IASJ
المجلات الاكاديمية العراقية
Tikrit Journal of Pure Science
ISSN: 1813 – 1662 (Print) --- E-ISSN: 2415 – 1726 (Online)
Journal Homepage: http://tjps.tu.edu.iq/index.php/j

Estimation the Radionuclides concentrations, Risk indicators and annual doses in soils of residential and agricultural regions in Kirkuk city

Berivan Mohammad Abdwllah , Sabah Mahmoud Aman Allah
Physics Department , College of Education for Pure Sciences – Kirkuk University , Kirkuk , Iraq
https://doi.org/10.25130/tjps.v25i1.218

ARTICLE INFO.

Article history:
-Received: 25 / 6 / 2019
-Accepted: 23 / 10 / 2019
-Available online: / / 2019

Keywords: Radioactive nuclides, internal and external exposure, Germanium detector, annual dose.

Corresponding Author:

Name:
Berivan Mohammad Abdwllah

E-mail: roseberi9993@gmail.com

Tel:

ABSTRACT

The aim of the current study is to measure the Specific activity of the radio nuclides**,** Risk indicators and annual doses in selected soils samples for the residential and agriculture areas in Kirkuk governorate by using the spectroscopy technique of high-purity germanium detector where 10 soil samples were collected at depth of 20 cm. The present study shows that radioactivity results for the isotopes were as the following: Radium ^{226}Ra, Actinium ^{228}Ac and potassium ^{40}K are (27.6±4.1-43.3±5.4 Bq.kg^{-1}) with average value (32.86±4.95 Bq.kg^{-1}) and (12.4±0.8-28.12±4.2 Bq.kg^{-1}) with average value (20.492±2.77 Bq.kg^{-1}) and (225±9.2-327±12.1 Bq.kg^{-1}) with average value (268.76±9.06 Bq.kg^{-1}) respectively. The factor Ra_{eq} Radium equivalent (63.966-92.759 Bq.kg^{-1}) and the radioactivity concentration (I_γ) (0.469-0.666 Bq.kg^{-1}), Hazardous factors of internal and external are (0.366280-0.247378 Bq.kg^{-1}) (0.172784-0.249254 Bq.kg^{-1}) respectively. The air absorbed does (D_γ) (30.332-43.185) nGy.h^{-1}, while the Risk indicator for the internal and external annual effective dose were (0.148797-0.220033) mSv.y^{-1} and (0.037199-0.052963) mSv.y^{-1} respectively. The comparison of the present results present a good agreement with the acceptable standard values of the World Health Organization (WHO) and has not influences on the health, environment and agriculture.

1- Introduction

The radiation applications in science, energy, industrial, medical applications and agriculture has been brought huge benefits to the humanity [1]. Radioactivity is defined as the spontaneously transformation of an excited nucleus into a stable nucleus after emitting radiation like (α), (β^{+}, β^{-}) or gamma rays (γ) [2]. The radioactive pollutants is a contamination which may be considered complex problem. The sources of radioactive contamination in the environment vary due to its behavior of newly deposited radioactive nuclides different from the behavior of the nuclides that already founded inside the soil samples [3]. The winds is the main factor in spreading the pollutants as it moves the soil to various areas carrying the pollutants, which leading to contamination of air and surface soil [4]. The current research work for the scanned regions suggests that the level of radionuclide concentrations ^{238}U, and ^{234}Th chains in the soil samples of Kirkuk city for the radioactivity of natural and their output ^{228}Ac and ^{226}Ra natural sources of ^{40}K using a the high purity germanium detector. The measured factors in the present study are radiological risk effects account for human health (radium equivalent activity Ra_{eq}) Bq.kg^{-1}, activity concentration indicator (I_γ), the internal risk indicator, the external risk indicator, the absorbed dose rate in air nGy.kg^{-1}, the values of internal annual effective dose is equivalent (mSv.y^{-1}) and the values of external annual effective dose equivalent (mSv.y^{-1}).

2 - The theoretical part

2-1 Specific Activity concentration (N)

Specific activity is defined as the radioactivity of per units of mass or volume of the natural radioactive material, which measured in a (Bq/kg or Bq/m^3). It's given by the equation [5].

$$N\left(\frac{Bq}{kg}\right)=\frac{N}{\varepsilon(e_\gamma).I_\gamma(e_\gamma).m.t} \dots\dots (1)$$

N : net count under the peak.

$\varepsilon(e_\gamma)$: γ ray detector efficiency.

$I_\gamma(e_\gamma)$: the percentage proloaloityof γ ray emission from the radionuclides under study.
m : mass of the sample measured by kg.
t : count time in second.

