Soil, Coal and Ash Radioactivity around Baganuur Coal Deposit in Mongolia

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Abstract: The specific radioactivity concentrations of ^{238}U, ^{232}Th, ^{40}K were measured in soil, coal and ash samples, which were collected from some points of Baganuur district of Ulaanbaatar city in Mongolia, using HP-Ge gamma-spectrometer. Results of measurements of natural and man-made radioactive nuclides in soil, coal and ash samples were presented. It was determined radioactive background and specific radioactivity of soil, coal and ash samples, which were collected from Baganuur district of Ulaanbaatar city, compared with other province data in Mongolia.

I. INTRODUCTION

There were collected soil, coal and ash samples with 10*10 square cm, deep 5cm, which is collected from Baganuur district of Ulaanbaatar city in Mongolia. For determination of natural and man- made radioactivity and dose rate was used gamma ray spectrometer. Samples were put into 700cm^3 volume of Marinelli vessel and measured for one hour by gamma ray spectrometer with semiconductor detector.

There were determined the specific radioactivity of isotope in a soil by full assimilation square following the standard **MNS 5626:2006.**

The specific radioactivity of isotope in a soil samples was determined by following equation[1].

$$A_i = \frac{N(E_i) - \Phi(E_i)}{t \cdot k \cdot \varepsilon_0(E) \cdot k_\gamma \cdot m} \qquad (1)$$

Where: A_i - specific radioactivity of isotope(Bq/kg);

N(E)-spectral line square,

$\Phi(E_i)$- radioactive background,

ε_0 (E) – absolute/ үнэмлэхүй/ efficiency(ρ=1g/cm^3) for water,

k- gamma ray relaxation constant in a sample,

k_γ- ascent of gamma quantum,

m - sample mass(kg),

t - measured time(s)

There was used a detector efficiency using standard solutions with many isotopes, which was prepared in California of USA in 1994 and Amersham group of Germany in 1996. The specific radioactivity of the ^{226}Ra isotope in a soil sample was determined very powerful 609.31 keV (^{214}Bi) line. There was determined percentage of 186,21 keV line square in total line square of 186 keV of ^{235}U ба ^{226}Ra and was examined equivalency between uranium and radium.

For determination of **t**he specific radioactivity **^{232}Th** – were registered gamma rays with energies **583,19 keV (^{208}Tl), 911,16 keV (^{228}Ac).** So for determination of **t**he specific radioactivity of ^{238}U, ^{232}Th, ^{226}Ra were used several lines respectively and it increased experiment belief.

The specific radioactivity of **^{40}K, ^{137}Cs** isotopes were determined **1460,75 keV, 661.66 keV** gamma ray lines.

There was determined the specific radioactivity ^{226}Ra, ^{232}Th, ^{40}K in soils of Baganuur district of Ulaanbaatar city and compared these results with world mean value and results were shown in figure 1-3.

Specific radioactivity of ^{232}Th ,^{238}U, ^{40}K of coal and ash samples, collected from Baganuur thermal station was determined gamma spectrometer. Total radioactivity was determined by following formula:

$$A = A_{Ra} + 1.3\ A_{Th} + 0.09\ A_K < 370 \text{ (Bq/kg)}$$

Where: A_U ,A_{Th} ,A_K- are specific activities of ^{238}U, ^{232}Th, ^{40}K (Bq/kg).

For determination of dose rate in air 1 meter above the soil was used following formula [1].

$$P=0{,}427\ A_U + 0{,}662\ A_{Th} + 0{,}043\ A_K \quad (2)$$

Where: P –dose rate(nGr/h);

A_U ,A_{Th} ,A_K- are specific activities of ^{238}U, ^{232}Th, ^{40}K (Bq/kg).

For determination of effective equivalent dose for an year by population of Baganuur district was used formula:

$$D(\text{мкЗв})=0.2\times P(\text{nGr/h})\times 0.7(\text{Sv/Gy})\times 8760(\text{h/year})$$

