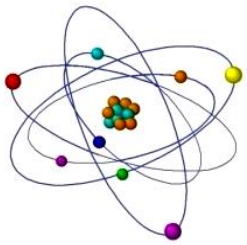
ENVIRONMENTAL GAMMA RADIATION DISTRIBUTION IN WESTERN GEORGIA



Amiranashvili A.G.
Iv. Javakhishvili Tbilisi State University, M.Nodia Institute of Geophysics,

ABSTRACT

*Some results of investigation of environmental gamma radiation (**Γ**) distribution in western Georgia are presented.Measurement of Γ was made on ~ 20 cm above the ground surface at 228 different points by using portable gamma survey meter. The terrain height (H) varied from 1 to 1928 m above sea level. A map of the distribution of the values of Γin the study area is presented. The statistical characteristics of the values of Γ and the peculiarities of their distribution on the territory of western Georgia have been studied. In particular, the following results were obtained. Mean value of Γ is 87nSv/h, range of change: 40-194 nSv/h.The repeatability of the values **gamma radiation** has a unimodal form with the right asymmetry with a max of 20.6% at the value Γ = 87 nSv/h.There is an increase in the values of Γ with the terrain height.Wherein coefficient of linear correlation of individual values of Γ with the H is 0.26.Connection of the height-averaged values of Γ on the H has the form of a power function:* $\Gamma = 53.608 \cdot H^{0.0927}$.

Keywords: Environmental Gamma-Radiation, Natural Radioactivity.

INTRODUCTION

Studies of the natural radioactive in Georgiahave been going on for a long time. A survey of these works, in particular, can be found in [1-2]. Let's note some of them.So, the determination of the content of radioactive elements in the waters of Georgia is conducted since 1912 (mainly the radioactive elements of the uranium series: uranium, radium and radon). At the end of the Thirties of past century these works of the Institute of Geophysics were continued, and was including a study of rock radioactivity [2].

Preliminary studies of radon in the human habitat in different regions in Georgia (habitable and public rooms, Tbilisi subway, etc.) were carried out in 2001-2002 [3-5]. Later there was realized in Georgia the large-scale monitoring of radon in the soil, drinking water and air of apartment houses; were built the maps of the distributions of radon in the indicated media; the connections of the content of radon with the metastasis of lung cancer were revealed; also recommendations were given regarding the protection of population from the dangerous levels of the content of radon. The chemical composition of drinking water simultaneously was studied, were conducted the measurements of the gamma-radiation of soil and walls of the rooms of the houses, content of light ions, meteorological parameters, etc. [6-11]. Traditionally were examined the general problems of radiology [12-14].

In the last years was continued the study of the influence of the ionizing radiations (radon, gamma-radiation, cosmic rays) on the formation secondary aerosols in the atmosphere according to scheme gas→ particle. It is obtained that all types of the indicated ionizing radiations are the catalyst of the formation of sub-micron aerosols from the gases [15-17]. Inparticular, in contaminated air an increase in radon leads to an increase in the content of secondary aerosols and the decrease of the concentration of light ions (i.e., to worsening inthe quality of air). In the final - this is negative influences on the health of people [16-17].

This work is a continuation of previous research.Some results of investigation of environmental gamma radiation distribution in western Georgia are presented below.

Study Area, Materials and Methods

Study area – western Georgia. Measurement of values of **gamma radiation** was made on ~ 20 cm above the ground surface at 228 different points by using portable gamma survey meter.The data on the values of gamma radiation for 51 points were taken from [18], measurements at the remaining 177 points were carried out by the author of this work in 2007-2008.The terrain height varied from 1 to 1928 m above sea level.

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods of random events [18-19].

The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; Range – Max-Min; Median - median value; Mode – modal value; St Dev - standard deviation; σ_m- standard error; $C_V = 100 \cdot St\ Dev/Mean$ – coefficient of variation, %; Skew – coefficient of skewness;K_{urt} - coefficient of kurtosis; Count – number of measured points; 95% and 99%(+/-) – 95% and 99% confidence intervals of average; R^2 – coefficient of determination; R – coefficient of linear correlation;α - the level of significance; Γ- value of **gamma radiation,** nSv/h; H - terrain heightabove sea level, meter.

RESULTS

Results in Fig. 1-4 and in the Table are presented. In Fig.1. General picture of distribution of dose of**environmental** gamma radiation in western Georgia is presented.