2-2 Radium Equivalent Activity (Ra_{eq})

Radium equivalent activity (Ra_{eq}) stand for a factor which is used to ensure the uniform distribution of natural radionuclide's, ^{226}Ra , ^{232}Th, and ^{40}K measured by ($Bg.kg^{-1}$), Which is calculated by using the following equation [6,7].

$$Ra_{eq}\left(\frac{Bq}{kg}\right) = N_{Ra} + 143 \times 10^{-2} N_{Th} + 7.7 \times 10^{-2} N_K \ldots\ldots (2)$$

N_{Ra} N_{Th} and N_K are the Specific activity of ^{226}Ra, ^{232}Th and ^{40}K respectively. The maximum acceptable value for the equivalent radium is (370) $Bg.kg^{-1}$ [7,8].

2-3 Gamma ray indicator Concentration Indicator (I_γ)

The gamma γ radiation risk indicator is a radiometric factor in which the risk levels γ rays associated with natural radionuclide's are estimated, and they can be calculated using the following equation:

$$I_\gamma\left(\frac{Bq}{kg}\right) = \frac{N_{Ra}}{150} + \frac{N_{Th}}{100} + \frac{N_K}{1500} \ldots\ldots (3)$$

The risk indication for γ rays is less than unity [5,9].

2-4 Risk Indicators

Risk indicator defined as a radiological factor used to measuring internal and external radiation risks. The internal Risk indicator (R_{in}) and the external risk indicator (R_{ex}) calculated by using the following equation [6,10].

$$R_{in}\left(\frac{Bq}{kg}\right) = \frac{N_{Ra}}{185} + \frac{N_{Th}}{259} + \frac{N_K}{4810} \leq 1 \ldots (4)$$

$$R_{ex}\left(\frac{Bq}{kg}\right) = \frac{N_{Ra}}{370} + \frac{N_{Th}}{259} + \frac{N_K}{4810} \leq 1 \ldots. (5)$$

The internal Risk indicator (R_{in}) and the external Risk indicator (R_{ex}) should be less than unity [9,11].

2-5 Absorbed Dose Rate in Air (D_γ)

The average absorbed dose of γ-rays in air D_γ at (1m) above ground level can be calculated using the following equation.

$$D_\gamma(nGy.h^{-1}) = 46.2 \times 10^{-2} N_{Ra} + 60.4 \times 10^{-2} N_{Th} + 4.17 \times 10^{-2} N_K \ldots. (6)$$

The conversion factors used for calculating the gamma absorbed dose in the air correspond to (46.2×10^{-2} nGy/h) for ^{226}Ra, (60.4×10^{-2} nGy/h) for ^{232}Th and (4.17×10^{-2} nGy/h) for ^{40}K [5,6].

2-6 Annual Effective Dose Equivalent (AEDE)

The annual effective dose equivalent represents a radiation parameter which used to determine the health effects of the absorbed dose measured by ($mSv.y^{-1}$). The annual effective dose estimates using the conversion factor (0.7 $Sv.Gy^{-1}$) which converts the absorbed dose in air to the effective dose, as well as using the internal occupancy factor (80%) and the external occupancy factor (20%) can be calculated using the following equation [12,13].

$$AEDE_{in}(mSv.y^{-1}) = D_\gamma(nGy.h^{-1}) \times 10^{-6} \times 8760h.y^{-1} \times 0.7Sv.Gy^{-1} \times 80\% \ \ldots (7)$$

$$AEDE_{out}(mSv.y^{-1}) = D_\gamma(nGy.h^{-1}) \times 10^{-6} \times 8760h.y^{-1} \times 0.7Sv.Gy^{-1} \times 20\% \ \ldots (8)$$

3- Experimental part

All the radioactivity parameter has been measured by using quanty and quality analysis for gamma rays using high-purity germanium detector. In Radiation protection center: RPC Ministry of Environment.

3-1 Description of the study area

The coordinates details of the selected locations for the present study are illustrated in table (1) and shown in figure (1) were obtained by using GPS.

Table (1): The detailed samples information for the locations and dates study.

