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Radiometric Comparison of Selected Sites in the Southern and Northern Part of the Campus Section of University of Kufa

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Abstract: **In the current study, the Southern and Northern parts of the campus portion of the university of Kufa were used to determine the gamma background radiation dose indoors and outdoors for the chosen region. Utilizing a portable dosimeter survey, "Inspector + (Alert model RAP RS1), S.E. international, (Inc, USA)" measurements were taken. At 51 locations, the mean equivalent dose of natural radionuclides (EADE) was calculated (21 in the south and 30 in the north),using a Geiger-Muller tube with an extremely sensitive gamma detector. The mean $EADE_{total}$ for site soil radiation in the south was 0.3481 mSv.h^{-1}, where was (0.3813) mSv.h^{-1} in the north section. An estimate of health hazards was derived based on average EADE values that were lower than those reported globally in prior research; nonetheless, the results did not identify any significant dangers for students, employees, and faculty of science professionals residing in the analyzed regions. The mean outdoor and intdoor absorbed dose expressed in unit (nGy. h^{-1}) for the southern and northern section, respectively, were (59.52 and 45.78) and (65.186 and 50.14), respectively for north section. According to the findings of the research region, the internationally approved limit of 1.45 10^{-3} for excess lifetime cancer risk (ELCR) was associated with the lowest ELCR, UNSCEAR (2000) advises against exceeding this level because it does not represent a major risk to people.**

Keywords: **Annual Effective dose, experimental dosimeter inspection, absorbed dose.**

I. INTRODUCTION

The soil that makes up the earth's crust can be viewed as a radioactive danger from an environmental standpoint because it continuously exposes people to radionuclides and because, in the case of agricultural soil, it allows radionuclides to contaminate crops and, ultimately, people [1]. The soil-to-plant transfer may be viewed as a significant process since radioactive materials eventually enter human food chains through plant roots. Moreover, natural radioactive decay series can disintegrate in liquid and move to surface water reservoirs, increasing radiation exposure in the general population[2]. This is particularly true when aquatic plants and animals absorb radioisotopes from soil and river debris [3]. The estimated yearly average radioactive exposure from natural sources is 2.4 mSv. Inhaling or ingesting terrestrial and cosmogenic radionuclides, which can be present in the air, water, food, and soil, may result in internal exposure, or direct radiation from both cosmic and terrestrial sources may result in external exposure.[4].

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Simple and terrestrial radionuclides that are common in the earth's oceans, soil, rocks, and water are included in natural radioactivity. Construction materials, which are substantial sources of radiation exposure for individuals, also contain it. People breathe in radionuclides every day and consume them in their food [5]. Numerous researchers worldwide are extremely interested in measuring natural radioactivity in soil, and during the past 20 years, national surveys have been carried out all over the world [6].

Given that soil, one of the most valuable natural resources, is found at the top layer of the earth's crust. Mineral sand, organic matter, water, air, and living things all make up soil [7]. Natural background radiation, which is equivalent to 2.4 mSv per person, accounts for around 80% of the total radiation to which a person is exposed annually [8]. However, no study has been done that relates to locating Gamma background radiation in the air for selected samples in different locations at An-Najaf Governorate [9].

This study set out to assess the gamma background radiation at many carefully chosen sites in the south and north of Kufa University in Iraq. In order to determine the comparable Annual Effective Dose from exterior and interior exposure, as well as the Excess Lifetime Cancer Risk (ELCR) brought on by the presence of gamma background radiation (absorbed indoors and outdoors).

II. EXPERIMENTAL MEASUREMENTS

The measurements were made in February 2022, and 51 locations for campus portion of the university of Kufa various residential areas in southern and northern section were selected. A portable dosimeter survey ["Inspector Alert model RAP RS1, 516ALASADI AND AL-TAWEEL S.E. International, Inc., USA"] was used to measure the amount of gamma background radiation in the chosen areas. A mica window sensitive to Alpha, Beta, and (X-ray and Gamma-ray) is included with this gadget. The German Secondary Dosimeter Laboratory calibrated the G.M. detector. The detector was positioned at least 40 cm above the ground to compute the radiation levels both inside and outside. Were examined for gamma background radiation; three values at each location (residential quarters) were recorded ,was estimated both indoors and outdoors of the location, three readings were listed at each location (residential quarters).