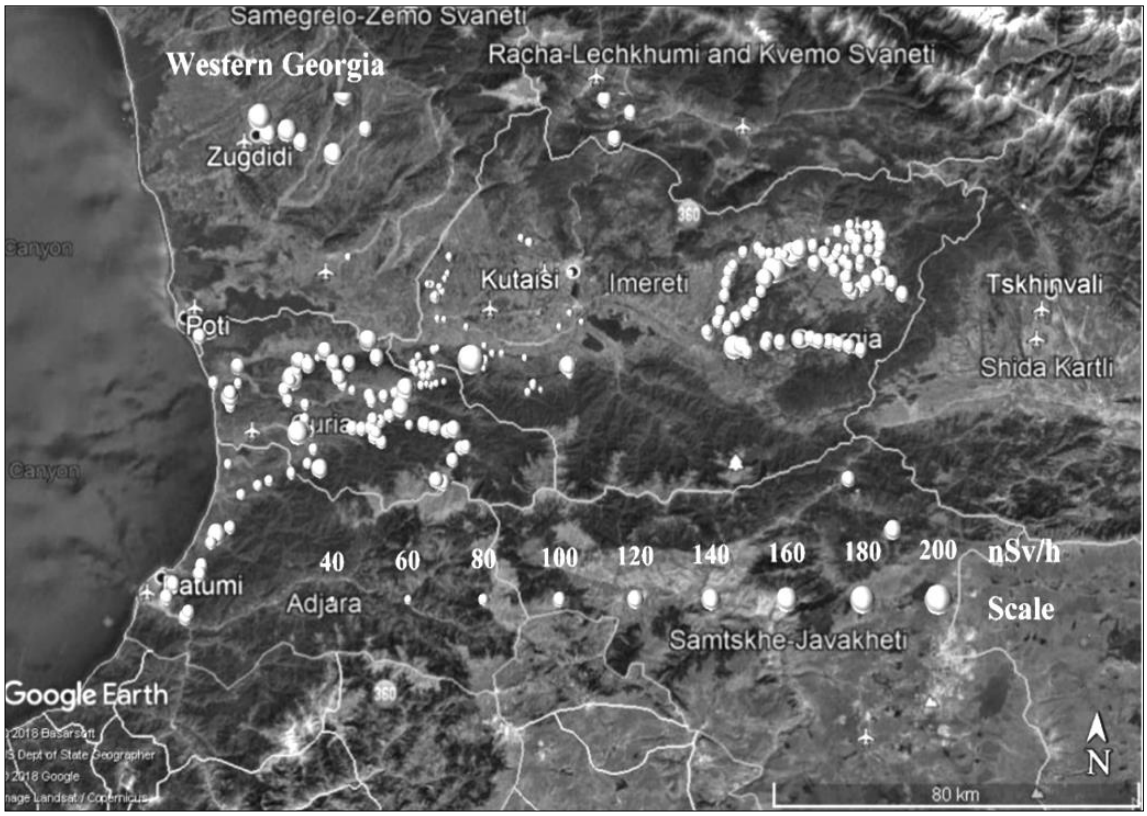


Fig. 1. Distribution of dose of environmental gamma radiation in western Georgia.

The statistical characteristics of valuesof gamma radiation in western Georgia in the Table are presented.

Parameter	nSv/h	Parameter	nSv/h
Mean	87	σ_m	2
Min	40	C_v, (%)	34.1
Max	194	Skew	0.52
Range	154	Kurt	0.50
Median	87	Count	228
Mode	88	95%(+/-)	3.9
St Dev	30	99%(+/-)	5.1

Table. Statistical characteristics of valuesof Γ in Western Georgia.

As follows from this Table mean value of Γ is 87±3.9nSv/h (95% confidence intervals of average) and 87±5.1nSv/h (99% confidence intervals of average), range of change: 40-194 nSv/h.Median, modal and coefficient of skewness values of gamma radiation indicate that the distribution of Γ values is unimodal.Value of coefficient of kurtosis indicates a weak right asymmetryof this distribution.

This is clearly demonstrated in Fig. 2, which shows the repeatability of gamma radiation values. The maximum repeatability is 20.6% at a value of Γ = 87 nSv/h.

In this case value of R between values of Γ and the H is only0.26 (α< 0.005), (Fig.3)– negligiblecorrelation [19].