Sample code	*Name*	*Longitude*	*Latitude*
S1	Laylan	44.5277	**35.3125**
S2	Laylan/ Yahyaawa	44.5067	**35.3232**
S3	Cheman	44.4882	**35.4896**
S4	Seakanyan	44.3610	**35.5566**
S5	Kirkuk city residential group	44.4458	**35.4858**
S6	Barwdkhana	44.4258	**35.4838**
S7	Shorja	44.4065	**35.4550**
S8	judgments residential group	44.3910	**35.4516**
S9	Panja Ali	44.4359	**35.4172**
S10	Daqwq	44.4866	**35.1459**

3-2 Preparation Soil Samples

Some precaution must be taken into consideration in collecting and preparing the samples under study is that keep these samples clean and preventing them from contamination. Four sample where collected in different time intervals during the period 22-27/1/2019, at a depth of (20 cm) beneath the soil surface. The soil samples are dried to remove the moisture and left it for a period of seven days to ensure the full equilibrium and homogeneity situation and then grind in order to become as a fine powder, and sifted with (0.2 mm) pores clamp to remove the gravel and plant roots sticking, the samples were weighed using a high sensitivity scale of 0.0001/gm. And (500 g) are taken from each dried soil, then the samples are placed in a pot Marinelli Beaker which this design of vessel is similar to the detector neck.

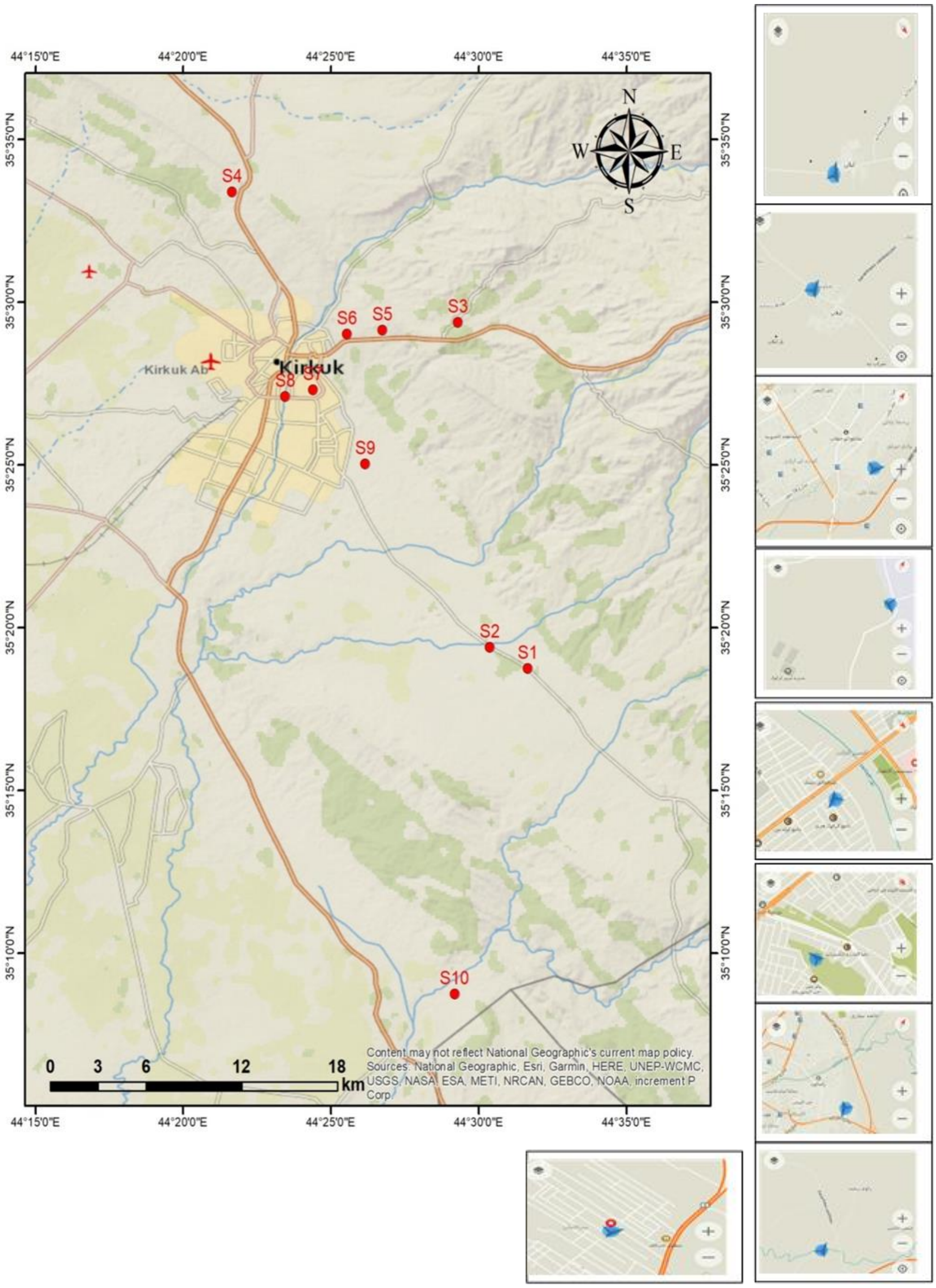

Fig. 1: The locations under study in Kirkuk city

3-3 Radioactivity Measurement System: The gamma-rays were detected by using a germanium detector system which , shown in fig (2).

