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Biological Effects of Background Radiation and Their Risk of Humans

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ABSTRACT

Background: Exposure rate measurements of the natural background radiation are found in some selected locations of the university of Kufa in Najaf city, Iraq.
Materials and Methods: The experimental results of this study are using a G-M survey meter [SEI Inspector EXP (Digital Radiation Detector, USA)]. Two radioactive sources (^{137}Cs and ^{60}Co) are used to calibrate the G-M exposure rate meter.
Results: The most frequently recorded readings of the gamma-ray dose rate were observed between 74 and 93 nGy h^{-1}. The absorbed dose rates are found to be from 55 nGyh^{-1} at Science College (Chemistry Store) to 189 nGy h^{-1} at Science College (Classroom) (mean= 99 nGyh^{-1}).
Conclusions: Meanwhile, absorbed dose rates of background radiation fell within the range reported in other listed regions worldwide. This finding indicates that selected location in the present study has normal values and may not be harmful and have not biological effects on people in this region.

Keywords: Background radiation; Gamma-ray dose; SEI inspector; University of Kufa

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INTRODUCTION

Radiation is in our environment and since the formed Earth. Life has evolved in the presence of a significant level of ionizing radiation. This radiation comes from cosmic, the terrestrial and even from within human bodies. It is in the air, food, water, and the materials used to build homes. Brick and stone homes have higher radiation level than wood homes. The natural radiation that is always present known as "background" radiation [1]. Background radiation levels can vary from one location to the next. A U.S. resident receives an annual radiation exposures from natural source of about 310 mrem. For low levels of exposure, the biological effect is small they may not be detected. The body is repaired damage from radiation, chemicals, and another hazard. Living cells exposed to radiation could: repair themselves, leaving no damage; die and be replaced, and like million of body cells do every day; or incorrectly repair themselves, and resulting in biophysical changes. Data for links between radiation exposure and cancer are based on populations receiving high-level exposure. Cancers associated with high-dose exposure (greater than 5×10^4 mrem) include leukemia, breast, bladder , liver, colon, lung, esophagus, ovarian, multiple myeloma, and stomach cancers [2-4]. The time between radiation exposure and the detection of cancer is the latent period. This period can be many years. However, there are no data to establish a firm link between cancer and dose below 10^4 mrem. The regulations assume any amount of radiation may pose some risk. High radiation doses (greater than 50,000 mrem) tend to kill cells. Low dose damage or alter a cell's genetic code. High doses can kill many cells that

tissue and organ are damaged. This, in turn, may cause a rapid body response called Acute Radiation Syndrome (ARS). The higher radiation dose, sooner effects of radiation was appearing, and the higher the probability of death [5, 6]. However, experts believe that 50% of people would die within 30 days after receiving a dose of 350,000 to 500,000 mrem to the whole body, over a period ranging from a few minutes to a few hours. Genetic effects and cancer are primary health concerns from radiation dose exposures. Cancer would be about 5 times more likely than a genetic effect.

These effects can result from a mutation in the cells of an exposed person that passed to their offspring [1-6]. The radiation exposure in Europe and the United States is 0.5 mSv y^{-1} [7]. This dose may exhibit strong regional variations. Dose rates up to 18 mSv y^{-1} recorded in Germany's Black Forest regions. The highest known exposure dose rate on Earth reported to occur in the following areas: Kerala, India with 26 mSv y^{-1}, Brazil on the Atlantic coast with 120 mSv y^{-1}; and Ramsar, Iran with 450 mSv y^{-1} [7]. The terrestrial radiation dose rates from gamma-rays emitted by naturally occurring radionuclides are influenced by soil types as well as geological and geographical conditions [8]. The previous studies about background radiation are done in different countries. The natural exposure rates in the present study were within the exposure rate range of background radiation in other countries [9-13].

Study area

The university of Kufa is an old Iraqi university located in Najaf governorate, Iraq in coordinates of 32.0302° N, 44.3733° E. It is found in 1987 and comprises 21 faculties as shown in Table 1. Figure 1 shows University of Kufa map.

