

## ASSESSMENT OF INDOOR AND OUTDOOR RADON CONCENTRATIONS IN TALYSH, AZERBAIJAN

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**Keywords:** radon volume activity, radon danger, Talysh, thermal waters, people's health, life expectancy

**Summary.** The article describes the results of modern radiation monitoring of the environment conducted in the Talysh region of Azerbaijan. Radiometric studies covered five districts of the Talysh region: Masalli, Lyankyan, Astara, Yardimli and Lerik. Radiometric studies have monitored the level of radon concentrations in residential areas and in water. Measurements of radon volume activity in residential buildings were carried out in settlements of the studied region. The radon volume activity in residential areas was measured with radon Scout and radon Scout Plus radiometers from SARAD. The volume activity of radon in water was estimated using RAD7 (DURRIDGE) radiometers. A MKS-AT1125 dosimeter-radiometer was used to determine the radiation level. Indoor radon volume activity in the Talysh district ranges from 20 to 660 Bq/m<sup>3</sup>. Based on the data obtained, maps of the distribution of radon volume activity are constructed separately for each region. According to these maps, the Lerik region, known for its long-livers, is characterized by relatively high levels of radon. Studies have shown that there is a definite correlation between radon levels in dwellings and life expectancy. The radon content in thermal waters varies very widely from 8.34 Bq/l to 93.3 Bq/l. According to sanitary and hygienic standards for radon content, thermal waters of Talysh are not dangerous for people's health when taking baths and using them as drinking water, except for the Buludul source in Yardimli district. The content of radon in the water of this source exceeds the maximum permissible concentration for drinking water (60 Bq/l) by more than 1.5 times.

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### Introduction

According to the International Committee on Radiation Protection, 40-75% of total human exposure to natural radioactive sources comes from radon and its decay products. In 1987 radon and its decay products were classified by the International Agency for Research on Cancer as being carcinogenic to humans. Researches conducted in Europe and USA showed that radon is the second cause after smoking providing lung cancer diseases (Cohen, 1993). Radon is the main factor of lung cancer among non-smokers (Calabrese, Baldwin, 2002). Protecting people from exposure to the radioactive natural gas radon and its decay products is a national problem and requires the study of a number of issues related to the source of radon and the presence of radon in buildings.

Indoor radon studies in Azerbaijan were carried out for the first time in 2010-2011 by Institute of Geology and Geophysics of Azerbaijan National Academy of Sciences. These studies were conducted with the financial support of the Swiss National Science

Foundation. In 2014-2015 the investigation of radon problem in Azerbaijan was continued in the framework of Azerbaijan State Program (2014-2018). A study of the radon problem in Azerbaijan shows that its distribution in space is uneven and mosaic in nature. The regions with the highest concentrations are confined to the mountainous folded massifs of the G.Caucasus and Talysh, while those with the lowest concentrations are confined to the lowlands (Aliyev et al., 2017). The main objective of the study was to assess the results of the current monitoring of the radiation situation in the Talysh region and the correlation analysis between the life expectancy of the population and radon levels in their places of residence, as well as to develop measures for reducing the risk of radon emissions on a case-by-case basis.

### Materials and methods

Radiometric work in the study area included measurements of the radon volume activity in residential premises and in the water of mineral springs

which water is used by local residents, as well as measurements of radiation levels in the environment. Radon volume activity in residential areas was measured with Radon Scout and Radon Scout Plus radiometers from SARAD. They were installed in residential premises for several days. Radon volumetric activity in soil and water was measured by using RAD7 radiometers (DURRIDGE). The radiation level was measured by using dosimeter radiometer MKC-AT1125. Based on the averaged values of the data obtained, maps of the distribution of radon volume activity over the districts of the region under study were constructed. Maps were produced by using the Surfer program (production of Golden Software).

## Results and discussion

**Indoor radon.** Radiometric studies had covered five districts of the Talysh region: Masalli, Lyankyaran, Astara, Yardimli and Lerik. As mentioned above, measurements of radon volume activity in residential buildings were carried out in the human settlements of the study area. Indoor radon concentrations are measured in the living rooms of houses at ground level. Regarding the recruitment of participants, priority was given to older buildings by randomly selecting 3-5 dwellings in each area. Most of the houses inspected were built 30-50 years ago using bricks made of cement and sand and cemented floors. In Masalli district, studies were carried out in 17 settlements. The radon concentration here varied within 20-170 Bq/m<sup>3</sup>. In 38 surveyed settlements of Lyankyaran district radon concentration varied within 20-600 Bq/m<sup>3</sup>. In the Astara district, research was carried out in 23 localities. The radon concentration here varied within 50-190 Bq/m<sup>3</sup>. In Yardimli district 19 settlements were surveyed. The radon volume activity here varied within 50-730 Bq/m<sup>3</sup>. In Lerik district, studies were conducted in 32 localities. The radon concentration here varied within 89-215 Bq/m<sup>3</sup>. On the basis of the obtained data the map of distribution of radon volume activity for Talysh region has been constructed.

