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Assessment of Alpha-Decay Products and Their Correlation with Lung Cancer Risk in Some Selected Districts in the Kurdistan Region, Iraq (Oil & Gas Block)

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ABSTRACT

This study is investigating the relation between the soil sample alpha-decay and lung cancer risk from selected districts in the Garmian zone, Kurdistan region, Iraq. The presence of the oil and gas blocks is due to the geological properties of the zone. Also, the formation of the zone consists of the lower Fars that contain naturally occurring radioactive materials in the environment. The samples were collected from 41 locations across 27 districts, the samples were prepared and analyzed by an alpha spectrometer to determine the alpha decay activity concentration. The results define that the activity ranged from 4.19 Bq/m^3 to 179 Bq/m^3 with an average of 32.4 Bq/m^3. The lung cancer cases per year per million people range from 2- 37 cases. This article determines the importance of analyzing soil radioactivity as a factor in the environment to the health risk. This research results underscore the need for more studies to improve the effectiveness of the alpha- decay from natural radionuclides to inform the risk that is associated with public health.

Keyword: Alpha decay, GMC Geiger, Garmian zone, lung cancer risk, radon, soil.

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1. INTRODUCTION

Radon is a radioactive material that is one of the uranium daughters that comes after some series of decays with different levels of activity. It can occur in rocks that include uranium. Many kinds of rocks may consist of higher levels of activity. such as volcanic rock, dark shale, granite, sedimentary rocks that include phosphate, and metamorphic rocks[1]. Radon, as a physical property, has three main isotopes with three different half-life's, such as ^{219}Rn with $T_{1/2}$ = 3.96 sec, ^{220}Rn-$T_{1/2}$ = 5.6 sec and ^{222}Rn-$T_{1/2}$=3.823 days that are three main radon isotopes in 40 known isotopes up to today[2, 3]. All radon isotopes naturally decay into alpha particles[4], which include two protons and two neutrons also known as helium nuclides. After alpha decay, radon nuclei will be unstable, known as excitation for that purpose, our nuclide should spread out that energy to stabilize, which is a fundamental physics rule that energy, which is spread out, comes from the nuclear shell's transition, and the radiated energy is equal to the difference between the upper and lower states in terms of electromagnetic waves or gamma rays in a more accurate concept[5], so each sample has its own radiation levels, which depend on the concentration of radon[6]. The process of sampling measurement starts with take a sample on the surface of earth crust from 0-10 cm because geological formation of this region represents the Early- Middle Jurassic formation which is nearly consist same soil structure or a little difference that may produce a difference in radon gas concentration because first 10 cm had higher spread out than deeper[7], and crushing samples into a smaller size as possible with maximum five-minute store and preparing to test by Rad 7 detector in four cycles which is each cycle need 20min to measure the activity of radon and print the output after each sample 5-10 minute cleaning(purge) of a test chamber, during a sampling process the Geiger counter GMC-500 Plus has been used as well, and samples weights are from 130 to 145g, which depends on the soil structure. The minimum readout result is 4.19 Bq/m^3 on average, and the maximum is around 179 Bq/m^3 on average, by Rad7, but the Geiger counter directly gives an amount of radiation in ($\mu Sv/h$ or microsieverts per hour), but it's for total radiation, which comes from all sources, so we can determine the radon effect, which is the radon radiation level that has its own biological effect. Radon, known as a chemical element, has the Rn symbol with an atomic number of 86 and a 222.0 atomic mass with 87 protons and 136 neutrons, known as a radioactive gas in a noble family without any color, and it's in a gas phase[8], and its