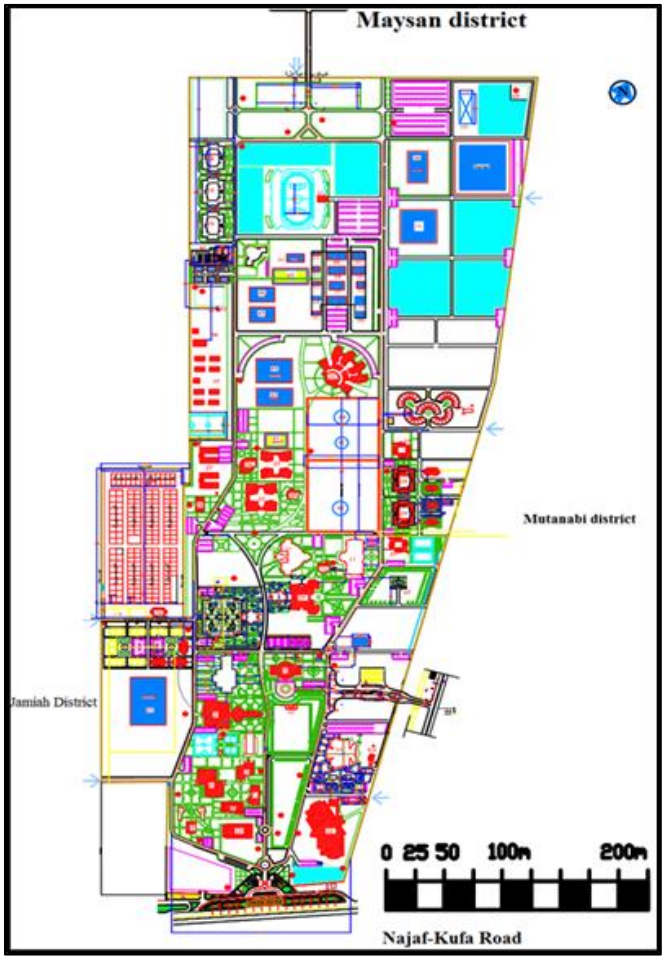

Figure 1: The university of the Kufa map with sampling sites

Table 1: Geographic site of sampling points

SC	Location	Coordinates
L1	University Presidency (Inside)	N32 01 15.3, E 044 22 21.0
L2	University Presidency Gardens (Outside)	N32 01 15.3, E 044 22 21.0
L3	Physical Education College Football Stadium	N32 01 44.0, E 044 22 11.2
L4	Physical Education Basketball Stadium	N32 01 44.0, E 044 22 11.2
L5	Faculty of Physical Education Garden	N32 01 44.0, E 044 22 12.0
L6	Faculty of Physical Education	N32 01 44.0, E 044 22 11.6
L7	University of Kufa (Beside gate) Gateway	N32 01 09.0, E 044 22 21.0
L8	University of Kufa Gateway (Near gate)	N32 01 09.0, E 044 22 21.10
L9	University of Kufa Gateway (Garden gate)	N32 01 09.0, E 044 22 21.8
L10	Faculty Fiqh/ Inside Building	N32 01 12.4, E 044 22 41.3
L11	Faculty Fiqh/ Inside Building	N32 01 12.4, E 044 22 41.8
L12	Faculty Fiqh/ 2nd Floor	N32 01 12.4, E 044 22 41.5
L13	Faculty Fiqh Parking	N32 01 12.4, E 044 22 41.3
L14	Faculty of Engineering Garden/ Classroom	N32 01 45.5, E 044 22 14.9
L15	Faculty of Engineering / Classroom	N32 01 51.9, E 044 22 14.4
L16	Deanship of the Faculty of Engineering Garden	N32 01 49.4, E 044 22 12.7
L17	Faculty of Computer and Mathematics Garden	N32 01 48.8, E 044 22 7.3
L18	Faculty of Computer and Mathematics/ Classroom	N32 01 49.7, E 044 22 15.3
L19	Deanship of the Faculty of Mathematics and Computer	N32 0.1 49.7, E 044 22 16.3
L20	Garden computer center and Internet / Faculty of Engineering	N32 01 48.8, E 044 22 12.0
L21	Nanotechnology Research Unit	N32 01 48.8, E 044 22 9.4
L22	Faculty of Pharmacy Gardens	N32 01 24.6, E 044 22 26.3
L23	Faculty of Pharmacy / Club Student	N32 01 24.1, E 044 22 24.9
L24	Pharmacy College/ Library	N32 01 24.1, E 044 22 24.9
L25	Pharmacy College/ Classroom 4	N32 01 24.1, E 044 22 24.9
L26	College of Nursing/ Biochemical Laboratory	N32 01 24.1, E 044 22 22.0
L27	University clinic	N32 01 27.1, E 044 22 15.8
L28	University Apartments for singles	N32 01 27.2, E 044 22 15.0
L29	University Presidency Gardens (Front)	N32 01 34.3, E 044 22 32.1
L30	Front Faculty of Arts	N32 01 39.1, E 044 22 27.3
L31	Faculty of Arts / Department of Geography	N32 01 39.7, E 044 22 26.6
L32	Geography Dept. Classroom	N32 01 39.3, E 044 22 27.5
L33	Science College (Front Image Processing)	N32 01 41.6, E 044 22 27.8
L34	Science College (Inside Image Processing)	N32 01 41.7, E 044 22 27.9
L35	Science College (Image Processing)	N32 01 42.3, E 044 22 31.0
L36	Guesthouse University of Kufa	N32 01 43.0, E 044 22 34.2
L37	Cultural Scientific Center	N32 01 36.8, E 044 22 27.6
L38	Science College Classroom	N32 01 33.3, E 044 22 22.6
L39	Science College (Back Nuclear Lab.)	N32 01 34.5, E 044 22 17.6
L40	Science College (Environment Lab.)	N32 01 33.8, E 044 22 16.3
L41	Science College (Front Nuclear Lab.)	N32 01 33.4, E 044 22 22.8
L42	Science College (Parking)	N32 01 34.5, E 044 22 17.6
L43	Science College (Chemistry Store)	N32 01 34.5, E 044 22 20.3
L44	Science College (Registration)	N32 01 34.5, E 044 22 20.3
