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Rn-222 concentration in green houses in Erbil governorate

Zakariya A. Hussein
Department of Physics, Faculty of Sciences and Health, Koya University, Erbil, Iraqi Kurdistan

Abstract: Greenhouses are possible places with high Rn-222 concentrations, since soil, the source of Rn-222, is directly exposed inside them. The radon concentrations in 11 greenhouses in different locations within Erbil governorate were measured using LR-115 detectors. The measurements were carried out over a period of 90 days. The average indoor radon concentrations was found between 25.62 ± 1.64 Bq/m^3 and 75.36 ± 2.66 Bq/m^3. The outdoor radon concentration is lower than indoor radon for each greenhouse. The mean effective dose from radon concentration (Rn-222) and its progenies was estimated to be 0.68 ± 0.02 mSv/y for a farmer working in a greenhouse. Estimated risk factors of radon induced lung cancer in greenhouses were shown to vary from 14.82 ± 1.24to 20.24 ± 2.92 per million persons.

Keywords: LR-115 detectors, Indoor radon and Greenhouses.

1. Introduction

A greenhouse is a structural building with different types of covering materials, such as a glass or plastic roof and frequently glass or plastic walls; it heats up because incoming visible solar radiation (for which the glass is transparent) from the sun is absorbed by plants, soil, and other things inside the building [1]. Radon is one of the most important natural contributors to the radiation dose received by humans [2,3]. ^{222}Rn is emanated from soil and rock, which is the main source of ^{222}Rn to the atmosphere. Atmospheric ^{222}Rn concentration depends on the emanation power on the ground and advection/diffusion in the air [4,5]. Measurement of the indoor radon is highly desirable because the radiation dose received by the human population due to the inhalation of radon and its progeny contribute more than 50% of the total dose from natural sources [6,7]. Recent experimental and epidemiological studies suggest that inhalation of radon progeny, which are the most important source of irradiation of the human respiratory track in the workplace and domestic environment could be a cause of lung cancer [8,9]. Indoor radon measurements are generally associated with dwellings. However, a typical person spends more than eight hours a day in their workplace, so that it is recognized as essential to monitor workers' exposure to radon to control their health risks. In this study the indoor radon concentrations in 11 greenhouses in different locations within Erbil governorate were measured over a period 90 days. These concentrations were then used to calculate the dose from radon and its progenies.

2. Materials and Methods

Erbil governorate has several institutes for the development of agricultural activity. We selected 11 greenhouses at the institutes for measurement of Rn-222 concentrations, as shown in Figure 1. The characteristics, average temperature and humidity for each greenhouse listed in Table 1. LR-115 detectors (1.5 × 1.5) cm^2 were positioned in direct indoor air contact at several locations in Erbil governorate for 90 days, the distance between the detectors and the ground level is 2.5 m [10,11]. For each greenhouse were placed 4 radon dosimeter in the ceiling greenhouse and 2 placed in outdoor greenhouse. In a one-step chemical etching process, the detectors were etched in a 2.5 N NaOH solution at 60 ± 1 C^o for a period of 2 h. The counting of alpha damage tracks was done using an optical microscope with a magnification of 400X was used. The average effective dose (H in unit mSv/y) of radon and its progeny can be calculated from the following relation [12].

$$H = C \times F \times O \times T \times D$$

Where C is the radon concentration in Bq/m^3, F equilibrium factor 0.4 [12], O for occupancy factor, T for time (1000 h/y) and D for dose conversion factor (9 x 10^{-6} mSv/h (Bq/m^3).