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density is around 9.73g/cm^3 in normal situations and 4.4 $g/cm^3$when it's in a liquid phase. The melting point of radon-222 is around 202 K, and the boiling point is around 211.5 K[9]. Radon has 86 electrons with a full outer shell, and (2, 8, 18, 32, 18, 8) is the electron order per shell of radon[8], which has six periods[4, 10]. Radon, a common compound, is radon fluoride gas and is considered a health hazard[11]. Radon as a radioactive material naturally originates through uranium's long series after 14 transformations over several billion years, and the uranium series ends with lead-206. Now the word father for radon is radium-226 after decay[12], an alpha particle terminates to radon-222 in a 1600-year half-life[13]. The decay of a particle inside of high atomic number elements is a very complicated process known as the tunnel effect, and radon with a (222 amu) atomic mass has strong potential, and its alpha particle has (5.49 MeV)[14], so it's difficult to spread out, personally I'm saying it's teleportation, but it's a tunnel effect, and that is a reason to make the daughter element unstable. Then the target of our work is the Garmian zone in Sulaymaniyah city and the location of the Garmian zone has been shown in Fig-1[15], and we were going to analyze the radon concentration in the 27 different human living locations by 41 samples. After the determination of the radon concentration the average of different samples in the same area will be calculated to determine the total effect on the people that are living there. By radon concentration other parameters can be count such as annual effective dose, potential alpha energy concentration, exposure of radon progeny and lung cancer cases per year per million people because radon is in the gas phase have ability to move into human lungs during the breathing cycle. All these parameters will be calculated for total samples after that the average will be calculate per each different area. Garmian zone is a key zone between Iran, Iraq and the Kurdistan region, also the Garmian zone includes many oil and gas reserves and we are going to detail more in the study zone section[1]. Also, Garmian zone is known for significant gas and oil reserves, with more than 20 billion barrels of oil that produce 23,000 barrels per day and Garmian waste gas to power plant project over a 165 MW facility, which uses flare gas from oil to generate electricity. The main foreign investment is back to Gazprom Neft, which is highly operational in Garmian zone in Iraq. Also, Garmian zone includes multiple tourist locations such as Sherwana castle, Darbandi Khan lake and Kifri's Sara building[16-18].

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2. STUDY ZONE

Radon gas is a radioactive material that exists in nature for radiation mapping purposes we should determine the natural radiation of an area where humans live there and the main aim of the determination is to deal with the areas that humans are in touch with, and Garmian located in (62 km) south of Sulaymaniyah city and (102 km) east of Kirkuk city, 41 samples have been taking from some selected district from Bani Khelan to Gulajo and samples have been taking inside or close to the human living areas along (86.7 km) which include many villages and towns and Kalar city. For more information, the elevation of Garmian in generally close to 231 m and is known as hot area[7, 19]. The position shown in Fig. 1 may or may not be in the exact place on the map. The Kurdistan region of Iraq is located in the Middle east of Asian continent, and the geological

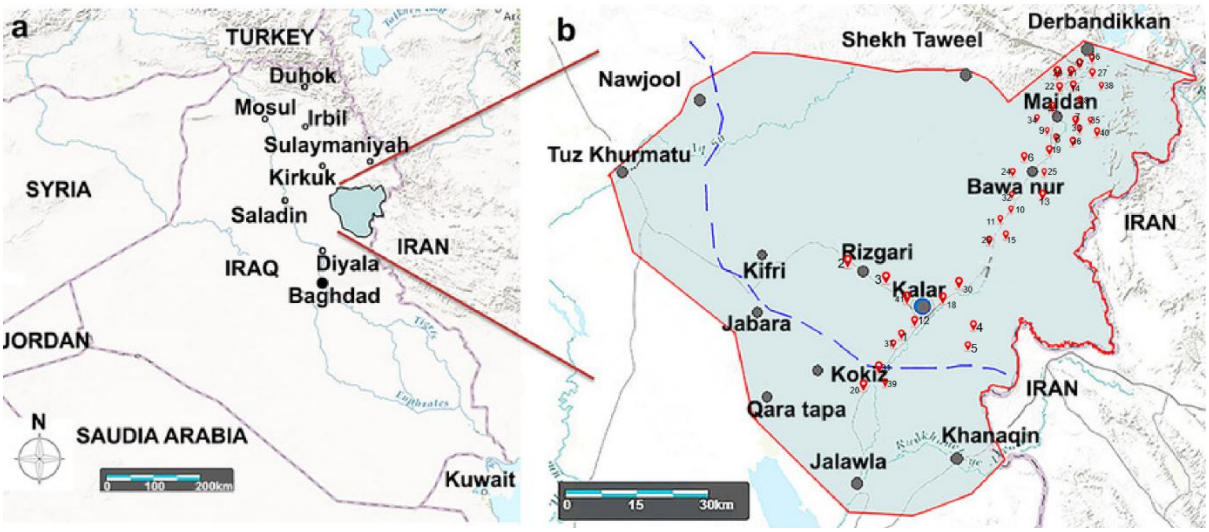

Figure 1. study region and sample's exact locations.

