International Journal of Academic and Applied Research (IJAAR)
ISSN: 2000-005X
Vol. 3 Issue 5, May – 2019, Pages: 7-10

Variations of Radon Flux Density from the Soil Surface in Samarkand and Jizzakh Regions of Uzbekistan

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Abstract: *We present results on assessment of radon flux density variations from the soil surface in the territory of typical rural dwellings of Samarkand and Djizak regions of Uzbekistan. Acquired data indicates to necessity of preliminary radiation surveying of territories allocated for living spaces.*

Keywords — radon flux; dwellings; exposure dose; radionuclide; decay**.**

1. INTRODUCTION

The increasing level of technogenic load on the subsoil can cause the appearance of natural processes leading to the migration of radioactive gases in the earth through geological faults, cracks in the earth's surface, in natural water sources, in which radon coming from the earth's rocks easily dissolves. Due to the relatively long half-life and a gaseous state radon spreads through the pores and cracks in the Earth's rocks and out of the ground into the air space and the atmosphere. The main sources of radon in the air of the premises is its release from the soil under the building and from building materials and structures.

In the latest recommendations of international organizations, controlling the level of radon activity in the air of residential premises has been reduced from 600 to 300 Bq / m3, which is associated with obtaining new scientific data on the contribution of radon and its DDP (Decay of daughter product) to the population dose load.

According to sanitary standards and rules of SanPiN No. 0193 06, when selecting areas of the territory under the construction of residential houses and buildings of social and domestic space use the radon flux density from the ground surface should not exceed 80 mBq / (m2 × s)

The study of radon in Uzbekistan is devoted to a limited number of scientific papers which have their own specific character [2-6].

Despite large-scale studies of the RFD levels on the territory of Uzbekistan underway, monitoring of this regulated indicator of radiation safety is not carried out.

The purpose of this work is to study the variations of RFD from the soil surface in typical rural settlements of the Samarkand and Jizzakh regions of Uzbekistan.

Measurement of RFD from the soil surface was carried out in 3 typical rural dwellings of Samarkand and 2 dwellings of the Jizzakh region. In addition, soil samples were taken to determine the radionuclide composition, as well as measurements of the dose rate (MED) of gamma radiation. During the sampling process, GPS coordinates of the sampling points and meteorological parameters (temperature, humidity and pressure) were recorded.

Radon was sampled using a set of sorption columns with activated carbon SKT-3, used in the "passive" sampling mode (by the method of diffusion adsorption). In order to eliminate the effect of residual radon and the effect of moisture on the error in determining the equivalent air volume passing through the sorption column, the latter were pre-degassed before drying in an oven for 2-4 hours and weighed with an accuracy of 0.01 g.

To measure the RFD from the soil surface, the racks with sorption columns were installed on the prepared surface (40 x 40 cm area with a removed vegetation cover to a depth of 5-10 cm) and covered with a 3.3-liter sampling chamber. In sunny weather, to prevent the camera from heating, it was covered with a white non-woven fabric. The exposure time was 3 hours at 8-12 sites in the territory of each dwelling.

2. EQUIPMENT, CALIBRATION, MEASUREMENT AND DATA PROCESSING.

Sorption columns were measured on a scintillation NaI (Tl) gamma spectrometer with a crystal size of Ø80 x 80 mm and an energy resolution of 8.5% on the 662 keV line.

The energy calibration of the spectrometer was performed by certified point sources of ^{137}Cs and ^{232}Th radionuclides. Efficiency calibration was carried out using a volume source ^{226}Ra deposited on activated carbon SKT-3 with dimensions Ø60 x 25 (corresponds to the geometry of

sorption columns), activity 680 Bq with an error of establishing activity of 7%.

Measurement of RFD was carried out according to the certified methodology of the Scientific-Technical Center (STC) RADEK (St. Petersburg, Russia):

"Measurement techniques of radon flux density from the surface of soils, soils and materials using passive sorption radon detectors (DRSP) based on activated carbon and scintillation gamma spectrometer" (certificate 225/09 dated March 10, 2009 VNIIM named after Mendeleev, St. Petersburg)

The set and processing of the spectra was carried out using the software ASW STC RADEK. Measurement errors were calculated at a confidence level of 0.95.

3. Results of Measurements

Sorption columns were displayed for 3 hours at 56 control sites on the territory of the dwellings. Measurements on the spectrometer were carried out not earlier than 3.5 hours after the end of exposure to establish a radioactive equilibrium between radon and its daughter decay products.

Table 1-5 shows the values of radon flux density, and in table 6. boundary values of the outage for each dwelling in the Samarkand and Jizzakh regions are given.