L45	Science College (Adminstrative-2nd Floor)	N32 01 34.5, E 044 22 20.3
L46	Science College (Adminstrative-3rd Floor)	N32 01 34.5, E 044 22 20.3
L47	Science College (Biology Dept. Exam Panel Room)	N32 01 33.8, E 044 22 16.3
L48	Science College (Biology Dept. Scanning Electron Microscope)	N32 01 33.8, E 044 22 16.3
L49	Science College (Classroom)	N32 01 33.8, E 044 22 16.3
L50	Hosting Buildings	N32 01 34.5, E 044 22 20.3
L51	Medical College (Big Garden)	N32 01 34.5, E 044 22 20.3
L52	Medical College (Surgery Lab.)	N32 01 15.3, E 044 22 29.8
L53	Medical College (Laser Unit)	N32 01 15.6, E 044 22 29.4
L54	University Restaurant	N32 01 15.6, E 044 22 29.4
L55	Dental / Laboratory Cancer / Stem Cell Research Laboratory Clinics	N32 01 15.6, E 044 22 29.4
L56	Cancer Research Centre (Medical College Photocopy)	N32 01 15.6, E 044 22 29.4

MATERIALS AND METHODS

Background radiation for fifty-six locations of the University of Kufa in Najaf city, Iraq are surveyed. The experimental results of this study are using a G-M survey meter [SEI Inspector EXP (Digital Radiation Detector - α ß ɤ x, 436 Farm Rd. Summertown, TN, USA)]. Two radioactive sources (^{137}Cs and ^{60}Co) are used to calibrate the G-M exposure rate meter. The SEI Inspector EXP offers maximum performance in a lightweight, rugged solution for using the survey meter in fieldwork. The SEI Inspector EXP is designed for individuals operating in tough environments, such as first responders, miners, and HAZMAT crews. A unit is a small, handheld, microprocessor-based instrument, which offers excellent sensitivity to the low level of gamma, alpha, beta, and x-rays. The digital readout is displayed with a red count light and a beeper sounds with any count detected. Additional features include an adjustable timer, external calibration controls, selectable alert, backlight display, internal memory, built-in efficiencies for common isotopes, and free Observer USB Software. SEI Inspector has external halogen-quenched, uncompensated GM tube with thin mica window, and 1.4-2.0 mg cm^{-2} areal density. The effective diameter of the window is 45 mm (1.77 inch). Radiation symbol on front label and end panel mark the center of the detector.

Selectable Alert Set Range is 0.001 mR h^{-1}- 50 mR h^{-1} at 1m. Pulsating beeper sounds the alert. The adjustable alert level is used for mR h^{-1}, CPM, and µSv h^{-1}. An alarm will sound when in Timer Mode when setting the alarm threshold is reached. The meter will hold at OVER RANGE in fields as high as 100 times the maximum reading. Display update every 3 s. At low background radiation level, the update is the average for the past 30 s period. The timed period for average decreases as the radiation level increases. Backlit 4 digit liquid crystal display with the indicator. Display updates every three seconds with size of 150 x 80 x 30 mm (5.9 x 3.1 x 1.2 in.) and probe: 260 x 70 x 25 mm (10.25 x 2.75 x 1 in). The total gamma ray exposure rates from the soil and inside the building were measured for 5 min at 3 readings per site of 1m above the ground level.