property of Kurdistan has been part of the Kurdistan region of Iraq which is known as the hot and dry zone which is land that is produced or formed by the stretching of tectonic plates, as shown in Fig.1 our targets are clean location and in general are a human living area, the samples location name, their coordinates shown in table.1(A, B) which are exact position and samples has been taken on the exact coordinate, in general, that location shows the most of the district that human living there and has direct interaction with them to analyze the interaction or the effect of the radon(^{222}Rn) gas on the human body by biological effect. Then Garmian include many oil and gas

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reserves such as Saraqala field, Chia Surkh block, Kor Mor block and Qara Hanjir block. Kor Mor field produces huge amount of natural gas, condensate and LPG (liquefied petroleum gas).

Table 1. part A of the samples name and its coordinates.

No.	Samples name	Latitude (degree) N	Longitude (degree) E	No.	Samples name	Latitude (degree) N	Longitude (degree) E
01	Shekh Langari Taza	34.5575637	45.2492929	**13**	Bawanur 4	34.8161152	45.5108743
02	End Rizgari	34.6574766	45.2341627	**14**	First Taza De 2	34.9815935	45.6010840
03	Begin of Rizgari	34.6461434	45.2780093	**15**	Qula Sutaw	34.7194657	45.4583925
04	End Salh Agha	34.5762560	45.3487334	**16**	Bani khelan 1	35.0655409	45.6682047
05	Begin of Salh Agha	34.5730025	45.3386956	**17**	Bani khelan 3	35.0655431	45.6575938
06	Bawanur 1	34.8331376	45.5182537	**18**	Begin of kalar	34.6477518	45.3506498
07	Maidan 2	34.9165522	45.6201047	**19**	Lawawan 2	34.8758884	45.5389044
08	Lawawan 1	34.8738001	45.5384491	**20**	Gula jo	34.4693425	45.1707672
09	Awa Khery	34.8903364	45.5617233	**21**	Tuni Baba 1	35.0454851	45.5854568
10	Qula barz	34.7876197	45.4861112	**22**	First Taza De 1	34.9797444	45.6031597
11	Esayi	34.7655481	45.4643957	**23**	Pebaz 2	34.9331212	45.6089882
12	Grda Gozina	34.5807630	45.2812400	**24**	Bawanur 3	34.8237046	45.5109122

Also, there are many tourists' location inside Garmian zone such as Sherwana castle, Tuni Baba, Kifri's Sara building, Darbandi Khan lake and Sirwan river, et al. the Kalar city is a central of the Garmian zone, which is known as very strong economy city in Iraq especially in Kurdistan region, because is it close to the Bashmakh border that all transferring between Iran- Iraq- Kurdistan passing though Garmian zone especially Kalar city such as building material, oil, gas, food, vegetable, cars, motorcycle, plastics for house needy, also clothes, factories required material such as lime, dolomite, many types of carbon, silicon, manganese and et al. all required stuff that transfer between two countries are passing though Garmian zone.

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Table 1. part B of the samples name and its coordinates.

No.	Samples name	Latitude (degree) N	Longitude (degree) E	No.	Samples name	Latitude (degree) N	Longitude (degree) E
25	Bawanur 2	34.8291958	45.5123550	**34**	Pebaz 1	0.155	1.240
26	Second Taza De	34.6967575	45.4274512	**35**	Maidan 1	0.141	1.128
27	Bani Khelan 2	35.0635881	45.6636224	**36**	Azadi 2	0.195	1.560
28	Tovga	34.9396567	45.6248233	**37**	Shekh Langari Kon	0.124	0.992
29	Tuni Baba 2	35.0326130	45.6116466	**38**	Aawbar	0.158	1.264
30	Barlut	34.6700733	45.4068810	**39**	Banasiaw	0.130	1.040
31	Qarabulagh	34.4906952	45.1912469	**40**	Baqubara	0.121	0.968
32	Mahmoudia	34.8065085	45.5014185	**41**	Center of Rizgari road	0.130	1.040
33	Azadi 1	34.9014780	45.6072407				