II. EXPERIMENT RESULTS

Fig 1. Baganuur thermal power plant

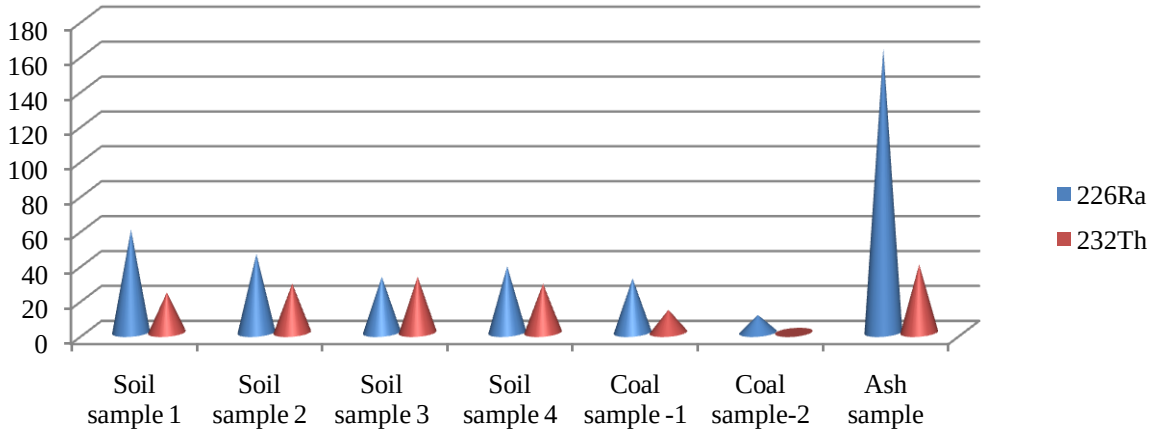

Fig 2. Specific radioactivity of ^{226}Ra, ^{232}Th of soil, coal and ash samples,

collected from Baganuur district **(**Bq/kg**)**

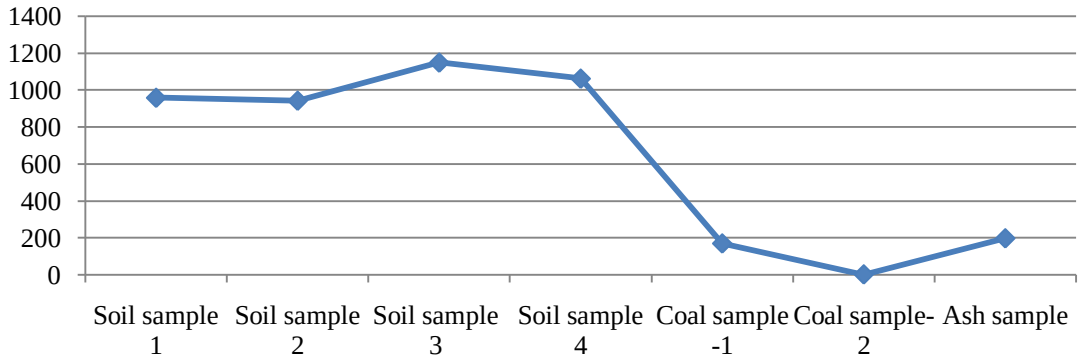

Fig 3. Specific radioactivity of ^{40}K of soil, coal and ash samples,

collected from Baganuur district **(**Bq/kg**)**

COORDINATES OF SOIL, COAL AND ASH SAMPLING POINTS, COLLECTED

FROM BAGANUUR COAL DEPOSIT

TABLE 1.

№	Sample name	Position of sampling points	Coordinates
1	Soil sample 1	Around Baganuur coal deposit	N47^{0}45`57.4`` E108$^0$18`17.1``
2	Soil sample 2	Around Baganuur coal deposit	N47^{0}44`57.4`` E108$^0$18`12.8``
3	Soil sample 3	Around Baganuur coal deposit	N47^{0}42`19.2`` E108$^0$18`27.0``
4	Soil sample 4	Around Baganuur coal deposit	N47^{0}43`31.2``

			E108^{0}19`10.2``
5	Coal sample -1	Around Baganuur coal deposit	N47^{0}42`01.3`` E108$^0$18`29.4``
6	Coal sample-2	Around Baganuur coal deposit	N47^{0}44`33.3`` E108$^0$20`05.1``
7	Ash sample	Around Baganuur thermal station	
8	Water sample	Around Baganuur coal deposit	N47^{0}43`08.2`` E108$^0$18`13.9``
9	Water sample	From the of baganuur district	

