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GAMMA DOSE RATE VALUES IN THE KULAKÇAYIRI NATURAL LAKE AND THE VICINITY (ARNAVUTKÖY, İSTANBUL)

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Abstract

With the formation of the world, the radioactivity affected humanity throughout history. The rock beds beneath the soil layer forming natural radioactivity are sources of terrestrial radioactivity. Environmental gamma radiation consists of terrestrial and cosmic sources. The gamma dose rate method is used to determine the radiation emitted by the terrestrial radiation. In this study, the gamma dose rates were determined by conducting measurements at twenty points at intervals of 12 km from Kulakçayırı Lake and its vicinity. Outdoor gamma doses in the air at a height of 1 meter above the ground level were measured using a portable gamma scintillation detector. The measurements were made once per hour. The average outdoor gamma dose values measured at 20 locations measured per hour in the air at an altitude of 1 m was 37.5 nGy / h.

Keywords: Gamma dose rate, Kulakçayırı lake, environmental radioactivity.

1. Introduction

Radionuclides found naturally and artificially on Earth make up the sources of available radiation that people are exposed to. Cosmic sources, radioactive elements found in rocks, and artificially obtained radionuclides cause the formation of environmental gamma radiation. Examining the Earth's geological structure, it is seen that there are rock beds at a certain

thickness just beneath the soil layer. It is known that a significant part of the gamma radiation is originated from the surface layer at 0-25 cm depth (Kam, 2004).

Depending on the sources of natural and cosmogenic natural radioactivity, environmental radioactivity measurements are required to determine the background radiation level [2]. The terrestrial composition of the background is originated from various radioactive nuclides. The levels of radionuclides in the receiving environment (soil, water and air) change depending on the geological and geographical characteristics of a zone [3].

The soil not only contains organic and inorganic compounds but also natural radionuclides including U-238, Th-232 and K-40. Gamma radiation emitted from naturally occurring radioisotopes is known as terrestrial background radiation. Calculations show that about 50-80% of the total gamma dose comes from U-238, Th-232 and K-40 natural radionuclides on the ground. Since the granite rocks contain significant amounts of thorium, gamma radiation is very high in measurements made in and around these areas [3].

In this study, gamma dose rates, which are caused by natural radionuclides in the soil, were calculated by taking measurements at twenty different locations once per hour at Kulakçayırı Lake and its vicinity.

2. Materials and method

The investigation area is Kulakçayırı Lake and its vicinity, a superficial water source between the province of Istanbul, the counties of Arnavutköy and Hadımköy and the Black Sea. Location map of the investigation area is given in Figure 1.



Figure 1: Location Map of Investigation Area

The land has a topographic structure that is sporadically rugged and close to flat at some places. The region is located in Marmara climatic zone. Depending on the Marmara climatic type, winters in the region are cold and rainy while the summers are warm. There is an increase in surface waters due to precipitation in the region. The investigation area consists of hilly and wavy plains in the northern and eastern regions and slightly wavy plains in the southern and western regions [4].

The study area mainly consists of Trakya Formation (undifferentiated), which is Lower Carboniferous. The Upper Cretaceous (Campanian-Maastrichtian) aged Sariyer Formation unconformably overlies this basis. The unit consists of lavas, tuff and aglomera, intercalated marl, conglomerate and sandstone lithology. The Upper Eocene aged Ihsaniye Formation comes with angular unconformity lies on the Sariyer Formation. The unit consists of clayey limestone, sandy limestone, marl, claystone and sandstone with tuff intermediate level. The Upper Oligocene Danişment Formation with a hollow unconformity lies on this unit. Danişment formation consists of fine-medium bedded sandstone and laminated claystone alternations. Miocene-Pliocene Belgrad Formation lies on the Danişment Formation. All the units found in the base are covered with sand dunes in the plains close to the Black Sea, and covered by the alluvials in the valley beds and flat areas with angular incompatibility [5].