3. MEASUREMENT OF RADON

Soil samples are prepared as small as possible to release a radon gas quickly inside the desiccant which is closed to cut off any exchange between the environment and inside of the desiccant to directly measure the radon gas which is spread out by our samples[20], and in the connection between desiccant and Rad7 the point of heavy gas much be consider and connect the inlet to the down pass to pull the radon gas into the detector tank as shown in Fig.2[21], and connect the outlet to the upper pass of the desiccant to continue that process during the cycles each cycle in our detector requires twenty minutes we prefer to set up the device to the highest cycles possible to give more data and better average results for that aim four cycles has been used which is mean one hour and twenty minutes for each sample, during exchange the samples 5-10 minute used for cleaning the detector tank to remove all radiation sources inside the detector medium that gives more accurate result which is decrease the data confusion between two samples or more that process known as purge in Rad7, between the inlet junction of the device and the down pass of

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desiccant the small drying tube must be connect to clean airflow. The inside process is based on a semiconductor which is a silicon photodiode connected directly to the high-voltage divider circuit around (-3000 volts) and then connected to the amplifier circuit[22, 23],

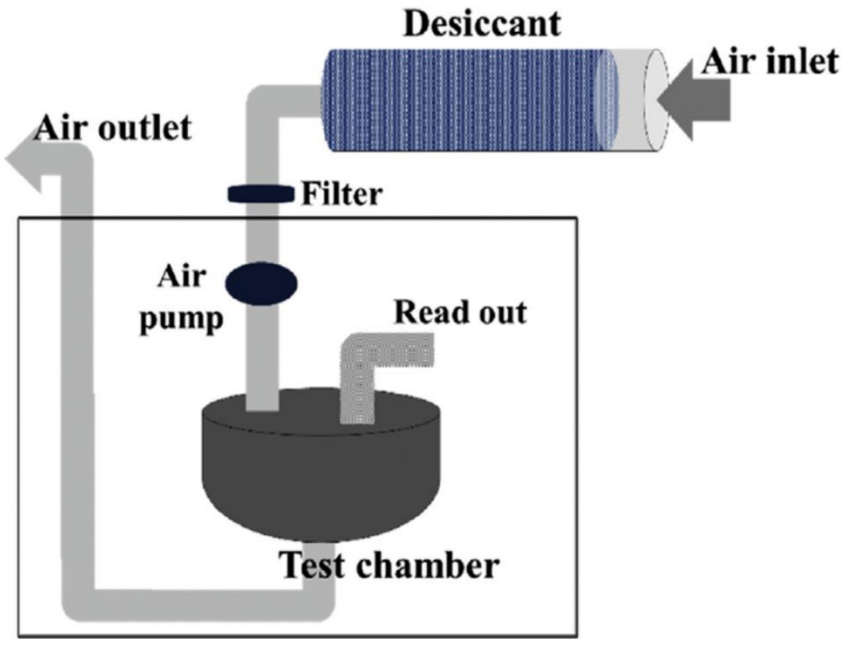

Figure.2 the internal structure and external connection of Rad7 device ideally.

which is ended by a printer or computer connection to read out the result cycle by cycle and then gives the spectrum and average value of radon activity concentration in air (Bq/m^3)[24].

4. EFFECT CALCULATION

The annual effective dose (AED) which has (mSv/y)[24], refers to the amount of radiation energy that absorb by a person in one year.

$$AED(mSv/y) = C_{Rn} \times F \times H \times T \times D \quad (1)$$

Where, C_{Rn} is radon concentration, F is an equilibrium factor (0.4), H refers to the occupancy factor (0.8) that shows the interaction between radiation and a person in 24h, T is a time in hours per year (8760 h/y) and D is a dose conversion factor ($9 \times 10^{-6} \frac{mSv}{Bq.h.m^{-3}}$).

