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INFLUENCE OF SOIL, COAL AND ASH RADIOACTIVITY TO POPULATION HEALTH OF BAGANUUR CITY OF 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, ash samples were presented. We have made analysis on population health, disease and death reasons of Baganuur district and compared with other district data.

INTRODUCTION

Baganuur district is located as an exclave of 620 km² at the border between the Töv and Khentii aimags. It is one district of Ulaanbaatar city in Mongolia. In 2011 population of Baganuur district was 27036. From 1960 was began coal exploration in this area. Later Soviet Union built the largest open pit coal mine in Mongolia. Baganuur city is one of the largest industrial production locations in Mongolia, and would rank among the country's ten largest cities. There are efforts under way to separate its administration from the capital to make it an independent city.

Baganuur is the endpoint of a side line of the Trans-Mongolian Railway, which connects to the main line in Bagakhangai. Due to high operation cost, Mongolian railway had stopped the passenger trains from UB-Baganuur-UB though freight trains are normally transporting coal to UB and other neighbouring towns. Baganuur is also accessible via 138 km of paved road completed in 2004.

We have collected soil, coal and ash samples from points of Baganuur district of Mongolia and were determined specific radioactivity of radionucldes ^{238}U, ^{232}Th, ^{40}K in the samples and influence of these nuclides to population health.

METHODOLOGY

In order to evaluate the inventory of the environmental radiation levels in the Zuunbayan town, samples of soils were appropriately collected and analyzed in the laboratory by gamma spectrometry. Surface soil of the vicinity of the Zuunbayan town was sampled from 15 x 15 cm square area and 5 cm in depth. Soil sample was put into the Marinelli-beaker with capacity of 700 mL and measured for 3600 s at gamma spectrometry of Nuclear Research Center, National University of Mongolia. The samples were measured for 3600 s in a high resolution gamma-spectrometry system, incorporating an HPGe detector of 20 % relative efficiency and a computerized multichannel analyzer of 4096 channels.

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Gamma measurements were performed with a typical high-resolution gamma spectrometer based on a shielded High-Purity Germanium (HPGe) detector, coaxial type, with $52cm^3$ effective volume and energy resolution of 2.0 keV FWHM for the 1332 keV gamma ray line of Co^{60}. The detector was coupled to the Multi Channel Analyzer system (MCA) and PC board card S-100 Canberra analyzer. The spectrometer was calibrated using 1000mL, 700mL Marinell liquid calibration source of Am^{241}, Cd^{109}, Co^{57}, Ce^{139}, Cs^{137}, Y^{88} and Co^{60} traceable to international standards and emitting γ-rays in the energy range of 59-1836 keV. Specific activity of $Ra^{226}, Th^{232}, K^{40}$ and Cs^{137} was calculated based on the most intensity gamma energy of 609.3 keV (Bi^{214}), 581.3 keV (Tl^{209}), 1460 keV and 661.7 keV, respectively. The following formula has been used to determine the specific activity of radioactive isotope within soil by using the total absorption peak [1]:

$$A = \frac{N(Ei)}{k \cdot \varepsilon_0 \cdot (E) \cdot k_\gamma \cdot m \cdot t} \qquad (1)$$

Where: A – specific radioactivity (Bq/kg); $N(E_i)$ – area under of total absorption peak γ-rays with the energy E_i; k –geometry factor of the detector; $\varepsilon_0(Ei)$ - detector efficiency; k_γ - gamma ray emission factor; m – sample mass (kg); t – measuring time (sec);

External gamma radiation levels around the petroleum exploration field were measured using gamma survey meters (AT-6130, ATOMTEX Russian Company) and showed results of measurement in table1. Absorbed gamma dose rate in the air at 1 m above the ground surface for the uniform distribution of radionuclides (U-238, Th-232 and K-40) were calculated by following formula by using the following equation[1]:

$$P_{abs} = 0,427\,A_U + 0,662\,A_{Th} + 0.043\,A_K \qquad (2)$$

Where: A_{Ra}, A_{Th}, A_K – Ra-226, Th-232, K-40 - the specific activity (Bq/kg); P_{abs} - absorbed dose rate (nGy/h)

The effective equivalent dose from gamma-ray of radioactive isotopes was obtained by the equation [1]:

$$D(\mu Sv) = 0.2xP\left(\frac{nGy}{hour}\right)x0.7\left(\frac{Sv}{Gy}\right)x8760\left(\frac{hour}{year}\right) \qquad (3)$$

There were determined radium equivalent activity and specific radioactivity of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in soil, coal and ash samples of Baganuur district inMongolia by gamma spectrometer and compared these results with Tuv province samples data.