The observed outdoor absorbed dose rate was within the range of 52–87 nGy h^{-1}, and the mean dose rate of the area was calculated to be 71 nGy h^{-1} (compared with the world average value of 55 nGy h^{-1}). The indoor contribution is assumed to be 1.3 times higher than the outdoor dose as in equation (1) **Error! Reference source not found.**[10]:

$$D_{IN} = D_{OUT} \times 1.3 \; (\mathrm{nGy\,h^{-1}}) \tag{1}$$

The annual effective dose equivalent from outdoor terrestrial gamma radiation as in equation (2) is[11]:

$$EADE_{OUT} = D_{OUT} \; (\mathrm{nGy.h^{-1}}) \times 0.7 \; (\mathrm{Sv.Gy^{-1}}) \times 8760 (\mathrm{h.y^{-1}}) \times 0.2 \tag{2}$$

Where $EADE_{OUT}$ is outdoor annual effective dose equivalent (mSv $year^{-1}$). Mean absorbed a dose of indoor and outdoor Gamma background radiation was calculated using the 0.2 is the outdoor occupancy factor and 0.7 Sv Gy^{-1} is the quotient of effective dose equivalent rate over observed dose rate in air[12] , (taken from the UNSCEAR Report for environmental exposure to gamma-rays of moderate energy). This value is assumed to apply equally to males and females and to the indoor and outdoor environments. For indoor exposure, using an occupancy factor of 0.8, the annual effective dose equivalent as in equation (3) is[13]:

$$EADE_{IN} = D_{IN} \; (\mathrm{nGy.h^{-1}}) \times 0.7 \; (\mathrm{Sv.Gy^{-1}}) \times 8760 (\mathrm{h\,y^{-1}}) \times 0.8 \tag{3}$$

Where $EADE_{IN}$ is indoor annual effective dose equivalent (mSv $year^{-1}$). Where $D_{indoors}$ and $D_{outdoors}$ are the mean absorbed dose rates at indoor and outdoor. The conversion coefficient, which is reported by UNSCEAR 2000, is (0.7 Sv/Gy) to convert the absorbed dose in the air to Annual Effective Dose received by adults , also calculated the standard deviation (S.D)[14] ,for soil samples, 30 samples were taken from different places of the campus portion of the university of Kufa, 21 location from southern part , 30 site for northern section where the dose meter was fixed at a height of 40 cm.

In order to prove that the sites are free from the danger of natural radiation and that they are safe for college workers, the Excess Lifetime Cancer Risk (ELCR) must be calculated, which is calculated based on the radiation dose from equation (5)[15]:

$$\mathrm{ELCR} = \mathrm{AEDE} \times \mathrm{DL} \times \mathrm{RF} \qquad (4)$$

Excess Lifetime Cancer Risk per 100,000 people, AEDE =Annual effective dose equivalent in mSv, DL =Average lifespan (year) = 60/1years. RF = fatal cancer risk per Sievert, risk factor (Sv^{-1}) = 0.057Sv^{-1}.

III. RESULTS AND DISCUSSION

The results of gamma background radiation of selected locations campus portion of the university of Kufa of south and north in Al-Najaf governorate are presented in **Tables 1** for all taken locations, the Site description, Longitude and Latitude of the selected 51(21 site in south and 30 site in north) locations and **Figure 1**, show the two and three-dimensional radiological map for both parts of the selected area obtained from campus portion of the university of Kufa, Iraq.