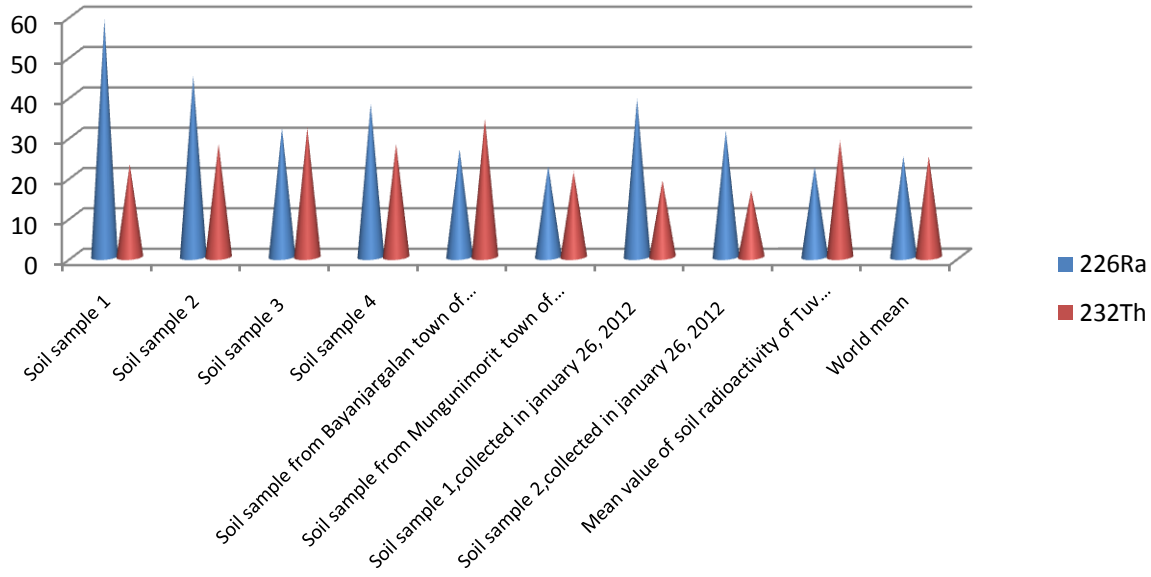

Fig 4. Compared results of specific radioactivity of ^{226}Ra, ^{232}Th of soil, coal and ash samples, collected from Baganuur district **(**Bq/kg**)**

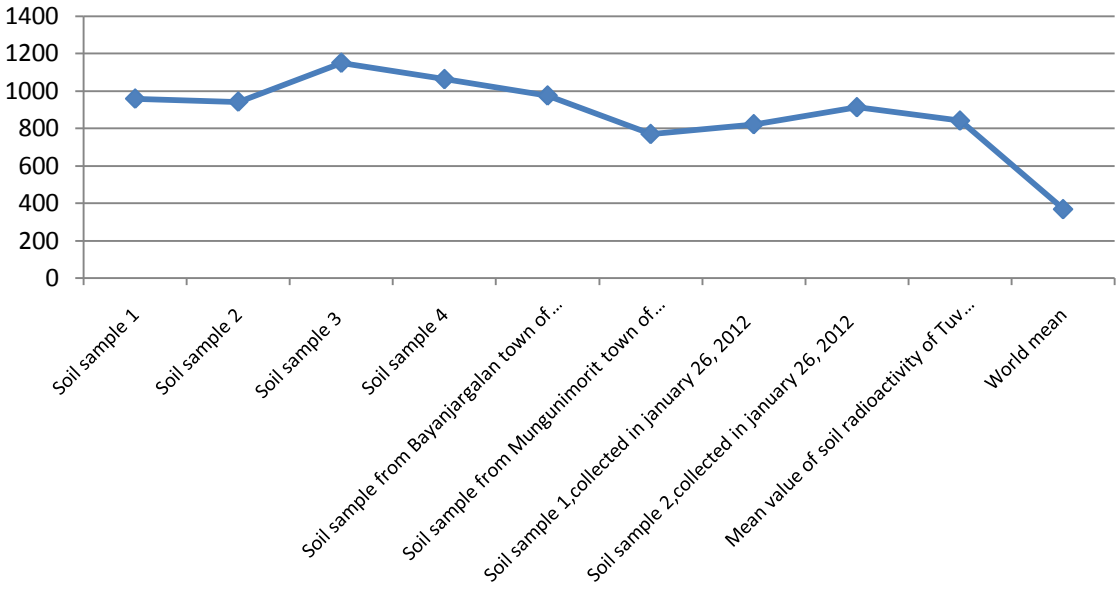

Fig 5. Compared results of specific radioactivity of ^{40}K of soil, coal and ash samples,

collected from Baganuur district **(**Bq/kg**)**

COMPARED RESULTS OF SPECIFIC RADIOACTIVITY OF ^{226}RA, ^{232}TH,^{40}K OF COAL AND ASH SAMPLES,

COLLECTED FROM BAGANUUR AND ZUUNMOD THERMAL STATIONS (BQ/KG)

TABLE 2.