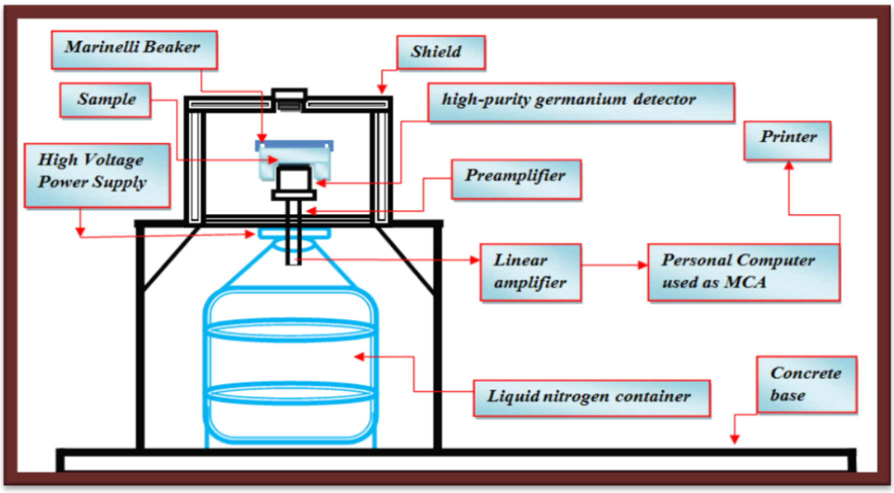

Fig. 2: sketch of detecting set-up.

4- Measurement of Specific Activity for Soil Sample

Nowadays modern techniques are capable of fabrication a high purity germanium crystals with trace quantity of impurities and reagent used is the production company (Canberra). Voltage detector (4000V) supplied by (TENNELEC). The germanium detector needs for $(17-18-19\ ℃)$ temperature and cooled by liquid nitrogen during operation to erasing the noise pulses of the current leakage that is generated in room temperature [14]. Detector is walled by bulletproof armor of thickness (10 cm) to reduce the effect of natural radiation background on the samples understudy to detector interface which enclosed by layers of aluminum, iron, copper and cadmium sheets respectively [15]. The qualitative activity of the soil sample is measured by placing the samples into template soil inside Marinelli pot as it installed on germanium detector for an interval ($3600\ sec$) and then measuring the sample efficiency by using equation (1). Table (2) illustrates the measurement of the specific activity for soil samples in Kirkuk city, The highest results for specific activity of radium was ($43.3 \pm 5.4\ \mathrm{Bq.kg^{-1}}$) for sample (S1) which is higher than the world average value of ($35\ \mathrm{Bq.kg^{-1}}$) [16,17] which may be results from the chimney dust of Laylan Cement factory which employing rock stones brought from Bazayan district in Sylumania contains high amounts of ^{226}Ra radioactive element that mixed with soils of that region. Inspection of the same table, we found the lowest value is ($27.6 \pm 4.1\ \mathrm{Bq.kg^{-1}}$) in the sample (S5) with average value ($32.86 \pm 4.95\ \mathrm{Bq.kg^{-1}}$) and the ^{214}Pb specific activity in (S2) was the lowest which is ($17.4 \pm 2.9\ \mathrm{Bq.kg^{-1}}$) and the highest value is for the (S1) was ($21.5 \pm 4.6\ \mathrm{Bq.kg^{-1}}$) with average ($22.53 \pm 3.02\ \mathrm{Bq.kg^{-1}}$) which by comparison with World average value show the result of present study is lower. The highest results for specific Activity of Thorium series of (^{228}Ac) is ($23.12 \pm 4.2\ \mathrm{Bq.kg^{-1}}$) for sample (S4) which is lower than the World average value of ($30\ \mathrm{Bq.kg^{-1}}$) [16,17], while the lowest value is ($12.4 \pm 0.8\ \mathrm{Bq.kg^{-1}}$) in the sample (S5) with average value ($20.492 \pm 2.77\ \mathrm{Bq.kg^{-1}}$) as show in Fig (3), and the ^{214}Pb specific activity in (S5) was the lowest which is ($14.4 \pm 0.6\ \mathrm{Bq.kg^{-1}}$) and the highest value was for the (S4) was ($27.2 \pm 5.3\ \mathrm{Bq.kg^{-1}}$) with average ($21.6 \pm 3.09\ \mathrm{Bq.kg^{-1}}$) which by comparisen with World average value show the result of the present study is less than the World average value.