Each measurement lasted one hour. Mobile Eberline Smart Portable (ESP) scintillator was used in the measurements. The SPA-6 model plastic scintillation sensor is connected to the tip of the device. These devices are systems that directly measure external radiation. In the measurements, the gamma radiation dose rate values obtained in $\mu\text{R/h}$ were converted to nGy/h and shown in Table 1 while the gamma dose rate distribution graph according to the locations were shown in Figure 2.

The values ranged between 48 and 32 nGy/h and the average was 37.5 nGy/h . The maximum value of 48 nGy/h (S-1) corresponds to a zone with a relatively higher soil radioactivity.

The absorbed gamma doses obtained in nGy/h can be converted to annual effective doses in mSv/y using 0.7 Sv/Gy conversion factor, 0.8 occupancy factor for closed areas and 0.2 occupancy factor for open areas [2].

As the measurements are carried out for the open field, an occupancy factor of 0.2 is used in the calculations. The annual effective dose was calculated using the following formula. Annual effective dose values are given in Table 1.

$$E_H \left(\frac{\text{mSv}}{\text{y}} \right) = D_H \left(\frac{\text{nGy}}{\text{h}} \right) \times 365,25 \text{ g} \times 24 \text{ h} \times 0,7 \times 0,2 \quad [6]$$

Table 1: The gamma dose rates (DH), annual effective dose rate (EH) values that are absorbed in the open environment for Kulakçayırı Lake and its vicinity.

STATIONS	Gamma Dose Rates D_H (nGy/hr)	Annual Effective Dose Rates E_H (mSV)
S-1	48	0.058
S-2	44	0.053
S-3	42	0.051
S-4	44	0.053
S-5	35	0.042
S-6	37	0.045
S-7	39	0.047
S-8	37	0.045
S-9	38	0.046
S-10	36	0.044
S-11	39	0.047
S-12	37	0.045
S-13	39	0,047
S-14	37	0.045
S-15	34	0,041
S-16	33	0.040
S-17	32	0,039
S-18	32	0.039
S-19	34	0.041
S-20	33	0.040

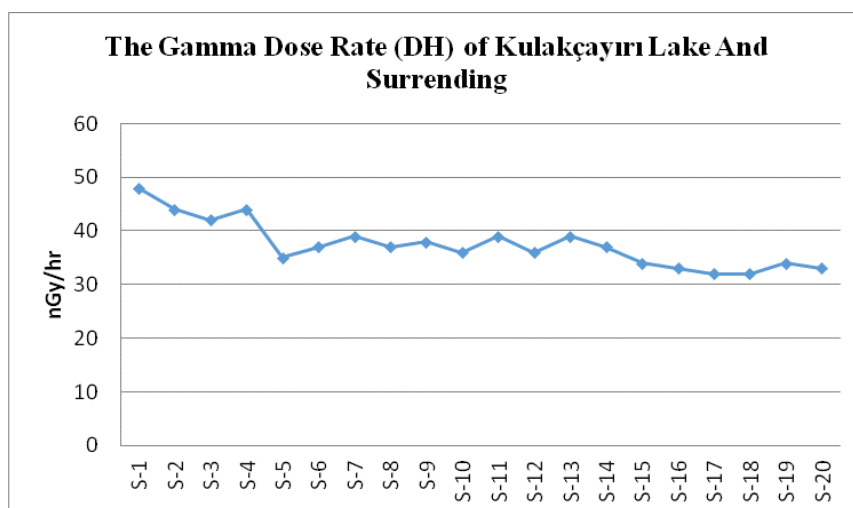


Figure 2: The gamma dose rate (DH), annual effective dose rate (EH) values absorbed in the open area in the Kulakçayırı Lake and its vicinity

3. Conclusion

As a result of analyses, the gamma dose rate value at Kulakçayırı Lake and its vicinity reached the highest value (48 nGy / h) at the S-1 location and the lowest value (32 nGy / h) at the S-17 and S-18 locations.

The results of environmental gamma radiation dose rate analysis show vary between locations. This difference is directly related to the concentration of radioisotopes in the soil structure of the zone, since the main sources of dose values are land and space originated.

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