Table 1: Values of radon flux density Φ_{Rn} from the ground surface. Samarkand region, Urgut district, the dwelling of Mergancha. The object "Mergancha".

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-4	RFD -1	29.04.2017 / 12:26	29.04.2017 / 18:55	60,2 ± 08,0
CS-5	RFD -2	29.04.2017 / 12:34	29.04.2017 / 19:27	45,6 ± 06,6
CS-6	RFD -3	29.04.2017 / 12:40	29.04.2017 / 20:00	66,8 ± 08,8
CS-7	RFD -4	29.04.2017 / 12:46	29.04.2017 / 21:04	68,7 ± 11,0
CS-8	RFD -5	29.04.2017 / 12:55	29.04.2017 / 20:32	44,7 ± 05,0
CS-9	RFD -6	29.04.2017 / 12:59	29.04.2017 / 21:29	73,4 ± 10,0
CS-10	RFD -7	29.04.2017 / 13:08	29.04.2017 / 21:37	67,1 ± 07,2
CS-11	RFD -8	29.04.2017 / 13:11	29.04.2017 / 22:02	64,8 ± 09,3
CS-12	RFD -9	29.04.2017 / 13:16	29.04.2017 / 22:09	31,9 ± 14,0
CS-13	RFD -10	29.04.2017 / 13:20	29.04.2017 / 22:34	76,6 ± 11,0
CS-14	RFD -11	29.04.2017 / 13:26	29.04.2017 / 22:41	72,6 ± 11,0
CS-15	RFD -12	29.04.2017 / 13:33	29.04.2017 / 23:06	41,9 ± 06,6

Table 2: The values of the radon flux density Φ_{Rn} from the ground surface. Akdarya district of the Samarkand region, Mahalla Pulatdorkhon. The object "Pulatdarkhon."

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-3	RFD -1	12.05.2017 / 08:20	12.05.2017 / 15:09	86,9 ± 11,0
CS-4	RFD -2	12.05.2017 / 08:30	12.05.2017 / 15:12	73,3 ± 7,6
CS-5	RFD -3	12.05.2017 / 08:35	12.05.2017 / 15:42	30,1 ± 8,2
CS-6	RFD -4	12.05.2017 / 08:40	12.05.2017 / 15:44	16,2 ± 3,0
CS-7	RFD -5	12.05.2017 / 08:43	12.05.2017 / 16:15	12,1 ± 3,3
CS-8	RFD -6	12.05.2017 / 08:50	12.05.2017 / 16:18	40,2 ± 4,3
CS-9	RFD -7	12.05.2017 / 08:55	12.05.2017 / 16:47	20,6 ± 9,9
CS-10	RFD -8	12.05.2017 / 08:58	12.05.2017 / 16:50	65,5 ± 8,0
CS-11	RFD -9	12.05.2017 / 09:02	12.05.2017 / 17:19	57,1 ± 6,6
CS-12	RFD -10	12.05.2017 / 09:05	12.05.2017 / 17:23	31,3 ± 3,6
CS-13	RFD -11	12.05.2017 / 09:08	12.05.2017 / 17:51	31,7 ± 9,8
CS-14	RFD -12	12.05.2017 / 09:20	12.05.2017 / 17:55	30,5 ± 3,9

Table 3: Values of radon flux density Φ_{Rn} from the ground surface. Samarkand region, Pastdargom district, Dimiskbola, Kamolot mahalla. The object "Kamolot".

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-3	RFD -1	01.07.2017 / 08:39	01.07.2017 / 14:37	18,6 ± 8,2
CS-4	RFD -2	01.07.2017 / 08:44	01.07.2017 / 14:48	42,6 ± 7,5

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-5	RFD -3	01.07.2017 / 08:48	01.07.2017 / 15:08	25,3 ± 3,8
CS-6	RFD -4	01.07.2017 / 08:50	01.07.2017 / 15:19	41,2 ± 4,3
CS-7	RFD -5	01.07.2017 / 08:54	01.07.2017 / 15:54	43,6 ± 4,9
CS-8	RFD -6	01.07.2017 / 08:58	01.07.2017 / 15:56	23,9 ± 3,4
CS-9	RFD -7	01.07.2017 / 09:02	01.07.2017 / 16:32	11,3 ± 2,3
CS-10	RFD -8	01.07.2017 / 09:08	01.07.2017 / 16:30	48,5 ± 7,4
CS-11	RFD -9	01.07.2017 / 09:15	01.07.2017 / 17:34	15,3 ± 4,5
CS-12	RFD -10	01.07.2017 / 09:26	01.07.2017 / 17:05	19,6 ± 4,8

Table 4: Values of the radon flux density Φ_{Rn} from the ground surface. Jizzakh region, Jizzakh district, Uchtepa mahalla. The object "Uchtepa".