Table (2): The specific activity of ^{238}U, ^{232}Th, ^{40}K radionuclides in soil samples.

Number of Sample	Specific Activity Concentrations ($Bq.kg^{-1}$)				
	^{238}U		^{232}Th		^{40}K
	^{214}Pb	^{226}Ra	^{212}Pb	^{228}Ac	
S1	21.5±4.6	43.3±5.4	17±2.6	19.6±3.8	272±8.9
S2	17.4±4	35±3.1	18.6±2.1	19±3.2	312±12.4
S3	24.1±3.1	31.6±5.4	26.1±5.9	18.6±3	327±12.1
S4	26.5±3.2	28.4±4.8	27.2±5.3	28.12±4.2	313.6±9.5
S5	21.4±2.9	27.6±4.1	14.4±0.6	12.4±0.8	242±6.4
S6	19.8±2.9	35±6.3	15.6±3.2	17.4±2.6	225±9.2
S7	23.4±4.7	29±5.9	22.2±3.8	19.8±2.9	245.6±6.4
S8	21.6±2.4	31±4.7	22.2±2.6	23.6±1.8	235±5.9
S9	24.2±2.4	29.5±3.1	26.5±2.9	23.4±2.3	282±10.3
S10	25.4±3.2	38.2±6.7	26.2±1.9	23±3.1	234±9.5
Max	26.5±3.2	43.3±5.4	27.2±5.3	28.12±4.2	327±12.1
Min	17.4±4	27.6±4.1	14.4±0.6	12.4±0.8	225±9.2
Ave	22.53±3.02	32.86±4.95	21.6±3.09	20.492±2.77	268.76±9.06
International standards [16,17]	35		30		420

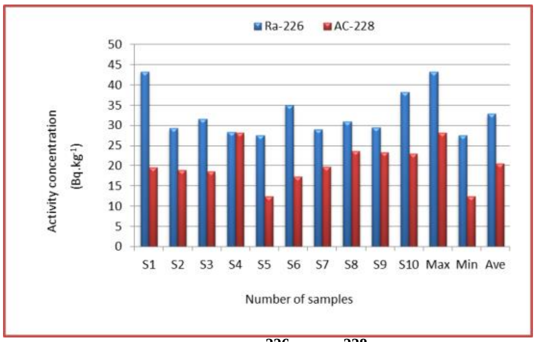

Fig. 3: Specific activity of (^{226}Ra – ^{228}Ac) radionuclide.

The highest results for specific activity of potassium (^{40}K) was ($327 \mp 12.1\ Bq.kg^{-1}$) for sample (S3) which is lower than the standard value of ($420\ Bq.kg^{-1}$) [16,17], while the lowest value is ($225 \mp 9.2\ Bq.kg^{-1}$) in the sample (S6) with average value ($268.76 \mp 9.06\ Bq.kg^{-1}$) as shown in figure (4). The specific activity for ^{137}Cs value throughout areas understudy found to be equals to ($1.5\ Bq.kg^{-1}$) which is about ten times less than the standard value ($14.8\ Bq.kg^{-1}$) [18].

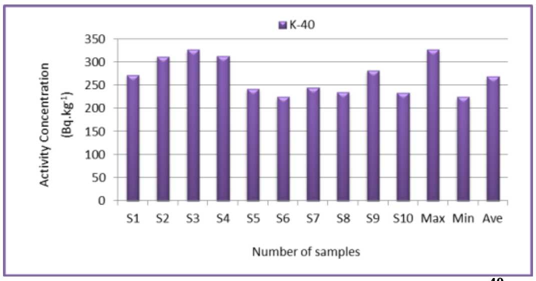

Fig. 4: The specific activity of the radionuclide (^{40}K).

Table (2) summarize the radium equivalent which obtained by using equation 2, the results show that the value of Radium equivalent (Ra_{eq}) in soil samples ranging (S5 = 63.96 to S1 = 92.27) $Bq.kg^{-1}$, and the total activity of radium (82.29) $Bq.kg^{-1}$ as shown in figure (5). The present study results affirm that the activity rate of radium equivalent for the selected regions is less than the international standards of activity equivalent of radium (370) $Bq.kg^{-1}$.