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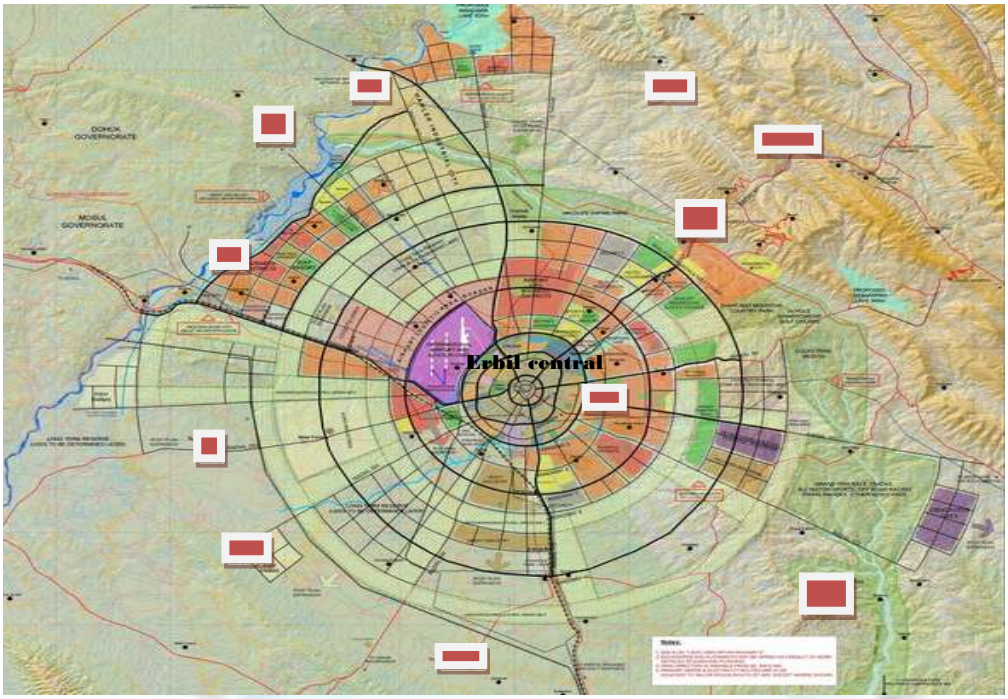

Figure 1: Locations of the 11 greenhouses within Erbil governorate governorate

Table 1: characteristics of the greenhouses, where are shown the materials in the roof, walls, floors, average temperature and humidity

No.	Location	Roof	Walls	Floor	Average temperature (c^o)	Average humidity (%)
1	Erbil Central	Glass	Glass	Soil	18-25	18-22
2	Koya	Plastic	Plastic	Concert	20-26	20-25
3	Soran	Plastic	Plastic	Concert	16-25	22-24
4	Rawandz	Plastic	Plastic	Soil	20-28	25-30
5	Xabat	Glass	Glass	Soil	22-25	24-26
6	Shaqlawa	Plastic	Plastic	Concert	20-24	23-25
7	Daratu	Plastic	Plastic	Concert	19-23	22-26
8	Sktan	Plastic	Plastic	Soil	18-24	24-26
9	Hiran	Plastic	Plastic	Concert	20-26	22-25
10	Bahrka	Plastic	Plastic	Soil	21-24	20-25
11	Kawrgosk	Plastic	Plastic	Soil	23-25	21-24

3. Results and discussion

The data of the average indoor and outdoor radon (Rn-222) concentration levels in the 11 greenhouses within 90 days , as measured using passive nuclear track detectors (LR-115 detectors) are listed in Table 2. The highest and lowest average indoor radon concentration was found in a Rawandz location (75.36 ± 2.66 Bq/m^3) and Erbil central in (25.62 ± 1.64 Bq/m^3), respectively, as shown in Figure 2. Greenhouses are possible places with high Rn-222 concentrations, because soil, which is the Rn-222 source, is exposed inside them and their plastic or glass coverings prevent diffusion of Rn-222 to the outside. The level of indoor radon recorded in this study compared with international reports under the acceptance level (148 Bq/m^3) [13]. The average effective dose and lung cancer per year per million persons are listed in Table 3. The high level of environmental radioactive pollutant at the work place and public sector are important risk factor for lung cancer in workers.

