 0.082	0.319 ±0.039
8	al-garbohyaa	32.822 ±2.212	62.212± 9.700	0.040 ± 0.081	0.305 ±0.038
9	Al-hashmaya	25.463 ±2.258	48.926 ±8.419	0.031 ± 0.076	0.240 ±0.034
10	abrahamya	39.106 ±3.109	75.637 ±10.718	0.047 ± 0.082	0.371 ±0.042
11	Al-Qasim	14.424 ±1.058	27.760 ±4.686	0.017 ±0.074	0.136 ±0.025
12	al-jamjma	28.500 ±2.454	55.060 ±8.709	0.034 ± 0.076	0.270 ±0.036
13	al-sibhya	41.430 ±2.636	77.890 ±11.687	0.050 ±0.087	0.382 ±0.043
14	mahawil	34.763 ±2.216	65.204 ±10.373	0.042 ± 0.084	0.319 ±0.039
15	Mahawil	40.621 ±2.320	76.053± 11.196	0.049 ±0.086	0.373 ±0.042
16	sadda	32.134 ±2.059	60.815± 9.403	0.039 ±0.080	0.298 ±0.038
17	al-msayib	32.056 ±2.723	61.686 ±9.817	0.039 ±0.080	0.302 ±0.038
18	Al-amam	33.376 ±2.869	65.283 ±8.697	0.040 ±0.074	0.320 ±0.039
19	jarf al -nasser2	20.674 ±1.462	39.884 ±5.977	0.025 ±0.067	0.195 ±0.030
20	Alkafel2	31.747 ±2.797	61.500 ±9.472	0.038 ± 0.078	0.301 ±0.038
21	markis2	19.875 ±1.934	38.308± 7.071	0.024 ±0.071	0.187 ±0.030
22	Abu Girq	17.023± 1.049	32.574 ±5.246	0.020 ±0.071	0.159 ±0.027
23	Al-mahawil2	42.775 ±3.018	81.013 ±12.159	0.052 ±0.087	0.397 ±0.044
24	markis1	22.989 ±1.189	43.161 ±7.051	0.028 ± 0.072	0.211 ±0.032
25	mashrua1	22.666 ±2.245	43.824 ±7.787	0.027 ±0.073	0.214 ±0.032
26	jarf al nasser1	14.161 ±0.965	27.270 ±4.414	0.017 ± 0.060	0.133 ±0.025
27	mashrua2	28.882 ±2.393	55.340 ±9.148	0.035 ± 0.078	0.271 ±0.036
28	madhatiy2	20.877 ±1.690	39.739 ±7.442	0.025 ±0.046	0.194 ±0.030
29	shomaliya1	26.338 ±2.542	51.466 ±7.774	0.032 ±0.072	0.252 ±0.035
30	scandaryaa	42.505 ±2.670	79.834± 11.886	0.052 ± 0.088	0.391 ±0.043
31	shomaliya2	20.639 ±1.573	39.509 ±6.726	0.025 ±0.070	0.193 ±0.030

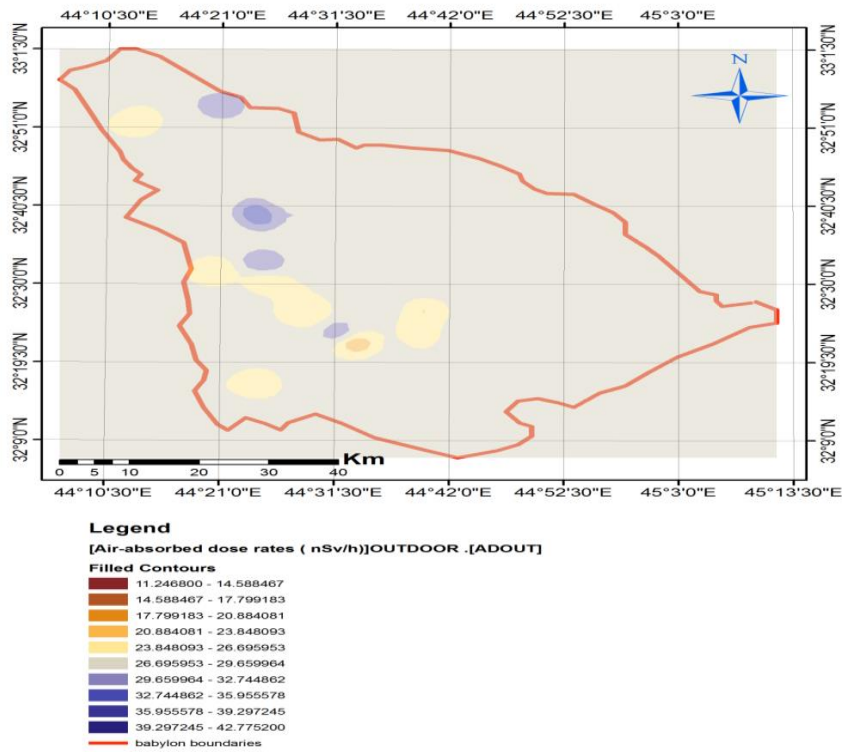


Figure 6. spatial distribution of Air-absorbed dose rate(OUTDOOR) in soil of study area