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-1	RFD -1	25.06.2017 / 09:10	25.06.2017 / 21:16	31,7 ± 3,9
CS-3	RFD -2	25.06.2017 / 09:15	25.06.2017 / 20:40	30,8 ± 5,6
CS-4	RFD -3	25.06.2017 / 09:20	25.06.2017 / 21:55	16,3 ± 6,0
CS-5	RFD -4	25.06.2017 / 09:25	25.06.2017 / 21:12	21,8 ± 3,5
CS-6	RFD -5	25.06.2017 / 09:28	25.06.2017 / 22:29	31,6 ± 3,0
CS-7	RFD -6	25.06.2017 / 09:32	25.06.2017 / 21:59	32,3 ± 3,6
CS-8	RFD -7	25.06.2017 / 09:34	25.06.2017 / 23:00	24,8 ± 3,7
CS-9	RFD -8	25.06.2017 / 09:36	25.06.2017 / 22:32	42,3 ± 5,2
CS-10	RFD -9	25.06.2017 / 09:38	25.06.2017 / 23:35	26,4 ± 7,2
CS-11	RFD -10	25.06.2017 / 09:41	25.06.2017 / 23:04	17,7 ± 2,9
CS-12	RFD -11	25.06.2017 / 09:44	26.06.2017 / 00:36	26,0 ± 4,8
CS-13	RFD -12	25.06.2017 / 09:50	25.06.2017 / 23:38	27,7 ± 2,8

Table 5: Values of radon flux density Φ_{Rn} from the ground surface. Jizzakh region, Gallyarali district, mahalla Sarbazar. The object "Sarbazar".

Controlling site	Sample name	Date / start time of exposure process	Date / start time of exposure process	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq×m^{-2}×s^{-1}
CS-4	RFD -1	25.06.2017 / 15:25	26.06.2017 / 01:12	67,2 ± 07,0
CS-5	RFD -2	25.06.2017 / 15:29	26.06.2017 / 00:39	52,9 ± 07,9
CS-6	RFD -3	25.06.2017 / 15:32	26.06.2017 / 01:46	41,9 ± 06,3
CS-7	RFD -4	25.06.2017 / 15:34	26.06.2017 / 01:17	70,7 ± 07,0
CS-8	RFD -5	25.06.2017 / 15:37	26.06.2017 / 02:19	40,9 ± 13,0
CS-9	RFD -6	25.06.2017 / 15:39	26.06.2017 / 02:51	20,8 ± 08,8
CS-10	RFD -7	25.06.2017 / 15:46	26.06.2017 / 03:24	31,1 ± 07,5
CS-11	RFD -8	25.06.2017 / 15:48	26.06.2017 / 03:57	40,6 ± 04,6

Table 6: The boundary values of the radon flux density Φ_{Rn} from the ground surface.

Object	Amount of sites	$\Phi_{Rn} \pm \Delta\Phi_{Rn}$, mBq/(m^2×s)		
		min	Max	Average
Samarkand region, Urgut district, the village of Mergancha	12	31,9 ± 14,0	76,6 ± 11,0	59,5
Samarkand region, Akdarya district, Pulatdorkhon makhalla	12	12,1 ± 3,3	86,9 ± 11,0	41,3
Samarkand region, Pastdargom district, Dimiskbola, Kamolot mahalla	10	11,3 ± 2,3	48,5 ± 07,4	29,0
Jizzakh region, Jizzakh district, Uchtepa mahalla	12	16,3 ± 6,0	42,3 ± 05,2	27,5
Jizzakh region, Gallyarali district, mahalla Sarbazar	8	20,8 ± 8,8	70,7 ± 07,0	45,8

Only in one control site of the Pulatdarkhon dwelling of the Akdarya district of the Samarkand region the exceeding limit value of RFD (80 mBq / (m^2 × s)) which is equal to 86.9 ± 11.0 mBq / (m^2 × s) was noted.

4. CONCLUSION

Analysis of the results of the research showed:

1. The range of changes of RFD is very wide, even in the range of the same of study site.
2. There is no correlation between measured RFD levels, gamma radiation dose rates and ^{226}Ra content in the soil.
3. The average value of the outage levels in the studied foothill dwellings is higher than in the plains.
4. The observed variations in the radon flux density from the soil surface are determined by geophysical and hydrological factors, since the measurements were carried out at comparable environmental parameters, and the correlation of the RFD variations with the ED (exposure dose) of gamma radiation and the radionuclide composition of the soil is not clearly expressed.
5. The results obtained on RFD from the soil surface indicate the need for a preliminary radiation survey of the territories allocated for residential construction.

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