Total radioactivity of radionuclides (^{238}U, ^{232}Th, ^{40}K) in ash samples of Baganuur district was determined by formula[4]:

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

Where: A_{Ra} ,1.3 A_{Th} , A_K are specific radioactivities of ^{238}U, ^{232}Th, ^{40}K respectively.

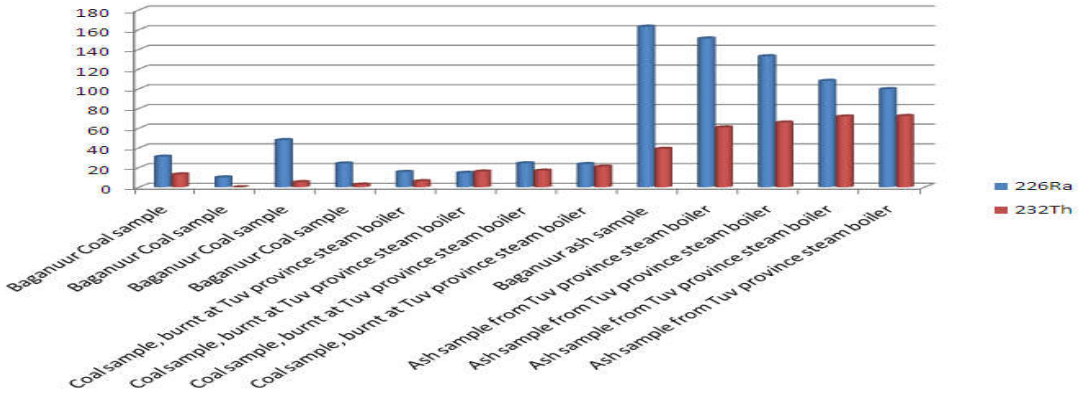

Fig.1 Compared results of **s**pecific radioactivity of ^{226}Ra, ^{232}Th in soil, coal and ash samples of Baganuur district and Tuv province in Mongolia, Bq/kg

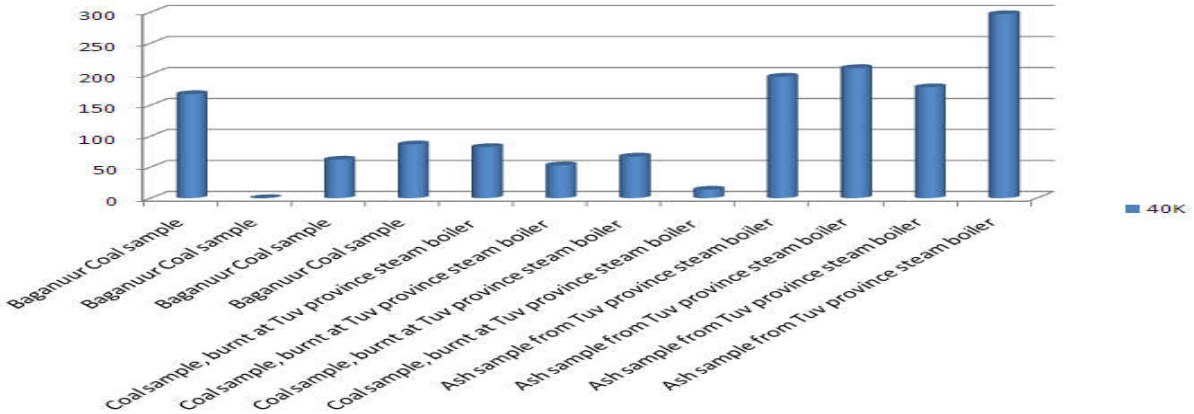

Fig.2 Compared results of **s**pecific radioactivity of ^{40}K in soil, coal and ash samples of Baganuur district and Tuv province in Mongolia, Bq/kg