Sample	Sample number	Isotope specific radioactivity (Bq/kg)			Total radioactivity(Bq/kg)
		^{226}Ra	^{232}Th	^{40}K	
Baganuur coal sample	1	31	13	168	
	2	10	<1.3	<29	
Baganuur coal sample, collected in 26th January 2012	1	47.9	5.2	62.2	
	2	24.1	2.7	86.8	
Coal sample, used in thermal station of Tuv	1	15.5	6.1	82.5	
	2	14.6	15.9	53.0	

province	3	24.3	16.8	67.2	
	4	23.5	20.9	13.8	
	Mean	19.5	14.9	54.1	
Baganuur ash sample	1	163	39	196	231.3
Ash sample, from thermal station of Tuv province	1	151	60.7	210	248.6
	2	133	65.7	179	234.4
	3	108	71.8	297	228.2
	4	99.6	72.3	262	217.2
	Mean	123	67.7	237	232.1
Russian standard					370

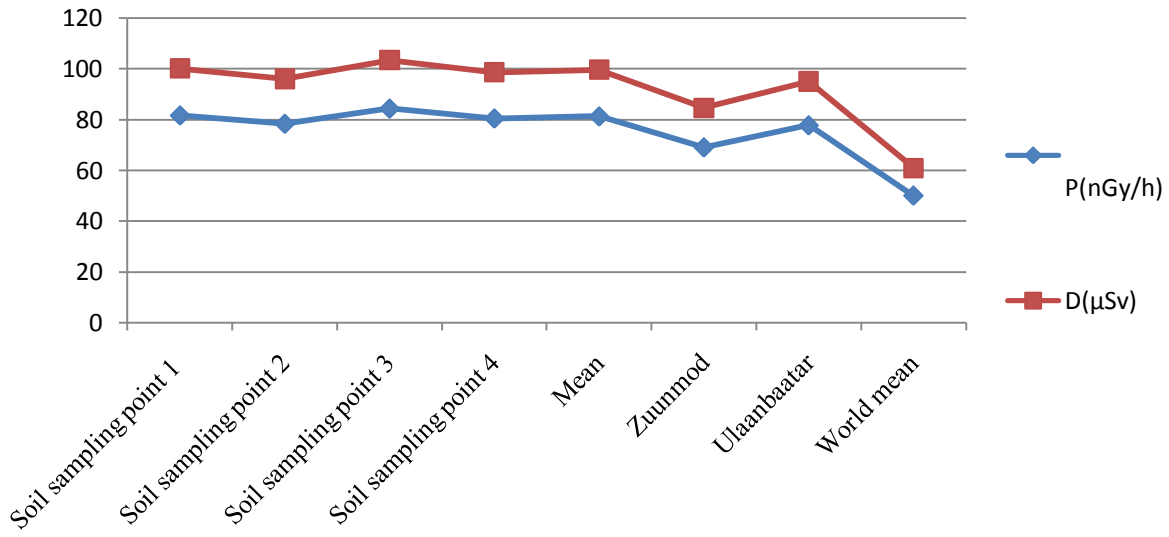

Fig.6. Compared results of dose rate and equivalent dose of population Baganuur district

III. CONCLUSION

1. Specific radio activity of ^{226}**Ra** in some soil samples of Baganuur coal deposit was1.3-2.4 times higher than world mean, specific radio activity of ^{232}**Th** was1.1-1.3 times higher**,** specific radio activity of ^{40}**K** was 2.51-3.1 times higher than world mean.
2. Specific radio activity in the ash samples of the Baganuur thermal station was 3-5.2 times higher

than coal sample. However total radio activity of the ash sample was 232.1 Bq/kg and it was lower than Russian building material standard (370 Bq/kg).

3. Radiation background of Baganuur district was 1.6-1.7 times higher than world mean and 1.2 times higher than Zuunmod town.
4. Effective equivalent dose of the population in Baganuur district was 1.6-1.7 times higher than world mean, 1.2 times higher than Zuunmod town and 1.1 times higher than Ulaanbaatar city of Mongolia.

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