Table 2: Indoor and outdoor radon concentration in greenhouses for different location in Erbil governorate

No.	Location	Indoor Radon Concentration Bq/m^3			Outdoor Radon Concentration Bq/m^3
		Maximum	Minimum	Average	
1	Erbil central	32.62±2.65	30.92±1.68	25.62±1.64	4.25±1.86
2	Koya	44.36±3.42	41.85±3.12	36.72±2.54	4.98±2.08
3	Soran	65.62±2.84	60.42±2.94	54.33±1.98	5.43±2.36
4	Rawandz	85.56±3.68	80.68±3.58	75.36±2.66	7.28±1.96
5	Xabat	34.84±2.12	31.34±1.92	27.56±1.88	5.12±1.66
6	Shaqlawa	62.55±3.45	55.87±3.64	50.45±2.32	5.84±2.74
7	Daratu	34.18±3.44	32.44±1.96	26.92±2.12	4.66±1.72
8	Sktan	59.88±2.86	55.24±3.16	50.94±2.24	5.82±2.68
9	Hiran	52.46±3.14	48.12±2.94	39.92±1.95	6.22±2.54
10	Bahrka	35.85±2.16	33.12±1.92	28.68±2.08	5.36±1.68
11	Kawrgosk	33.98±1.82	31.45±1.88	26.12±1.22	5.11±1.25

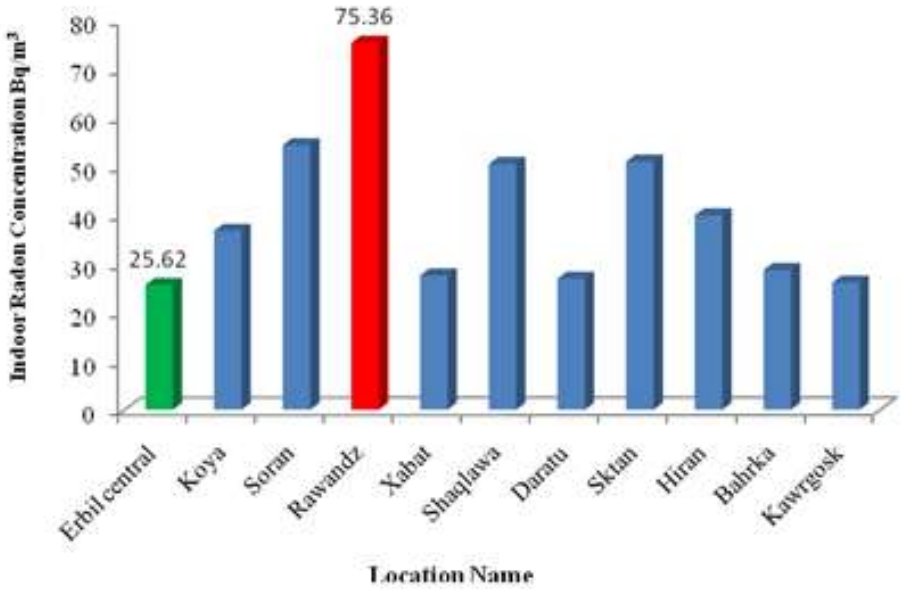

Figure 2: Variation of indoor radon concentration of the greenhouses for different location in Erbil governorate

Table 3: Average effective dose and lung cancer per year/106 person of the greenhouses for different location in Erbil governorate

NO.	Location	Average effective dose (mSv/y)	Average lung cancer/10^6 person
1	Erbil Central	0.32±0.01	14.82±1.24
2	Koya	0.65±0.04	16.65±1.18
3	Soran	0.92±0.05	19.25±1.84
4	Rawandz	0.98±0.08	20.24±2.92
5	Xabat	0.54±0.07	18.84±1.38
6	Shaqlawa	0.82±0.04	17.55±1.58
7	Daratu	0.77±0.02	16.42±1.44
8	Sktan	0.74±0.09	18.12±1.94
9	Hiran	0.62±0.05	17.24±2.02
10	Bahrka	0.48±0.07	15.92±1.92
11	Kawrgosk	0.46±0.06	15.26±1.88

4. Conclusion

Concentrations of Rn-222 were measured in greenhouses for different location in Erbil governorate. The highest and lowest average indoor radon concentration for the was found in, Rawandz and Erbil Central, respectively, this depended for the soil, temperature and humidity weather. The indoor radon is higher than outdoor for each greenhouse because enclosed spaces in contact with soil, the main source of radon. The mean effective dose from radon concentration was found 0.68 ± 0.02 mSv/y for a farmer working in a greenhouse.

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