RESULTS AND DISCUSSION

A total of 168 dose rate readings at 1 m from the ground are obtained using a portable survey meter. The most frequently recorded readings of the gamma-ray dose rate were observed between 74 and 93 nGy h^{-1}. The readings are presented in terms of nGyh^{-1} as shown in Table 1. The absorbed dose rates and dose equivalent radiation are found to be from 55 nGyh^{-1} at Science College (Chemistry Store) to 189 nGy h^{-1} at Science College (Classroom) (mean= 99 nGyh^{-1}) and 0.055 µSv h^{-1} to 0.189 µSv h^{-1} (mean= 0.099 µSv h^{-1}) (Table 2).

The mean dose rate in this study is 99 nGy h^{-1} ± 3 nGy h^{-1}. The highest mean dose rate of 189 nGy h^{-1}± 5 nGy h^{-1}, which is about 3 times higher than the world dose rate of 59 nGy h^{-1}, is observed at the Science College (Classroom).

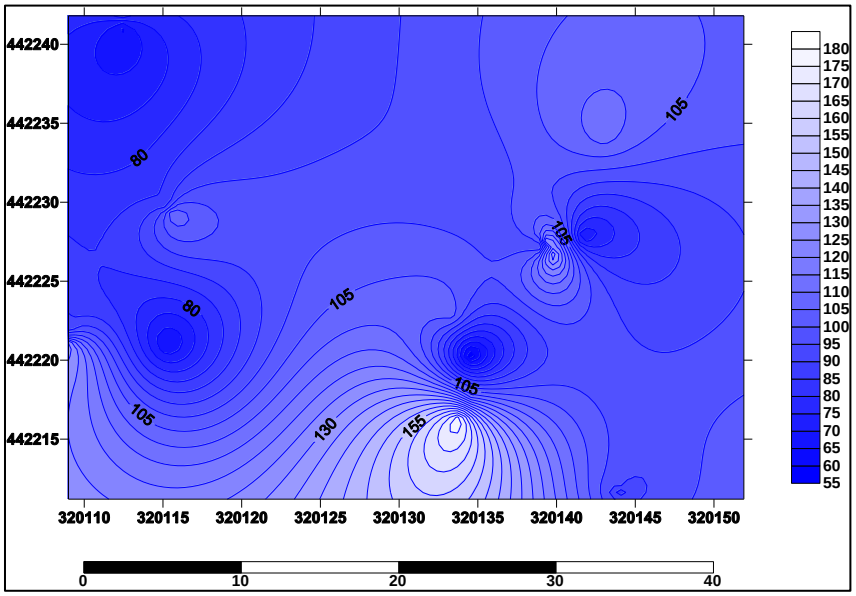

Figure 2: Contour map of dose rate by a dosemeter

Table 2 Gamma-ray dose rate in-situ

SC	Exposure to ionizing radiation (mR h-1) (mR h-1) (µR h-1)			Dose equivalent radiation (µSv h-1)	Gamma absorbed radiation dose (nGy h-1)
	Min.	Max.	Mean	Mean	Mean
L1	0.009	0.014	12	0.104	104.4
L2	0.004	0.01	7.33	0.063	63.8
L3	0.007	0.013	11	0.095	95.7
L4	0.005	0.01	7.33	0.063	63.8
L5	0.01	0.012	11	0.095	95.7
L6	0.008	0.011	9.66	0.084	84.1
L7	0.013	0.017	15.33	0.133	133.4
L8	0.01	0.018	15	0.13	130.5
L9	0.009	0.01	10.66	0.092	92.8
L10	0.005	0.01	7.33	0.063	63.8
L11	0.009	0.011	9.66	0.084	84.1
L12	0.008	0.01	9.33	0.081	81.2
L13	0.008	0.011	9.33	0.081	81.2
L14	0.01	0.012	11	0.095	95.7
L15	0.008	0.015	12	0.104	104.4
L16	0.008	0.014	11.66	0.101	101.5
L17	0.008	0.014	10.66	0.092	92.8
L18	0.014	0.022	17	0.147	147.9
L19	0.01	0.013	11.33	0.098	98.6
L20	0.007	0.014	11	0.095	95.7
L21	0.008	0.011	9.33	0.081	81.2
L22	0.007	0.01	8.33	0.072	72.5
L23	0.008	0.012	10	0.087	87
L24	0.007	0.014	10.33	0.089	89.9
L25	0.008	0.015	11	0.095	95.7
L26	0.007	0.01	8.33	0.072	72.5
L27	0.01	0.011	10.66	0.092	92.8
L28	0.012	0.016	14	0.121	121.8
L29	0.009	0.012	11	0.095	95.7
L30	0.009	0.011	10.33	0.089	89.9
L31	0.014	0.02	16.33	0.142	142.1
L32	0.013	0.017	15	0.13	130.5
L33	0.004	0.013	8	0.069	69.6
L34	0.007	0.011	8	0.069	69.6
L35	0.008	0.011	9.66	0.084	84.1
L36	0.008	0.019	13	0.113	113.1
L37	0.009	0.015	11.33	0.098	98.6
L38	0.007	0.013	10.33	0.089	89.9
L39	0.01	0.019	13.33	0.116	116
L40	0.017	0.025	20.66	0.179	179.8
L41	0.007	0.016	12.33	0.107	107.3
L42	0.012	0.018	15.66	0.136	136.3
L43	0.004	0.008	6.33	0.055	55.1
L44	0.014	0.019	16.33	0.142	142.1
L45	0.008	0.012	9.66	0.084	84.1
L46	0.011	0.019	14.66	0.127	127.6
L47	0.014	0.016	14.66	0.127	127.6
L48	0.006	0.009	7.33	0.063	63.8