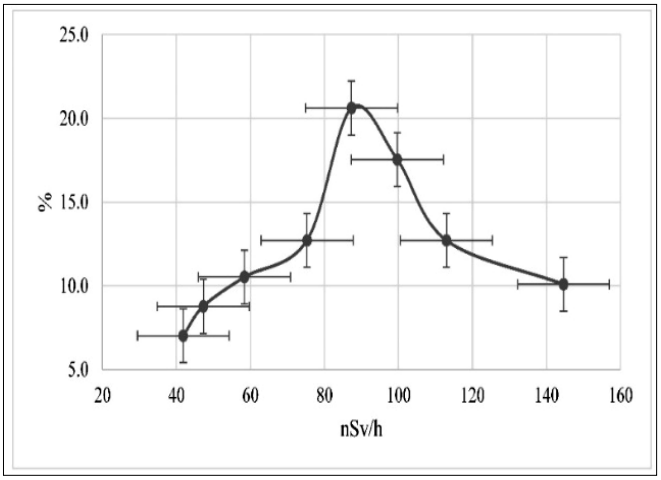


Fig. 2. Repetition of valuesof Γin Western Georgia.

Analysis of the data showed that the values of gamma radiation increase with the height of the terrain.

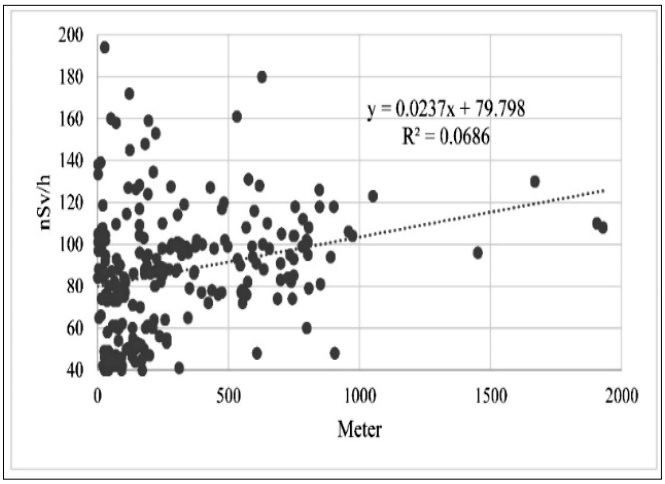


Fig.3. Correlation of individual values of Γ in Western Georgia with theheight of the terrain.

In Fig. 3 linear correlation of individual values of Γ in Western Georgia with the height of the terrain is presented.

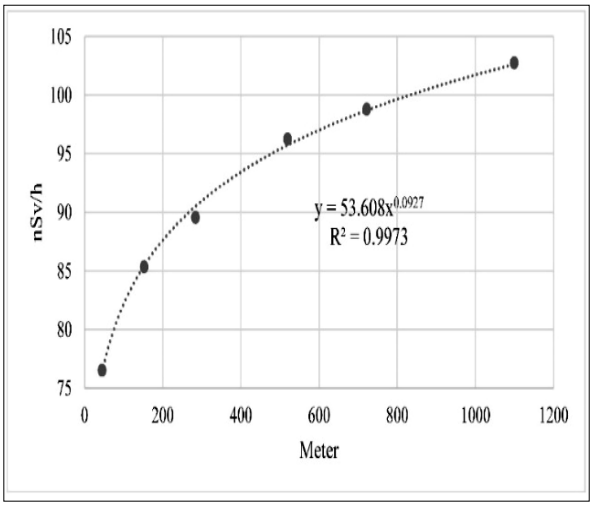


Fig. 4. Dependence of the height-averaged values of Γ in Western Georgia on the height of the terrain.

A much clearer picture is observed when averaging data on gamma radiation for different ranges of terrain heights (Fig. 4).In this case connection of the height-averaged values of Γ on the H has the form of a power function: $\Gamma = 53.608 \cdot H^{0.0927}$, $R^2=0.9973$ ($\alpha< 0.005$), (Fig. 4) - very high correlation [19].

Finally note that the data given in the Table on the wholeare in satisfactorily agreement with similar data given in [20-24].

So, in study [20] the environmental gamma radiation was measured at different 16 points in Bitlis (Turkey). The lowest values of environmental gamma radiation are 41 nSv/h at ground level and 35 nSv/h at the one-meter level on the location XIII, the highest values of environmental gamma radiation are 478 nSv/h at the ground level and 453 nSv/h at the one-meter level on the location XVI.

On paper [21] preliminary results measuring the gamma dose rate distribution in north eastern Burkina Faso where the concentration of uranium in the soil is elevated are presented.The dose rate at one meter above the ground varies between 50 nSv/h and 300 nSv/h. The mean value in the study area is about 128 nSv/h.