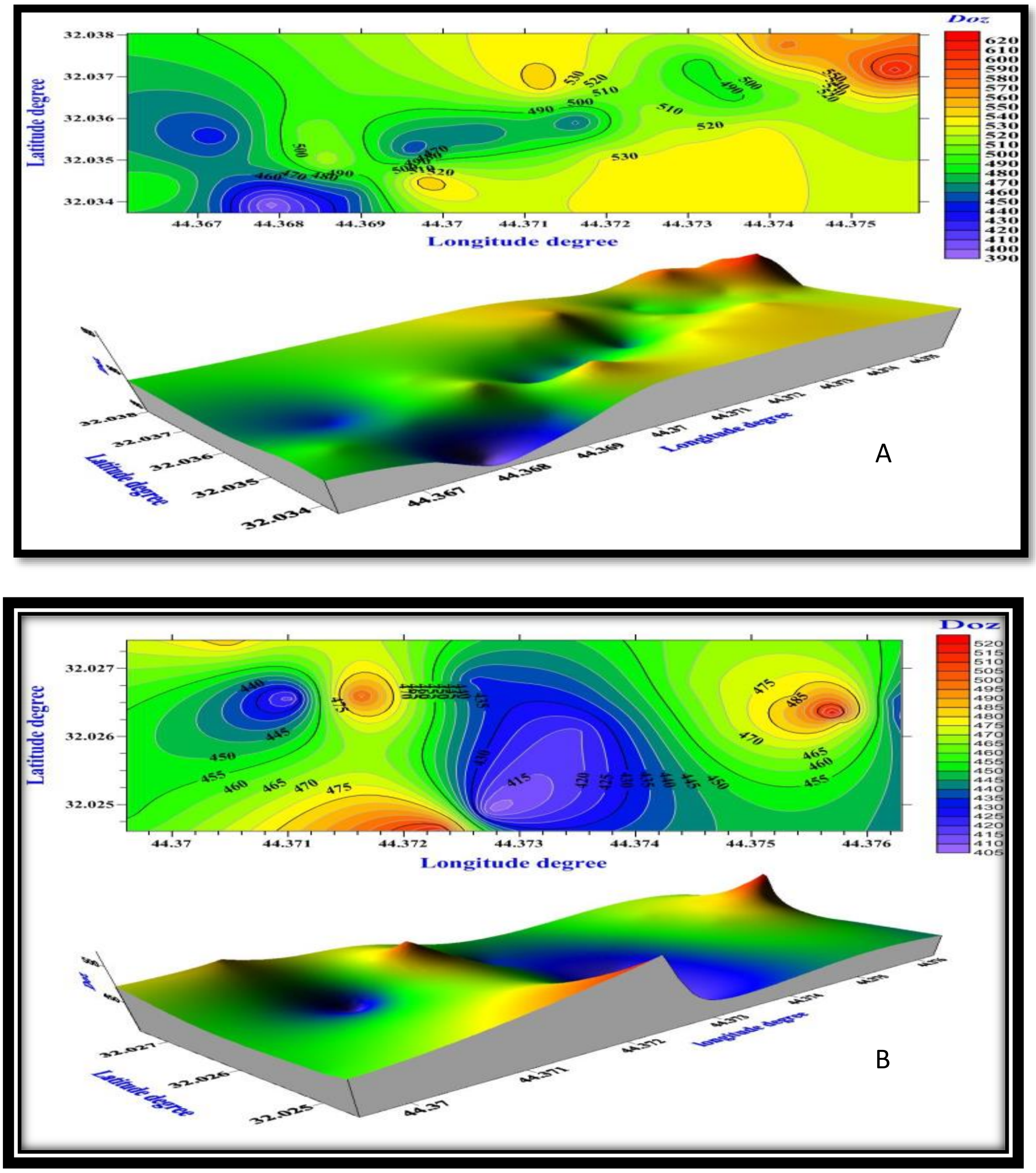

Fig. 1-A topographic map of the selected area: A; Northern part of the campus, B; Southern part of the campus .

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TABLE: 1 The Site description, Longitude and Latitude of selected locations.

Geographical coordinates					
	Southern part of the campus			**Northern part of the campus**	
Code			***Code***		
	Longitude	***Latitude***		***Longitude***	***Latitude***
SPC1	44,3722809	32,0264331	NPC1	E 44,3758265	**N 32,0363958**
SPC2	44,3733045	32,0266190	NPC2	E 44,3755113	**N 32,0371347**
SPC3	44,3733045	32,0266190	NPC3	E 44,3751938	**N 32,0380380**
SPC4	44,3734990	32,0260892	NPC4	E 44,3741434	**N 32,0377037**
SPC5	44,3696075	32,0248524	NPC5	E 44,3745253	**N 32,0368110**
SPC6	44,3723175	32,0246091	NPC6	E 44,3748907	**N 32,0360928**
SPC7	44,3727393	32,0249076	NPC7	E 44,3738879	**N 32,0356787**
SPC8	44,3747808	32,0260997	NPC8	E 44,3735728	**N 32,0364950**
SPC9	44,3745216	32,0267762	NPC9	E 44,3731520	**N 32,0373218**
SPC10	44,3762027	32,0265264	NPC10	E 44,3721884	**N 32,0370367**
SPC11	44,3725793	32,0268424	NPC11	E 44,3725284	**N 32,0361744**
SPC12	44,3729264	32,0269394	NPC12	E 44,3729002	**N 32,0353311**
SPC13	44,3753816	32,0266017	NPC13	E 44,3719306	**N 32,0350821**
SPC14	44,3757205	32,0263143	NPC14	E 44,3716469	**N 32,0359194**
SPC15	44,3757340	32,0262364	NPC15	E 44,3712054	**N 32,0367482**
SPC16	44,3762982	32,0262890	NPC16	E 44,3702438	**N 32,0364074**
SPC17	44,3762027	32,0265264	NPC17	E 44,3704869	**N 32,0356417**
SPC18	44,3704876	32,0274158	NPC18	E 44,3707957	**N 32,0350460**
SPC19	44,3710153	32,0265718	NPC19	E 44,3697868	**N 32,0345017**
SPC20	44,3720037	32,0267336	NPC20	E 44,3696148	**N 32,0352225**
SPC21	44,3716101	32,0265892	NPC21	E 44,3693848	**N 32,0361445**
			NPC22	E 44,3682814	**N 32,0357483**
			NPC23	E 44,3685678	**N 32,0349605**
			NPC24	E 44,3689101	**N 32,0341766**
			NPC25	E 44,3678845	**N 32,0339410**
			NPC26	E 44,3676152	**N 32,0348351**
			NPC27	E 44,3672129	**N 32,0355718**
			NPC28	E 44,3661350	**N 32,0351108**
			NPC29	E 44,3665725	**N 32,0343596**
			NPC30	E 44,3671982	**N 32,0337343**