L49	0.019	0.026	21.66	0.188	188.5
L50	0.008	0.016	12.33	0.107	107.3
L51	0.008	0.011	9.66	0.084	84.1
L52	0.009	0.011	10	0.087	87
L53	0.007	0.015	12	0.104	104.4
L54	0.012	0.013	12.66	0.11	110.2
L55	0.006	0.013	9	0.078	78.3
L56	0.006	0.009	7.33	0.063	63.8
Min.			6.33	0.055	55.1
Max.			21.67	0.189	188.5
Avg.			11.43	0.099	99.48

The lowest gamma-ray mean dose rate is observed in the Science College (Chemistry Store) at 55 nGy h^{-1} ± 4 nGy h^{-1}, which is lower than the world average. Gamma radiation level measured throughout of Kufa University Campus is conducted in present study. The dose rate contour map is shown in Figure 2. Figure 2. shows the isodose map of gamma radiation dose level measured is drawn to present environmental radiation level distribution in Kufa University. A comprehensive understanding of spatial distribution of dose rate is essential in assessing potential human risk associated with surface soil contamination by radionuclides. It is important for determining gamma radiation dose detriment to the population as a whole.

Table 3 summarizes the natural exposure rate in locations obtained from various regions worldwide and the levels obtained in this study. The natural exposure rates in the present study were within the exposure rate range of background radiation in other listed regions [11-17].

Table 3: Comparison of total of exposure rate (μR h^{-1}) in study area with those in other countries

Location	Exposure Rate
Germany [16]	10.45
Italy [16	8.27
Switzerland [16]	8.5
Ireland [17]	9.42
Iran [13]	14, 13
Kufa University (College of Medicine) [9]	12.6
Babylon and Al-Najaf Cities [17]	7.01, 10.68
Babylon University [10]	20.25
Babylon Government [15]	6.37
Kufa university (Colleges of science and agriculture) [11]	7.68
Najaf regions (Ansar, Hurya, Rashadya) [12]	9.22
Present Study	11.43

CONCLUSION

The most frequently recorded *in-situ* readings of the gamma-ray dose rate occurred between 74 to 93 nGy h^{-1}. The mean dose rate in the study area was 99 nGy h^{-1} ± 3 nGy h^{-1}. The highest mean dose rate of 189 nGy h^{-1}± 5 nGy h^{-1}, which is about 3 times higher than the world dose rate of 59 nGy h^{-1}, was observed in the Science College (Classroom). The lowest gamma-ray mean dose rate was observed in the Science College (Chemistry Store) at 55 nGy h^{-1} ± 4 nGy h^{-1}, which is lower than the world average. The university of Kufa classified as an area of normal background radiation. It's not expected to cause statistically significant radiology health impact on the human body.

ACKNOWLEDGMENT

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