Table (3) shows that the gamma indicator (I_{γ}) in soil samples in the range (S5 = 0.47 to S1 = 0.67) $Bq.kg^{-1}$,and the total rate value is (0.5823) as illustrated in figure (6). The obtained results remark that the activity concentration parameter in region to be less than the world average (0.8) [16,17]. The lower and higher values for internal risk indicator (R_{in}) in soil samples are (S5 = 0.25 up to S1 = 0.367) and total activity (0.30955) as shown in figure (6), the rate of internal risk indicator (R_{in}) in the regions found to be less than the international standards of unity [16,17]. The lower and higher values for external risk indicator (R_{ex}) in soil samples are (S5 = 0.173 up to S1 = 0.249) and the overall rate (0.2221) as shown in figure (6). The rate of external risk indicator in regions considered less than the international standards acceptable value of unity [16,17].

Table (3): The measured radiation parameters.

Number of Samples	(Bq.kg $^{-1}$)				(D_γ) (nGy.h $^{-1}$)	Annual Effective Dose (mSv.y $^{-1}$)	
	(Ra_{eq})	(I_γ)	Risk Indicator			AEDE	
			In	Ex		In	Out
S1	92.272	0.666	0.366280	0.249254	43.185	0.220033	0.052963
S2	80.494	0.593	0.296605	0.217415	38.023	0.186526	0.046631
S3	83.377	0.615	0.310611	0.225206	39.470	0.193622	0.048405
S4	92.759	0.509	0.327286	0.250529	43.183	0.211836	0.052958
S5	63.966	0.469	0.247378	0.172784	30.332	0.148797	0.037199
S6	77.207	0.557	0.303150	0.208556	36.062	0.176906	0.044219
S7	76.225	0.555	0.284267	0.205888	35.599	0.174633	0.043658
S8	82.843	0.599	0.307547	0.223763	38.376	0.188257	0.047064
S9	84.676	0.619	0.308444	0.228708	39.522	0.193879	0.048470
S10	89.108	0.641	0.343941	0.240697	41.298	0.202592	0.050648
Max	92.759	0.666	0.366280	0.249254	43.185	0. 220033	0.052963
Min	63.966	0.469	0.247378	0.172784	30.332	0.148797	0.037199
Ave	82.2927	0.5823	0.3095509	0.2221142	38.505	0.1897081	0.0472215
International standards [16,17]	370	0.8	1	1	55	0.45	0.07

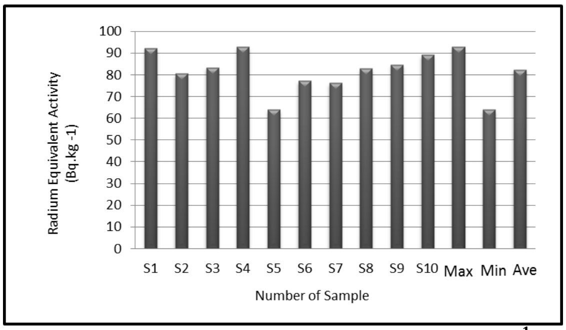

Fig. 5: The radium equivalent activity Ra_{eq} (Bq.kg^{-1}) in the samples.

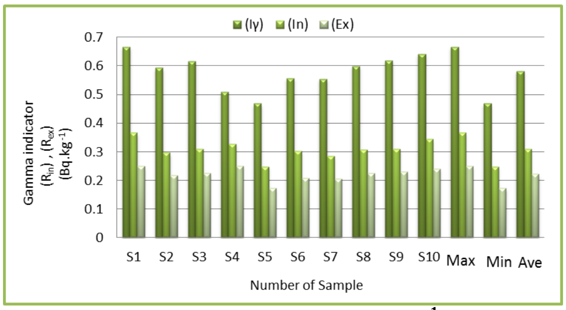

Fig. 6: The gamma indicator I_γ(Bq.kg^{-1}) and the internal (R_{in}) and external (R_{ex}) risk indicator in the samples.

The results of Calculated absorbed dose rate in air (D_γ) of the soil samples are shown in table (3) are ranged between (S5 = 30.33 to S1 = 43.18) nGy.h^{-1}, and the overall rate (38.505) nGy.h^{-1} as shown in figure (7). The results of the current study for the average absorbed dose rate is more less than the universal average dose rate value which is equals to (55) nGy.h^{-1} [16,17].

The Annual Effective Dose Equivalent rate ($AEDE_{In}$) views that values for internal measured in (nGy.h^{-1}) for soil samples ranging (S5 = 0.15 to S1 = 0.22) nGy.h^{-1} and the total rate is (0.189 nGy.h^{-1}) as shown in figure (8). The current results maintain that the average annual effective dose of internal exposure in the regions found to be less than the international standards of (0.45 nGy.h^{-1}).