From (Table 2), below we noted the maximum value for Outdoor Absorbed dose and Indoor Absorbed dose was (52.6 ±0.98 and 68.38 ±1.28) in the unit ($nGyh^{-1}$) respectively for the south part, while was (61.7 ±0.44 and 80.21 ±0.57) in the unit ($nGyh^{-1}$) respectively for the north part which was compared to global values as the mean was (59.52 and 45.78 while 65.186 and 50.14) that mean less than 59 $nGyh^{-1}$ and 84 $nGyh^{-1}$, this means it is safe[16] .

TABLE: II Outdoor Absorbed dose and Indoor Absorbed dose in the unit ($nGyh^{-1}$) with standard deviation (S.D).

Southern part of the campus			Northern part of the campus		
code	D_{out}	D_{in}	code	D_{out}	D_{in}
SPC1	42.4 ±0.49	55.12 ±0.64	NPC1	52 ±0.44	67.6 ±0.57
SPC2	47.5 ±0.25	61.75 ±0.32	NPC2	61.7 ±0.44	80.21 ±0.57
SPC3	43.2 ±0.37	56.16 ±0.49	NPC3	55 ±0.44	71.5 ±0.58
SPC4	41.9 ±0.56	54.47 ±0.73	NPC4	57.4 ±0.45	74.62 ±0.58
SPC5	45.4 ±0.06	59.02 ±0.07	NPC5	51.6 ±0.45	67.08 ±0.58
SPC6	51.9 ±0.88	67.47 ±1.15	NPC6	51.3 ±0.45	66.69 ±0.59
SPC7	40.7 ±0.73	52.91 ±0.95	NPC7	53.7 ±0.45	69.81 ±0.59
SPC8	46.8 ±0.15	60.84 ±0.19	NPC8	48.5 ±0.46	63.05 ±0.59
SPC9	46.7 ±0.13	60.71 ±0.17	NPC9	48.3 ±0.46	62.79 ±0.6
SPC10	44 ±0.26	57.2 ±0.34	NPC10	51.6 ±0.46	67.08 ±0.6
SPC11	43.4 ±0.34	56.42 ±0.45	NPC11	51.5 ±0.46	66.95 ±0.6
SPC12	43.8 ±0.29	56.94 ±0.37	NPC12	53.1 ±0.47	69.03 ±0.61
SPC13	48 ±0.32	62.4 ±0.42	NPC13	53 ±0.47	68.9 ±0.61
SPC14	52.6 ±0.98	68.38 ±1.28	NPC14	45.5 ±0.47	59.15 ±0.61
SPC15	48.3 ±0.36	62.79 ±0.47	NPC15	54.7 ±0.47	71.11 ±0.62
SPC16	43.3 ±0.36	56.29 ±0.47	NPC16	50.3 ±0.48	65.39 ±0.62
SPC17	44 ±0.26	57.2 ±0.34	NPC17	45.8 ±0.48	59.54 ±0.62
SPC18	48.5 ±0.39	63.05 ±0.51	NPC18	49.8 ±0.48	64.74 ±0.63
SPC19	41.6 ±0.6	54.08 ±0.79	NPC19	55.3 ±0.48	71.89 ±0.63
SPC20	47.1 ±0.19	61.23 ±0.25	NPC20	45.1 ±0.49	58.63 ±0.63
SPC21	50.4 ±0.67	65.52 ±0.87	NPC21	49.1 ±0.49	63.83 ±0.64
			NPC22	50.3 ±0.49	65.39 ±0.64
			NPC23	51.8 ±0.49	67.34 ±0.64
			NPC24	45.4 ±0.5	59.02 ±0.65
			NPC25	39.4 ±0.5	51.22 ±0.65
			NPC26	46.9 ±0.5	60.97 ±0.65
			NPC27	44.2 ±0.5	57.46 ±0.66
			NPC28	47.2 ±0.51	61.36 ±0.66
			NPC29	49 ±0.51	63.7 ±0.66
			NPC30	45.8 ±0.51	59.54 ±0.67
Mean	45.78	59.52	Mean	50.14	65.186
Max.	52.6	68.38	Max.	61.7	80.21
Min.	40.7	52.91	Min.	39.4	51.22