The potential alpha energy concentration (PAEC)[25] that refers to the total energy of alpha particle, which is released by short- lived radon progeny.

$$PAEC\ (WL) = F \times C_{Rn}/3700 \quad (2)$$

The exposure of Radon progeny(E_P)[26], which refers to the total potential alpha energy from radon progeny decay products that exposed to a person over a specific time.

$$E_P = T \times H \times F \times C_{Rn}/(170 \times 3700) \quad (3)$$

The lung cancer cases per year per million people (CPPP)[27], it's an epidemiological measure that used to compare lung cancer risk for different districts.

$$CPPP = AED \times (18 \times 10^{-6} mSv^{-1}.y) \quad (4)$$

The Total Dose[28], it's a sumation of all radiation doses an object absorb from all radionuclides over all time of exposure.

$$D_t = D_r \times T \quad (5)$$

This calculation is related to measurement of dose rate by portable Geiger detector in the sampling field. These calculations are to determine the radon effect on the human body which has different side effects on human cells that can be a cause of biological modification or hold the effect inside the parents to the new generation, higher radiation levels may pose a risk to the human body cells cause to growing abnormally. The WHO is recommended lower than (100 Bq/m^3) as normal range for radon concentration[29]. Where, D_t is total dose (μGy), D_r is dose rate (μGy/h) and T is time of people that spend it in thus districts (h). let us suppose that people spend 8 hours is each district that we measured. The total dose is a special equation that refer to the total radiation that detected by portable detector in the field during sampling process directly to determine the effect of the total radiation on the human body that spend 8 hours in outside.

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5. THE RESULTS & DISCUSSION

The alpha decay that radiates from radon gas is a natural radiation type that refer to interaction with the human body and going inside the human lung during breathing cycle, and it cause the lung cancer with a probability. The alpha decay travel distance is about (1- 4 cm) because of the particle mass and its charge that cause the high ionization interaction with its surrounding while its radiate, alpha have huge amount of interaction that may produce a high number of ionization during that small distance of travel that is the most demagogue reason while an element decay alpha particle inside the human body, our target is deal with radon that is in a gas phase.

Table 2. the samples name and its results according to the Geiger portable counter.

No.	Samples name	CPM	D_r (µSv/h)	D_t (µSv)	No.	Samples Name	CPM	D_r (µSv/h)	D_t (µSv)
01	Shekh Langari Taza	53	0.150	1.200	**22**	First Taza De 1	31	0.088	0.704
02	End Rizgari	47	0.133	1.064	**23**	Pebaz 2	40	0.113	0.904
03	Begin of Rizgari	39	0.110	0.880	**24**	Bawanur 3	56	0.158	1.264
04	End Salh Agha	30	0.085	0.680	**25**	Bawanur 2	61	0.172	1.376
05	Begin of Salh Agha	74	0.209	1.672	**26**	Second Taza De	38	0.107	0.856
06	Bawanur 1	42	0.119	0.952	**27**	Bani Khelan 2	26	0.073	0.584
07	Maidan 2	52	0.147	1.176	**28**	Tovga	53	0.150	1.200
08	Lawawan 1	59	0.167	1.336	**29**	Tuni Baba 2	50	0.141	1.128
09	Awa Khery	35	0.099	0.792	**30**	Barlut	50	0.141	1.128
10	Qula barz	58	0.164	1.312	**31**	Qarabulagh	44	0.124	0.992
11	Esayi	63	0.178	1.424	**32**	Mahmoudia	47	0.138	1.104
12	Grda Gozina	64	0.181	1.448	**33**	Azadi 1	59	0.167	1.336
13	Bawanur 4	37	0.104	0.832	**34**	Pebaz 1	55	0.155	1.240
14	First Taza De 2	56	0.158	1.264	**35**	Maidan 1	50	0.141	1.128
15	Qula Sutaw	45	0.127	1.016	**36**	Azadi 2	69	0.195	1.560
16	Bani khelan 1	44	0.144	1.152	**37**	Shekh Langari Kon	44	0.124	0.992
17	Bani khelan 3	65	0.184	1.472	**38**	Aawbar	56	0.158	1.264
18	Begin of kalar	41	0.116	0.928	**39**	Banasiaw	46	0.130	1.040
19	Lawawan 2	38	0.107	0.856	**40**	Baqubara	43	0.121	0.968
20	Gula jo	52	0.147	1.176	**41**	Center of Rizgari road	46	0.130	1.040
21	Tuni Baba 1	48	0.136	1.088	Normal Ranges		2- 50	0.03- 0.33	0.24- 2.64