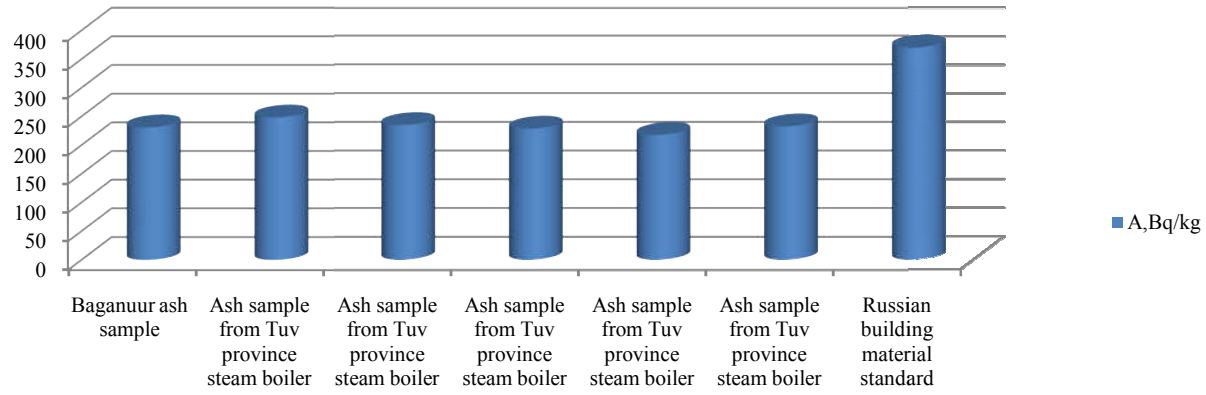

Fig.3 Compared results of total radioactivity of ash samples in Baganuur district and Tuv province in Mongolia, Bq/kg

Hospital characteristics of main districts in Ulaanbaatar city of Mongolia /by the statement of first 12 months of 2012 / [3]

Table I

	District name	Total examination	Precaution examination	Percentage of precaution examination	Ambulatory	Registered diseases				
						Other disease	new	old	New registered disease	New registered damage disease
1	Bayangol	926631	423977	45.755	204354	20878	15628	5250	58	601
2	Bayanzurkh	1068593	492895	46.126	260335	15885	10871	5014	236	157
3	Songinokhairkhan	1516089	706022	46.569	398158	18377	15666	2711	133	1654
4	Sukhbaatar	693343	297620	42.925	202198	20214	15452	4762	124	1412
5	Khanuul	731511	303939	41.549	198386	12849	10706	2143	125	2655
6	Chingeltei	769385	343994	44.71	188585	10693	8502	2191	111	394
7	Nalaikh	180659	53396	29.556	61983	5529	2283	3246	54	243
8	Baganuur	222702	89590	40.229	91094	19757	12481	7276	55	1505
	Summary	6108913	2711433	44.385	1605093	124182	91589	32593	896	8621

From table I you can see that disease at Bagnuur district population was lower than other districts, where there was not coal mine. Also cancer disease at Bagnuur district was lower than 2.02-4.3 times lower than other districts. Population death at Bagnuur district was lower than 1.8-11.05 times lower than other districts.

CONCLUSION

1. Specific radioactivity of ^{226}Ra in soil samples of Baganuur district was 1.3-2.4 times higher than world mean, specific radioactivity of ^{232}Th in soil samples of Baganuur district was 1.1-1.3 times higher than world mean and specific radioactivity of ^{40}K in soil samples of Baganuur district was 2.5-3.1 times higher than world mean.
2. Specific radioactivity of ^{226}Ra, ^{232}Th in ash samples of Baganuur district was enriched 3-5.2 times than coal samples. Total radioactivity in ash samples was 231.3 Bq/kg, which was lower than Russian building material standard/370Bq/kg/[4].
3. Cancer disease at Bagnuur district population was lower than 2.02-4.3 times lower than other districts. Population death at Bagnuur district was lower than 1.8-11.05 times lower than other districts, where there wasn't coal mine.

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