In work [22[according to the years of research, maps of pre-Chernobyl background radiation and radon volumetric activityin buildings within the territory of Belarus were constructed. In particular, values of gamma radiation were change in the range 10–120 nSv/h.

According to [23], the total natural dose rate of gamma radiation from soils on the territory of oil fields and beyond the sanitary protection zone (SPZ) in 2005 was 30-430 nSv/h.

In [24], it was found that the intensity of gamma radiation at individual points of the Ajichai fault was - within the fault: 60-150 nSv/h, outside the fault: 40-100 nSv/h.

CONCLUSION

In the future, we plan to continue retrospective analysis of the available data on natural radioactivity in the environment, as well as conduct more detailed studies in this direction for different regions of Georgia.

REFERENCES

1. Amiranashvili A.G. Boleslovas Styra. 105 Years from the Birthday. His Role in the Formation, Development and Modern Evolution of Nuclear Meteorology in Georgia. Journal of the Geophysical Society, Issue B. Physics of Atmosphere, Ocean and Space Plasma, v 20B, 2017, pp.73-87.

2. Institute of Geophysics – 50. (Editor - Academician Balavadze B.K.). Metsniereba, Tbilisi, 1983,144 s. (inRussian).

3.Amiranashvili A., Bliadze T., Nodia A., Nikiforov G., Chelidze L., Chikhladze V., Khazaradze K., Khazaradze R. Several researched results of radon concentrations in human environment, Proc. 1st Int. Conf. on Ecology and Environmental Management in Caucasus, Tbilisi, Georgia, October 6-7, 2001, pp. 61-62.

4. Amiranashvili A., Bliadze T., Nikiforovi G., Nodia A., Chelidze L., Chikhladze V. Radonis shemtsveloba Tbilisis metropolitenshi. Hidrometeorologiis institutis shromebi, ISSN 1512–0902, tomi 108, Tbilisi, 2002, gv. 59–64, (in Georgian).

5.Amiranashvili A., Bliadze T., Nodia A., Nikiforovi G., Chelidze L., Chikhladze V., Khazaradze R., Khazaradze K. Adamianis saarsebi sivrtseshi radonis kvlevis tsinastsari shedegebi. Q. Tbilisis ekologiuri problemebi. Q. Tbilisis meriis garemos datsvisa da bunebrivi resursebis regulirebis komiteti, Tbilisi, 2002, gv. 140–146, (in Georgian).

6.Amiranashvili A., Chelidze T., Melikadze G., Trekov I., Todadze M. Quantification of the radon distribution in various geographical areas of West Georgia, Journal of the Georgian Geophysical Society, Issue A. Physics of Solid Earth, ISSN 1512-1127, vol. 12A, Tbilisi, 2008, pp. 65–69.

7. Amiranashvili A., Chelidze L., Gvinianidze K., Melikadze G., Todadze M., Trekov I., Tsereteli D. Radon Distribution and Prevalence of Lung Cancer in Several Areas of West Georgia, Trans. of the Institute of Hydrometeorology, vol. No 115, ISSN 1512-0902, Tbilisi, 18 – 19 November, 2008, pp. 349–353.

8. Amiranashvili A., Chelidze T., Melikadze G., Trekov I., Todadze M., Chankvetadze A., Chelidze L. Preliminary Results of the Analysis of Radon Content in the Soil and Water in Different Regions of West Georgia. Trans. of MikheilNodia Institute of Geophysics, ISSN 1512-1135, vol. 60, Tbilisi, 2008, pp. 213–218, (in Russian).

9. Vaupotič J., Bezek M., Kapanadze N., Melikadze G., Makharadze T., Machaidze Z.,TodadzeM. Radon and Thoron Measurements in West Georgia. Journal of Georgian Geophysical Society, Issue (A), Physics of Solid Earth, v.15a, 2011-2012, pp. 128-137.

10. Chen J., Kekelidze N., Jakhutashvili T., Kajaia G., Tulashvili E., Elizbarashvili M., Chkhaidze M. Georgian Individual Risks of Radon Induced Lung Cancer. Radiation Emergency Medicine, vol. 2, N 1, 2013, pp. 27-34.

11. Melikadze G., Kapanadze N., Chankvetadze A.,KotetishviliK., Chelidze L., Giorgadze I. RadonDistributiononthe Territory of West Georgia. Journal of the Georgian Geophysical Society, ISSN: 1512-1127, Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 23(2), 2020, pp. 10-13.