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which is going inside the human lung and cause the most serious damage inside it and determine the annual effective dose, alpha decay energy and its effect or lung cancer cases per year per million people, before all of this the normal range for all these parameter must be calculated according to the WHO standard that put less than (100 Bq/m^3) for normal range and we are going to determine the other normal ranges by Eq. (1- 4) for other parameters, because except the radon concentration all other parts of the equations are constant. The results according to the GMC Geiger counter will be shown in table (2) and the normal ranges are determined by the detector guide card that determine the limits for the radiation measurements and count per minutes. The normal range for count per minute is between (2-50), normal range for dose rate is between (0.03- 0.33 μSv/h) and by eq. (5) we are going to determine the normal ranges for a total dose, which is between (0.24-2.64)[30]. then table (2) shows all samples information according to the Geiger counter in the field during the sampling process and the total dose according to the Eq. (5).

Table 3. determine the parameters that refer to the GMC Geiger counter for each district.

Number	Locations name	CPM	D_r (μSv/h)	D_t (μSv)
1.	Bani Khelan	45	0.134	1.069
2.	Aawbar	56	0.158	1.264
3.	Tuni Bana	49	0.139	1.108
4.	First Taza De	44	0.123	0.984
5.	Pebaz	48	0.134	1.072
6.	Tovga	53	0.150	1.200
7.	Maidan	51	0.144	1.152
8.	Baqubara	43	0.121	0.968
9.	Azadi	55	0.181	1.448
10.	Awa Khery	35	0.099	0.792
11.	Lawawan	48	0.137	1.096
12.	Bawanur	49	0.138	1.106
13.	Mahmoudia	47	0.138	1.104
14.	Qula Barz	58	0.164	1.312
15.	Esayi	63	0.178	1.424
16.	Qulasutaw	45	0.127	1.016
17.	Second Taza De	38	0.107	0.856
18.	Barlut	50	0.141	1.128
19.	Begin of Kalar	41	0.116	0.928
20.	Rizgari	44	0.124	0.995
21.	Grda Gozina	64	0.181	1.448
22.	Salih Agha	52	0.147	1.176
23.	Shekh Langari Taza	53	0.150	1.200
24.	Shekh Langari Kon	44	0.124	0.992
25.	Banasiaw	46	0.130	1.040
26.	Qarabulagh	44	0.124	0.992
27.	Gulajo	52	0.147	1.176
Normal ranges		5-50	0.03-0.33	0.24-2.64

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Also, table (3) shows the total detection by GMC Geiger counter for each district, which is a collection of detection and measurement of each district with different samples. The number of districts in Garmian zone is too much but the main ones are around 27 districts that we analyzed for alpha decay from radon gas in the soil samples, and the detection of total radiation by a portable detector is the method that important for pre-analyzation for each district because it tells where is the main problem and the amount of dose as well. To more clarification the normal ranges has been taken from the guide card with the portable detector for count per minute and dose rate but the total dose has been calculated with some other constant numbers on the guide card and the equation requirement. But the effect of the radiation can't be determined with the portable Geiger counter because it doesn't determine the type of radiation, it makes harder to determine the effect of the radiations because each type of radiation has different properties with different calculation and different constants.

Table 4. determine the radon activity for each sample in Garmian zone.

NO.	Name of locations	A_{Rn} (Bq/m^3)	NO.	Name of locations	A_{Rn} (Bq/m^3)	NO.	Name of locations	A_{Rn} (Bq/m^3)
1	Shekh Langari Taza	18.70	**15**	Qulasutaw	29.30	**29**	Tuni Baba 2	14.60
2	End Rizgari	16.60	**16**	Bani khelan 1	45.80	**30**	Barlut	25.00
3	Begin of Rizgari	27.10	**17**	Bani khelan 3	20.90	**31**	Qarabulagh	25.10
4	End Salh Agha	33.40	**18**	Begin of kalar	35.40	**32**	Mahmoudia	04.19
5	Begin of Salh Agha	27.10	**19**	Lawawan 2	29.20	**33**	Azadi 1	41.60
6	Bawanur 1	29.30	**20**	Gula jo	12.50	**34**	Pebaz 1	18.90
7	Maidan 2	52.20	**21**	Tuni Baba 1	18.80	**35**	Maidan 1	22.90
8	Lawawan 1	56.10	**22**	First Taza De 1	43.90	**36**	Azadi 2	08.38
9	Awa Khery	22.90	**23**	Pebaz 2	45.60	**37**	Shekh Langari Kon	14.60
10	Qula barz	68.80	**24**	Bawanur 3	12.50	**38**	Aawbar	14.70
11	Esayi	29.20	**25**	Bawanur 2	18.70	**39**	Banasiaw	68.90
12	Grda Gozina	31.30	**26**	Second Taza De	14.50	**40**	Baqubara	20.80
13	Bawanur 4	27.00	**27**	Bani Khelan 2	179.0	**41**	Center of Rizgari road	37.30
14	First Taza De 2	27.10	**28**	Tovga	37.50	Normal range		≤ 100