The annual effective dose rate of external exposure (AEDEOut) in soil samples are obtained by application the equation (8), the values ranging from (S5 = 0.037 to S1 = 0.053) mSv.y-1 and with rated value equals to (0.047) mSv.y-1 as shown in figure (8). The results of the current study that the outdoor annual effective dose rate is less than the universal standards acceptable value (0.07) mSv.y-1 [16,17].

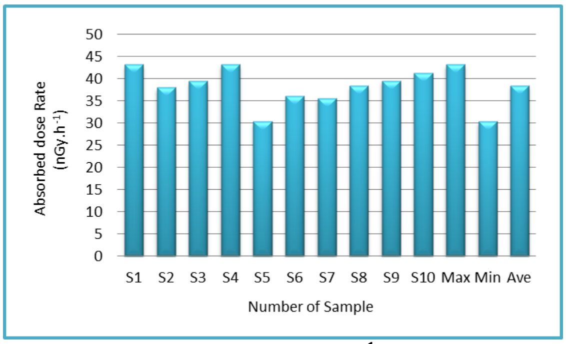

Fig. 7: Absorbed dose in air (nGy.h^{-1}) in the soil sample.

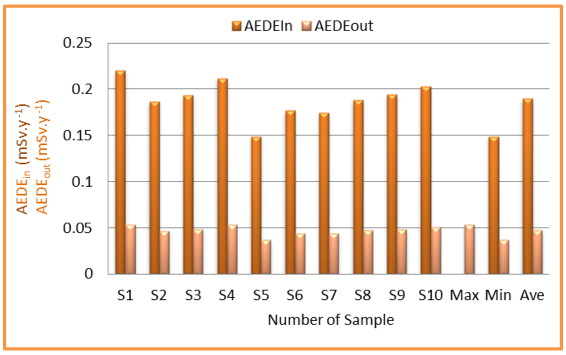

Fig. 8: Internal annual effective dose equivalent (mSv.y^{-1}) $AEDE_{in}$, external annual effective dose equivalent (mSv.y^{-1}) $AEDE_{out}$, in the soil sample.

Conclusion

The survey of the all results like activity concentration indicator (I_γ), internal risk indicator (R_{In}), external risk indicator R_{Out}, the values of absorbed dose in air (D_γ) nGy.kg^{-1}, internal annual effective dose equivalent ($AEDE_{in}$), external annual effective dose equivalent ($AEDE_{out}$), of the soil samples containing ^{226}Ra, ^{228}Ac and ^{40}K, are acceptable result as well as the elements ^{232}Th and ^{40}K were less than the standards values which reflects the safety of these agriculture and residential areas were studied except radium equivalent activity (Ra_{eq}) Bq.kg^{-1}, The value of S1 is the greatest in comparison to the standard values by NCRP which required the authority in the Kirkuk city inform the cement administration take more strict technical measurements to reduces the emissions diffused dust in Laylan area .

References

[1] Armin , A. (2010). Radiation Threats and your safety .Taylor & Francis Group:3.

[2] Michael, P. and Leo M. L. Nollet. (2007) .Radionuclide Concentrations in Food and the Environment. CRC Press:115.

[3] Al-Hakeem, M. M. R. (2001). Transportation of the radionuclide from the plants to the soil. Publications of the atom and developments. Querterly yearly magazine. **13(1):**38. (in Arabic).

[4] Michael, G. S. (2007). Radiation Protection and Dosimeter -An Introduction to Health Physics. Springer pp.155.

[5] Tawfiq, N. F.; Mansour, H. L. and Karim, M. S. (2015). Natural Radioactivity in Soil Samples For Selected Regions in Baghdad Governorate. *International Journal of Recent Research and Review*, **1**:1-7.

[6] Ramola , R. C.; Choubey, V. M.; Prasad G.; Gusain, G. S. and Kies, Z. A. (2011). Radionuclide analysis in the soil of Kumaun Himalaya, India, using gamma ray spectrometry. *Current Science*, **100(6)**:906-914.

[7] AL. Ahmed, A.; and Hussein , M. I. (2011). Natural Radioactivity. Measurements of Basalt Rocks in Sidakan Region Northeastern of Kurdistan. *Engineering and Technology, World Academy of Science*, **5(2)**:74

[8] Avwiri, G.O.; Osimobi, J. C. and Agbalagba, E.O. (2012). Evaluation of Radiation Risk Indices and Excess Lifetime Cancer Risk Due to Natural Radioactivity in soil profile of Udi and Ezeagu Local Government Region of Enugu State, Nigeria. *Journal of Environmental and Earth Sciences*, **(1)**:1-10.