12. Tsitskishvili M.S., Tsitskishvili M.M., Chkhartishvili A.G. Problems of radioecology of Caucasus and education for sustainable future of region. “Radiological and agroecologycal Researches”. Volume VI (The complete works consist of the materials of the International Conference devoted to XXX Anniversary of the Institute establishment), ISSN 1512-2786, Tbilisi, 2009, pp.28-34, (in Russian).

13. Tsitskishvili M.S., Ninua T.L., Mikeladze M.O. Regional parameterization by atmospheric transfer for reduction radioactive pollution. “Radiological and agroecological Researches”. Volume VI (The complete works consist of the materials of the International Conference devoted to XXX Anniversary of the Institute establishment), ISSN 1512-2786, Tbilisi, 2009, pp.181-185, (in Russian).

14. Matiashvili S. Overview of radioecological research in some current areas of Georgia. International Scientific Conference „Natural Disasters in Georgia: Monitoring, Prevention, Mitigation. Proceedings, Tbilisi, Georgia, December 12-14, 2019, pp. 145-149, (in Georgian).

15. Amiranashvili A., Bliadze T., Kirkitadze D., Nikiforov G., Nodia A., Chankvetadze A., Chikhladze V. Surface Radon as the Air Pollution Catalyst by Secondary Aerosols in Tbilisi. Trans. Of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 62, Tbilisi, 2010, pp. 197-206, (in Russian).

16. Amiranashvili A., Bliadze T., Chikhladze V. Photochemical smog in Tbilisi. Monograph, Trans. OfMikheil Nodia institute of Geophysics, ISSN 1512-1135, vol. 63, Tb., 2012, 160 p., (in Georgian).

17. Amiranashvili A.G. Increasing Public Awareness of Different Types of Geophysical Catastrophes, Possibilities of Their Initiation as a Result of Terrorist Activity, Methods of Protection and Fight with Their Negative Consequences. Engaging the Public to Fight Consequences of Terrorism and Disasters.NATO Science for Peace and Security Series E: Human and Societal Dynamics, vol. 120. IOS Press, Amsterdam•Berlin•Tokyo•Washington, DC, ISSN 1874-6276, 2015, pp.155-164. http://www.nato.int/science; http://www.springer.com; http://www.iospress.nl

18. REMR – Radiation background of western Georgia and dose of external exposure of public, Radiation ecology of the mountainous region, (REMR), part I, Georgian Academy of Ecological Science, Tbilisi, 2006, 236-245, (in Georgian).

19. Hinkle DE., Wiersma W, Jurs SG. Applied Statistics for the Behavioral Sciences. Boston, MA, Houghton Mifflin Company, 2003.

20. Sultan Şahin Bal, ŞuleKaratepe, Muhammed Fatih Kuluöztürk, Engin Yılmaz, Murat Kurşat.The annual change of environmental gamma radiation in Bitlis. BitlisEren University Journal of Science and Technology, 8(1), 2018, pp. 19–23.

21. Cedric Elisee Beogo, Ousmane Ibrahima Cisse, Abdoul Razak Kanazoe, Abdoul Razakou Maiga, Francois Zougmore**.** Preliminary results measuring the gamma dose rate distribution in north eastern Burkina Faso where the concentration of uranium in the soil is elevated. International Journal of Applied and Natural Sciences (IJANS) ISSN(P): 2319–4014; ISSN(E): 2319–4022, Vol. 8, Issue 5, Aug - Sep 2019, pp. 1–8.

22. Karabanov A. K., ChehovskyA. L., Beljashov A. V., Zhuk I. V., Chunichin L. A. Radon and prechernobylradiation background within the territory of the Republic of Belarus**.** Vestsi Natsyyanal'naiakademiinavukBelarusi. Seryyakhimichnykhnavuk - Proceedings of the National Academy of Sciences of Belarus. Chemical series**,** 2019, vol. 55, no. 2, pp. 205–211 (in Russian).https://doi.org /10.29235/ 1561-8331-2019-55-2-205-211

23. Tomina T.K. Radioekologicheskaya obstanovka na neftyanykh mestorozhdeniyakh prikaspiyskogo regiona. Izvestiya nauchno-tekhnicheskogo obshchestva «KAKHAK», № 2(24), 2009, s. 97-101.

24. Aliyev Ch.S. Seysmodislokatsiiiikh proyavleniye v radioaktivnykh polyakh. 6 str. http://seismology.az /journal /adminka /filemanager/files/custom_files/articles/2008/meq-2008-6.pdf