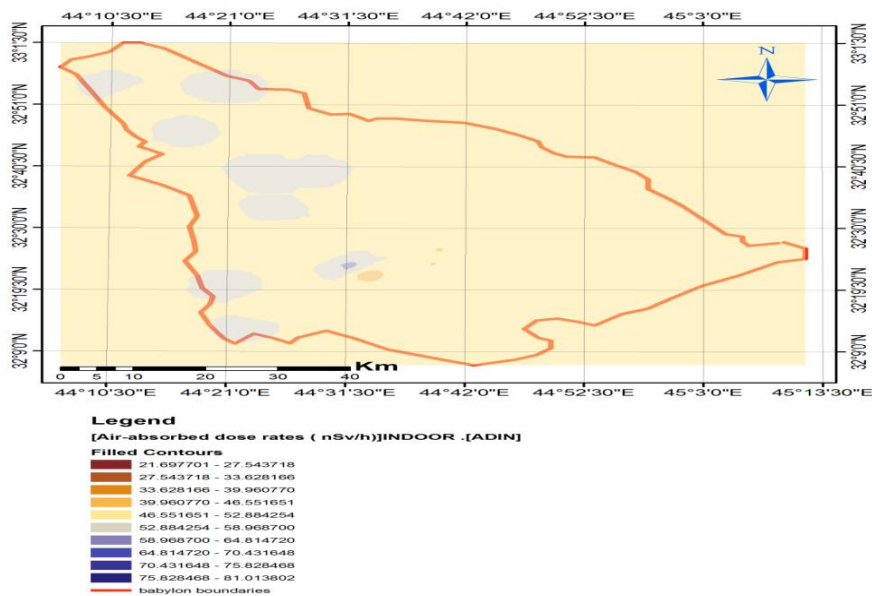


Figure 7. spatial distribution Air-absorbed dose rate (nSv/h)] indoor in soil

Table3. Radiological hazard parameters Index (I_γ) and Activity Utilization Index AUI.

No	Block	Radiological hazard parameters				
		H_{in} (Bq/kg)	H_{ex} (Bq/kg)	I_γ (Bq/kg)	AGDE $mSv.y^{-1}$	AUI $mSv.y^{-1}$
1	Al-thoraa 1	0.117 ±0.004	0.162±0.006	0.182±0.007	152.89	0.227
2	Al-thoraa 2	0.129± 0.004	0.151±0.006	0.161± 0.007	169.16	0.225
3	seanjar	0.163 ±0.005	0.219±0.007	0.245 ±0.008	206.41	0.349
4	Ananh	0.230 ±0.005	0.327±0.008	0.373 ±0.009	286.55	0.542
5	Al-Muammarh	0.057± 0.002	0.062±0.003	0.065±0.004	82.83	0.041
6	ashynawa	0.168 ±0.004	0.268±0.006	0.315±0.008	215.16	0.379
7	al dabla	0.192 ±0.005	0.253±0.008	0.282±0.009	238.83	0.439
8	al-garbohyaa	0.183 ±0.005	0.222±0.007	0.240±0.008	231.30	0.380
9	Al-hashmaya	0.140 ±0.005	0.185±0.007	0.207±0.008	179.73	0.285
10	abrahamya	0.217 ±0.005	0.314±0.008	0.360± 0.009	273.66	0.494
11	Al-Qasim	0.075 ±0.005	0.081±0.007	0.084±0.008	105.09	0.081
12	al-jamjma	0.156 ±0.005	0.212±0.007	0.239±0.008	201.45	0.311
13	sibhya	0.237 ±0.006	0.296±0.008	0.323±0.009	287.91	0.581
14	mahawil	0.198 ±0.005	0.235 ±0.007	0.253 ±0.008	242.79	0.458
15	Mahawil.	0.232± 0.006	0.273±0.008	0.292±0.009	283.57	0.539
16	Alsadda	0.178 ±0.005	0.211±0.007	0.226±0.008	227.06	0.357
17	al-msayib	0.178 ± 0.005	0.249 ±0.008	0.282±0.009	224.50	0.402
18	Al-amam	0.181± 0.004	0.269±0.007	0.311 ±0.008	235.67	0.367
19	jarf al -nasser2	0.108 ±0.004	0.124±0.005	0.131±0.006	149.97	0.132
20	Alkafel2	0.175 ±0.005	0.253±0.007	0.289 ±0.009	222.75	0.386
21	markis2	0.108± 0.004	0.140±0.006	0.155 ±0.007	141.27	0.198
22	Abu Girq	0.089±0.004	0.095±0.006	0.097± 0.007	123.62	0.106
23	Al-mahawil2	0.246±0.006	0.329±0.008	0.368 ±0.010	295.94	0.630
24	markis1	0.126±0.004	0.133±0.005	0.136 ±0.006	163.74	0.225
25	mashrua1	0.124±0.004	0.171±0.007	0.193 ±0.008	160.06	0.251
26	jarf al nasser1	0.073±0.003	0.078±0.004	0.080 ±0.005	103.47	0.072
27	mashrua2	0.160±0.005	0.211±0.007	0.235 ±0.008	203.31	0.338
28	madhatiy2	0.115±0.002	0.138±0.002	0.149 ±0.002	148.05	0.218
29	Al-shomaliya1	0.143±0.004	0.210±0.007	0.242± 0.008	186.14	0.286
30	Al-scandaryaa	0.244±0.006	0.304±0.008	0.332 ±0.009	295.05	0.604
31	Al-shomaliya2	0.110±0.004	0.128±0.006	0.137 ±0.007	148.13	0.172