The table (4) shows the alpha decay concentration from radon gas in soil for each sample with their sample's location name. the normal range is referred to the World Health Organization

(WHO) and other parameters normal range has been calculated from same normal range for activity concentration of alpha decay from radon gas in the soil sample. The activity of the alpha decay in thus districts, which are high in some location is refers to the geological formation of thus districts, which is lower Fars (Fatha formation) that consist sedimentary rocks such as Marl, Limestone and Anhydrite that contain amount trace of Uranium and Thorium, while this two elements decay, they produce the radium over a year's then radium decay to the radon isotopes like hazardous one radon-222. Table (5) shows the districts name, radon gas activity, annual effective dose, potential alpha energy, exposure of radon progeny and lung cancer cases per year per million people in average for each district with different samples that have been calculated by Eq. (1-4).

Table 5. determine activity concentration, annual effective dose, potential alpha energy, exposure of radon progeny and lung cancer cases per year per million people for each district in Garmian zone.

No.	Name	Mean of C_{Rn} (Bq/m^3) in Avg.	AED (mSv/y)	PAEC ($WL*10^{-3}$)	E_P (WLM/y)	CPPP ($x*10^{-6}$)
1	Shex Langari Kon	14.60	0.368	1.578	0.065	6.624
2	Shex Langari taza	18.70	0.472	2.021	0.083	8.496
3	Rizgari	27.00	0.681	2.919	0.120	12.258
4	Salh Agha	30.25	0.763	3.270	0.135	13.734
5	Bawanur	21.88	0.552	2.365	0.098	9.936
6	Maidan	37.55	0.947	4.059	0.167	17.046
7	Lawawan	42.65	1.076	4.610	0.190	19.368
8	Awa Khery	22.90	0.578	2.476	0.102	10.404
9	Qula Barz	68.80	1.736	7.438	0.307	31.248
10	Esayi	29.20	0.737	3.157	0.130	13.266
11	Grda Gozina	31.30	0.790	3.384	0.139	14.220
12	First Taza De	35.50	0.896	3.838	0.158	16.128
13	Qula Sutaw	29.30	0.739	3.168	0.131	13.302
14	Bani Khelan	81.90	2.066	8.854	0.365	37.188
15	Begin of Kalar	35.40	0.893	3.827	0.158	16.074
16	Gula jo	12.50	0.315	1.351	0.056	5.670
17	Tuni Bana	16.70	0.421	1.805	0.074	7.578
18	Pebaz	32.25	0.813	3.486	0.144	14.634
19	Second Taza De	14.50	0.366	1.568	0.065	6.588
20	Tovga	37.50	0.946	4.054	0.167	17.028
21	Barlut	25.00	0.631	2.703	0.111	11.358
22	Qarabulagh	25.10	0.633	2.714	0.112	11.394
23	Mahmoudia	04.19	0.106	0.453	0.019	1.908
24	Azadi	24.99	0.630	2.702	0.111	11.340
25	Awbara	14.70	0.371	1.589	0.066	6.678
26	Bnasiaw	68.90	1.738	7.449	0.307	31.284
27	Baqubara	20.80	0.525	2.249	0.093	9.450
Normal ranges		≤ 100	≤ 2.5	≤ 10.81	≤ 0.45	≤ 45

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All the districts where safe according to the WHO normal ranges, but there are three districts with highest activity compare to other like Qula Barz village, Bani Khelan town and Bnasiaw village, which are way above others. The Geiger counter shows there are some locations that have more count per minute than normal range but as we can see it doesn't refer to the alpha decay because as we can see in table (5) all these districts are in the normal range, then it shows that may consist to other type of radiation such as beta and gamma. The results in table (5) clarify the discussions that most lung cancer cases per year per million people because of alpha decay from radon gas concentration that in the normal range but still are high in some districts such as Qula Barz village, Bani Khelan town and Bnasiaw village with 31, 37 and 31 lung cancer cases per year per million people. Fig. (3) is clarifying the lung cancer cases per each district.

