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THE RADIOLOGICAL RISK ASSESMENT METHODOLOGY APPLIED ON SANDS FROM PUBLIC BEACHES

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Abstract

The radiological risk of public exposure to terrestrial radiation in the sand beaches is assessed through the total absorbed gamma dose rate in air and annual effective dose outdoors determination according to international recommendations. Corresponding hazards due to sand use as a building material has been estimated by gamma irradiation hazard indices, based on the data of natural radionuclides contents in sands from public seaside and riverbank beaches (Ulcinj, Belgrade-Danube) obtained in this study, using spectrometry of gamma radiation.

Introduction

Sand deposits originate either igneous or metamorphic rocks, changed during the weathering and erosion processes, but still with some constituent minerals bearing natural radionuclides from U and Th series and ^{40}K. The assessment of their radiological implications due to the gamma ray exposure of the body and irradiation of lung tissue from inhalation of radon and its daughters as well as possible radiation hazards arising due to the use of particular sand in the constructions and dwellings is of a special concern. The objective of our investigation was to identify natural radionuclides contents in sand samples from seaside (Ulcinj, Montenegro) and riverbank (Danube-Belgrade, Serbia) public beaches and to estimate corresponding radiation hazards and dose rates relevant for humans.

Materials and Methods

Superficial beach sand samples were collected from Ulcinj, Montenegro (Ulcinj City Beach, Ulcinj Great Beach) and the river sediment island (Lido Beach) on the Danube, near the Belgrade, Serbia. Samples are homogenized, dried at 110 ºC, weighed and sealed into Marinelli beakers for 40 days until the secular radioactive equilibrium was reached. The activities were obtained by standard gamma spectrometry, using HP Ge detector (Canberra) with 23% relative efficiency and resolution 1.8 keV for 1332.5 keV ^{60}Co gamma line.

Two different hazard indices were calculated: radium equivalent activity Ra_{eq} [1] and representative level index I_r [2]. The absorbed dose rate D in air was estimated [3] based on the average activity concentrations (Bq kg^{-1}) of ^{238}U, ^{232}Th and ^{40}K, obtained in this work. Annual effective dose E (mSv y^{-1}) outdoors was

than calculated according to ICRP (International Commission on Radiological Protection) recommendations.

Results and Discussion

The activity concentrations (Bq kg^{-1}) of natural radionuclides: ^{226}Ra, ^{232}Th and ^{40}K in sand samples analyzed in this study are presented in Figure 1.

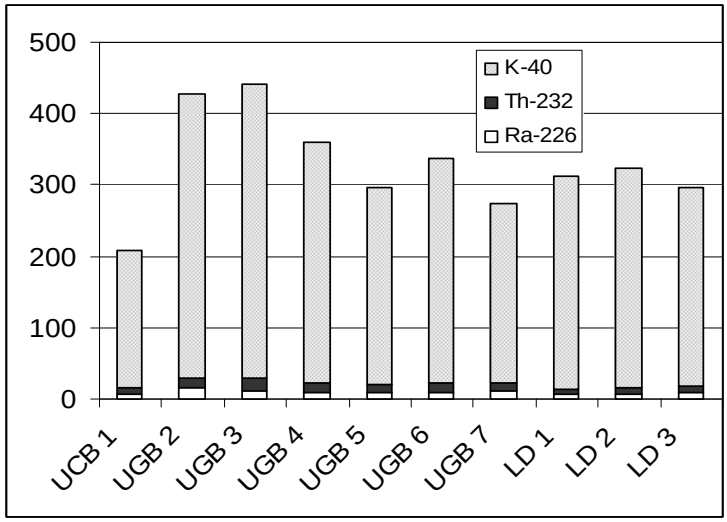

Fig. 1. The activity concentrations C (Bq kg^{-1}) of ^{226}Ra, ^{232}Th and ^{40}K in sand samples from Ulcinj (UCB, UGB1-UGB6) and Lido-Danube Beach (LD1-LD3)

The most of activity was due to the naturally occurring ^{40}K and much lower concentrations of ^{226}Ra and ^{232}Th were noticeable. There was no significant difference between the seaside and riverbank sand samples, The activity concentrations values are in accordance with some previous results [4] and the world quoted intervals: 7-50 Bq kg^{-1}, 10-50 Bq kg^{-1} and 100-700 (mean 370) Bq kg^{-1} for ^{226}Ra, ^{232}Th and ^{40}K in send minerals, respectively [3].

The gamma-ray radiation hazards indices: the radium equivalent activity (Ra_{eq}) and representative level index (I_r) values and corresponding dose values are shown in Table 2. The values of Ra_{eq} index for analyzed sands are in the same range as the population-weighted average value of global primordial radiation of 59 nGy h^{-1} [3]. This index is related to the external gamma dose and internal dose due to radon and its daughters and allows comparison of the activities and radiological effects of sediment samples containing different radionuclides concentrations.

Table 2. Gamma radiation hazard indices and corresponding dose values

Sample No	Ra_{eq} (Bq kg^{-1})	I_r (Bq kg^{-1})	D (nGy h^{-1})	E (mSv y^{-1})
1	35.1	0.27	17.4	0.041
2	67.4	0.52	33.7	0.021
3	67.5	0.52	33.9	0.041
4	54.1	0.42	27.3	0.033
5	47.7	0.37	23.8	0.029
6	51.9	0.40	26.1	0.032
7	47.7	0.36	23.6	0.029
Mean 1-7	50.5	0.43	28.1	0.033
8	40.0	0.32	20.6	0.025
9	43.7	0.34	22.3	0.027
10	43.7	0.34	22.0	0.027
Mean 8-10	42.5	0.33	21.6	0.026

The I_r values obtained for samples from Ulcinj and Belgrade Danube beaches are 33-43% of the 1 Bq kg^{-1} limit value. Both mean gamma-ray absorbed dose rates values are less than the world average: 55 nGy h^{-1} [3]. Finally, to make an estimate for the annual effective dose outdoors, *E,* we have used 0.7 Sv Gy^{-1} as the conversion coefficient from the absorbed dose in air to effective dose received by adults, and 0.2 for the outdoor occupancy factor.[3] Obtained values for all analyzed sands are lower than the worldwide outdoors annual effective dose average 0.07 mSv y^{-1} and below the value of 1.0 mSv y^{-1}, recommended by the ICRP as the maximum allowed annual dose for public.

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