[9] Hossain, M. K.; Hossain, S. M.; Azim, R. and Meaze, A. M. (2010). Assessment of Radiological Contamination of Soils Due to Ship breaking Using (HPGe) Digital Gamma-Ray Spectrometry System. *Journal of Environmental Protection*, **1(1)**: 10-14.

[10] Hussain, H. H.; Hussain R. O.; YousefR. M. and Shamkhi Q.(2010). Natural radioactivity of some local building materials in the middle Euphrates of Iraq. *Radio analytical and Nuclear Chemistry*, **284(1)**:43–47.

[11] EL-Taher, A.; and Makhluf, S. (2010). Natural radioactivity levels in phosphate fertilizer and its environmental implication in As suit governorate, Upper Egypt .*Indian Journal of Pure & Applied Physics*,**48(2)**:697-702.

[12] Veiga, R. (2006). Measurement of natural radioactivity in Brazilian beach sands. *Radiation Measurements*, **41(3**):189-196.

[13] Mehra , R.; Singh, S. and Singh, K. (2009). Analysis of ^{226}Ra, ^{232}Th and ^{40}K in soil samples for the assessment of the average effective dose, *Indian Journal of Physics*, **83(7):**1031-1037.

[14] Knoll , G. (1999). Radiation Detection and Measurement. John Wileysonspp. 234.

[15] Tennelec, R. (1988). High – Purity Coaxial Germanium Detector Systems. *Health Physics*, **50(6**):13.

[16] Cottens, E. (1990). Effect of Radioactive Minerals Potentiality and Primordial Nuclei Distribution on Radiation Exposure Levels within Muscovite Granite, WadiNugrus, Southeastern Desert, Egypt. In Proceeding of the Symposium on SRBII, Journey Radon , Royal Society of Engineers and Industrials of Belgium. Journal of Geosciences and Environment Protection**, 4(1):**62-78.

[17] United Nations Scientific Committee on the Effects of Atomic Radiation. (2000). Sources and Effects of Ionizing Radiation. *General Assembly*, 1.

[18] Bunzl, K.; Kracke, W.; Schimmack, W. and Zelle, L. (1998). Forms of fallout ^{137}Cs and $^{239+240}$Pu in successive horizons of a forest soil, *Journal of Environmental Radioactivity*, **39(1):**55-68.

تقييم تراكيز النويدات المشعة، معاملات الخطورة والجرعة السنوية في ترب مناطق سكنية وزراعية لمدينة كركوك

بيريفان محمد عبدالله ، صباح محمود امان الله
قسم الفيزياء ، كلية التربية للعلوم الصرفة ، جامعة كركوك ، كركوك ، العراق

الملخص

إن الهدف من الدراسة الحالية هو قياس الفعالية الإشعاعية النوعية وحساب معاملات الخطورة والجرعة السنوية في نماذج الترب المنتخبة لمناطق سكنية وزراعية لمحافظة كركوك باستخدام التقنية الطيفية لكاشف الجرمانيوم عالي النقاوة (HPGe). حيث تم جمع عشرة عينات بعمق (20) سنتيمتر من التربة لتلك المناطق. بينت الدراسة الحالية أن نتائج النشاط الإشعاعي لنظائر الراديوم ^{226}Ra والاكتنيوم ^{228}Ac و البوتاسيوم ^{40}K في هذه العينات تتراوح (27.6±4.1-43.3±5.4) بيكرل\كغم بمعدل (32.86±4.95) بيكرل\كغم و (12.4±0.8-28.12±4.2) بيكرل\كغم بمعدل (20.492±2.77)بيكرل\كغم و (225±9.2-327±12.1) بيكرل\كغم بمعدل (268.76±9.06) بيكرل\كغم على التوالي. مكافئ الراديوم Ra_{eq} كان (63.966-92.759) بيكرل\كغم ومعامل تركيز الفعالية الإشعاعية (I_γ) يبلغ (0.469-0.666) بيكرل\كغم، معاملات الخطورة الداخلية والخارجية بلغت (0.247378−0.366280) بيكرل\كغم و (0.172784-0.249254) بيكرل\كغم على التوالي, قيم الجرعة الممتصة بواسطة الهواء (D_γ) (30.332-43.185) نانوگري\ساعة، بينما الجرعة الفعالة الداخلية والخارجية السنوية بلغت (0.148797-0.220033) ملي سيفرت\سنة و (0.037199-0.052963) ملي سيفرت\سنة على التوالي. تُظهر مقارنة النتائج الحالية توافقًا جيدًا مع القيم القياسية المقبولة ولم تتعدى القيم المسموحة لمنظمة الصحة العالمية (WHO) ولا توجد تأثيرات سلبية لهذه المعاملات على الصحة والبيئة والزراعة.