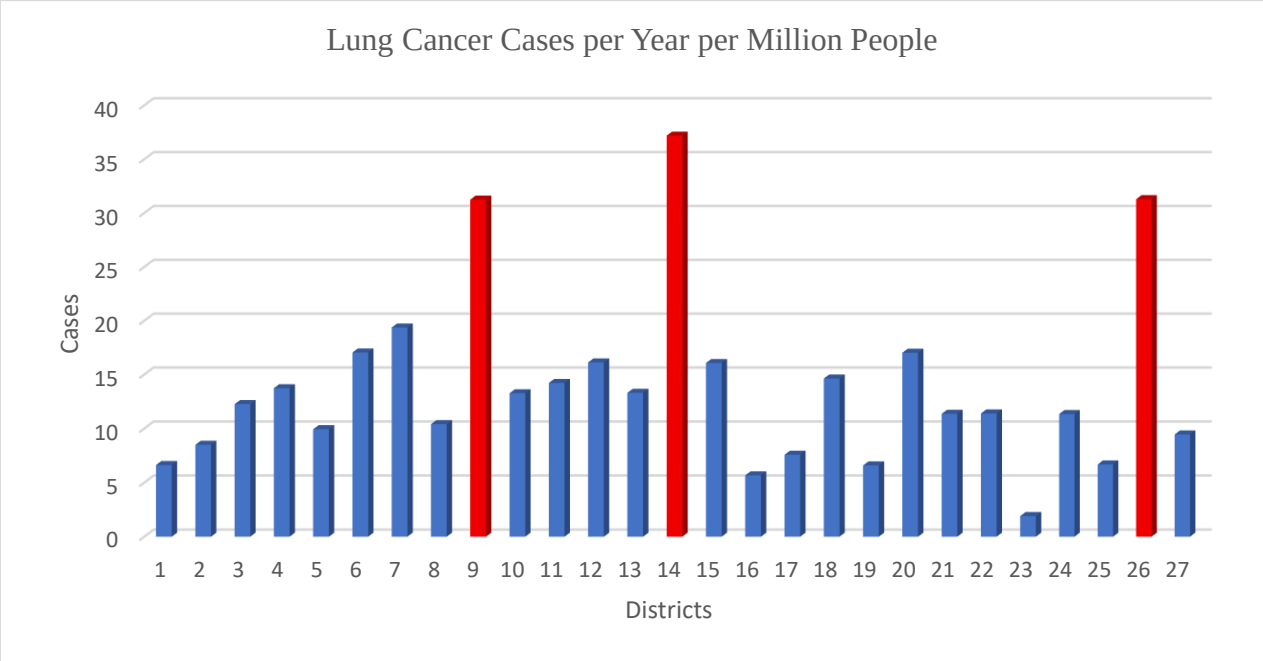

Figure 3. shows the lung cancer cases per year per million people according to the alpha decay from radon gas in soil sample.

6. Conclusion

Garmian is one of the most important zones in the Kurdistan region of Iraq, and many people are living there in different locations. We were going to check all areas where humans living there, the results were all healthy mostly below the normal range to samples but while getting average to different samples of the same area the results were great and below the normal range totally, also Qula Barz village, Bani Khelan town and Bnasiaw village has the highest level of radon concentration, but still below the range. On the other hand, there is Mahmoudia, much below the range. Radon is in the gas phase, which interacts with the human lung while they are breathing leaving damage inside it, and the determination of lung cancer probability was required, but it was low and below the standard range worldwide as we determined the highest result location of affection Qula Barz village, Bani Khelan town and Bnasiaw village and lower once is Mahmoudia but still, all of them under the range. Finally, we can say the Garmian zone is mostly safe to avoid the radon gas effect. As we know the radiation type is alpha particle with (1-4 cm) range of distance that depend on the potential alpha energy of the radiation, which is determine the travel range of the radiation.

Note

All authors declare that they have no conflict of interest.

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There are non-conflicts of interest.

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