TABLE: III Total annual effective dose equivalent in the unit ($mSv .year^{-1}$) and Excess Lifetime Cancer Risk ELCR for south and north part of the campus.

Southern part of the campus			Northern part of the campus		
code	$EADE_{total}$ $mSv.h^{-1}$	$ELCR*10^{-3}$	code	$EADE_{total}$ $mSv.h^{-1}$	$ELCR*10^{-3}$
SPC1	0.32	1.29	NPC1	0.40	1.58
SPC2	0.36	1.44	NPC2	0.47	1.87
SPC3	0.33	1.31	NPC3	0.42	1.67
SPC4	0.32	1.27	NPC4	0.44	1.74
SPC5	0.35	1.38	NPC5	0.39	1.57
SPC6	0.39	1.57	NPC6	0.39	1.56

SPC7	0.31	1.23	NPC7	0.41	1.63
SPC8	0.36	1.42	NPC8	0.37	1.47
SPC9	0.36	1.42	NPC9	0.37	1.47
SPC10	0.33	1.33	NPC10	0.39	1.57
SPC11	0.33	1.32	NPC11	0.39	1.56
SPC12	0.33	1.33	NPC12	0.40	1.61
SPC13	0.37	1.46	NPC13	0.40	1.61
SPC14	0.40	1.60	NPC14	0.35	1.38
SPC15	0.37	1.47	NPC15	0.42	1.66
SPC16	0.33	1.31	NPC16	0.38	1.53
SPC17	0.33	1.33	NPC17	0.35	1.39
SPC18	0.37	1.47	NPC18	0.38	1.51
SPC19	0.32	1.26	NPC19	0.42	1.68
SPC20	0.36	1.43	NPC20	0.34	1.37
SPC21	0.38	1.53	NPC21	0.37	1.49
			NPC22	0.38	1.53
			NPC23	0.39	1.57
			NPC24	0.35	1.38
			NPC25	0.30	1.20
			NPC26	0.36	1.42
			NPC27	0.34	1.34
			NPC28	0.36	1.43
			NPC29	0.37	1.49
			NPC30	0.35	1.39
Mean	0.3481	1.39	Mean	0.3813	1.52
Max.	0.4000	1.60	Max.	0.4691	1.87
Min.	0.3095	1.23	Min.	0.2996	1.20

From **Table 3**, the radioactivity variables total annual effective dose equivalent in unit (mSv. y^{-1}) the mean was 0.3481 and ELCR were calculated the values was 1.39 for south section, while was 0.3813 mSv.y^{-1} and the ELCR 1.52 for north section of campus of the university of Kufa which were compared with internationally permissible limits(0.52) , (1.45×10^{-3}) where was the less than internationally permissible for the southern part but to the northern part was the ELCR higher the acceptable value [17].

IV. CONCLUSION

All the studied radiation variables were found, where the annual total effective dose was calculated and it was less than the acceptable ranges, according to UNSCEAR 2000. The danger was also calculated and compared, and it was found that the southern part is more healthy than the northern part, and this indicates perhaps that the area previously was flooded with a lot of Fertilizers Finally, the level of gamma background radiation was determined in order to evaluate the health hazard factor around the site selected for different samples from the university campus, Iraq.

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Disclaimer: None

Conflict of interest: There are no conflicts of interest to declare.

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