Activity concentrations of ^{40}K , ^{238}U , ^{232}Th and ^{235}U in evaluated in soil of Babylon by equation(1)and equation (2). figure1. shows radionuclide concentrations in the soil of the selected area of study and sampling, from table1. observed activities concentrations of the radionuclides content soil Babylon highest value of $(397.230 \pm 3.802 \text{ Bq/kg})$ for ^{40}K $(37.091 \pm 1.005 \text{ Bq/kg})$ for ^{238}U , $(30.971 \pm 0.814 \text{ Bq/kg})$ for ^{232}Th and $(1.709 \pm 0.280 \text{ Bq/kg})$ for ^{235}U ., compared with the worldwide median values reported by UNSCEAR (see table 4.), where the concentration of radionuclide within the limits of global concentration. effectiveness concentrations and the spatial distribution of natural radionuclides of thorium(^{232}Th), uranium (^{238}U) potassium(^{40}K) and uranium (^{235}U) sampling soil from different locations of the city Babylon central Iraq, as shown in figures 2, 3, 4 for distribution uranium (^{238}U) homogenous concentration were present for each study area while potassium(^{40}K) showed an increase in north part of study area, the distribution of thorium(^{232}Th) concentration has three high concentration areas in the north ,center and south of the study area, the reason for the heterogeneous distribution of radionuclide is subject to several factors, including the geology of the area, in addition to some of the soils and this indicates the increase of potassium in the soil.

Table4. activity concentration of present work within in Iraq and different countries of world [16].

Countries	Spific Activity Concentration		
	^{40}K (Bq/kg)	^{232}Th (Bq/kg)	^{238}U (Bq/kg)
Syria	270	20	23
Egypt	730-1150	55-98	10-64
USA	370	35	40
Present work	315	37.091	17

The Radium Equivalent (Ra_{eq}) was calculated from equation (3) and the results were summarized in table1. The average value of the Radium Equivalent (Ra_{eq}) is lower than the world average of UNSCEAR(see figure 2 and table1) . table 2. gives the results of Air-absorbed dose rates and Annual effective dose calculated by equations (4),(5),(6)and(7) respectively. outdoor external dose $(28.205 \pm 2.161 \text{ nSv/h})$ and indoor external dose $(54.019 \pm 8.418 \text{ nSv/h})$ both within ranged world, annual effective dose the indoor $(0.265 \pm 0.035 \text{ mSv.y}^{-1})$ and $(0.034 \pm 0.074 \text{ mSv.y}^{-1})$ outdoor are lower than some of reported values for countries and lower than UNSCEAR. table3. summarizes the radiation hazard indices for soils obtained in region this study, Radiological hazard parameters internal (H_{in}) and external (H_{ex}) are calculated from equations (10) and (12) respectively the results presented in table2. The average value H_{ex} $(0.156 \pm 0.005 \text{ Bq/kg})$ and the internal hazard $(0.203 \pm 0.007 \text{ Bq/kg})$. both the external and internal hazard index should be less than 1. shows the Figure(4). Representative level index (I_{γ}), activity utilization index (AUI) and annual gonadal dose equivalent calculated by equations(8),(9) and(11) respectively, tabulated the results in Table3. From table3. we observation that (I_{γ}), AUI and annual gonadal dose all the values were below the safety limit of unity set by UNSCEAR.

6. Conclusion

From the experimental work on natural radioactivity ,we can conclude., The activity concentrations natural radioactivity of ^{238}U , ^{232}Th and ^{40}K have been measured in soil samples from Babylon by sampling locations using gamma ray spectroscopy.

The average specific activities 17.484 ± 0.654 Bq/kg, 37.091 ± 1.005 Bq/kg and 315.613 ± 3.198 Bq/kg for ^{238}U , ^{232}Th and ^{40}K respectively this value within measurement allowable world. That hazard indices, I_γ , H_{ex} and H_{in} the level indices are less than the world. Activity utilization AUI and annual gonadal dose all the values were below the safety limit of unity set by UNSCEAR.

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