Fig. 1 shows the distribution of indoor radon in Talysh mountain area. According to this map, the Lerik region, known for its long-livers, is characterized by a relatively high level of radon. According to the current regulatory document, the indoor radon volume activity should not exceed 200 Bq/m<sup>3</sup>. As can be seen from the Table 1, in villages where centenarians live, the level of indoor radon varies between 100-200 Bq/m<sup>3</sup>, averaging about 150 Bq/m<sup>3</sup>. According to the Arndt-Schultz physiological law, weak radon stimulation has an activating, moderate – normalizing, strong – suppressive, super-strong –

suppressive and harmful effects on human health (Lackey, 1982) (Table 1).

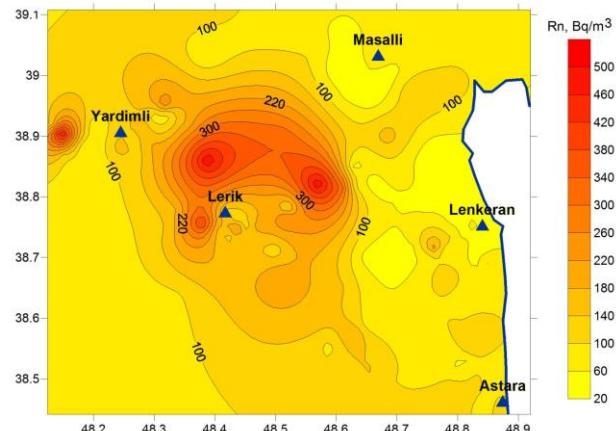


Fig. 1. Distribution of indoor radon volume activity in Talysh

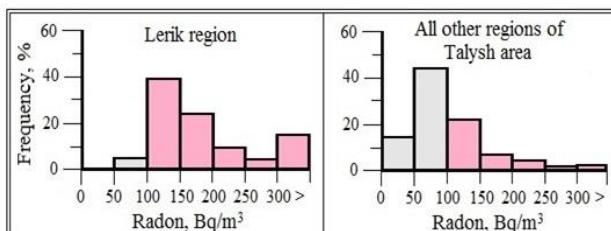
Table 1

The average radon values in some villages of Lerik district of Talysh, where there are centenarians

Vilages	Number of dwellings	Indoor radon, Bq/m <sup>3</sup> (average data)
Lerik	4	125 (101-140)
Shingedulan	4	127 (111-143)
Chayrud	4	199 (183-214)
Bilaband	4	113 (97-128)
Vizezemin	4	115 (109-131)
Pirasora	4	182 (166-197)
Barzavu	4	200 (181-217)
Chaqamiran	4	105 (89-121)
<b>Average</b>		<b>147.6</b>

The relatively higher level of radon in residential buildings in Lerik district compared to other regions of Talysh can be seen more clearly in the presented histograms (Fig. 2).

**Radon in mineral/thermal waters.** Investigation of 9 natural emergences of water in 7 thermal springs provided a wide range of concentrations from 3.73 to 93.3 Bq/l. These mineral waters are classified as weak radon waters. According to sanitary and hygienic regulations, radon in the thermal waters of Talysh is not considered dangerous for people's health either by bathing or drinking, except for the Buludul spring. Radon volume activity in this spring exceeds the maximum permissible concentration for the drinking water (60 Bq/L) by more than 1.5 times (Table 2).



**Fig. 2.**Histograms of distribution of indoor radon values in Lerk and other regions of Talysh mountain area

### Conclusion

The results of studies have shown that there is a certain correlation between radon levels in dwellings and longevity. However, this does not mean that radon can definitely be considered the main factor of

longevity. Undoubtedly, a number of factors, such as climate, ecology, genetics and etc., contribute to this. To this complex we can also include that radon volume activity between 100-200 Bq/m<sup>3</sup> can have a positive effect on people's health and their life expectancy.

### Acknowledgment

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Radon volume activity in thermal waters of Talysh

**Table 2**

№	Spring	R, nSv/h	Radon, Bq/L		
			max	min	mean
1	Istisu (Masalli)	116	3.73	0.834	2.62
2	Donuzuten (Masalli)	118	7.51	2.99	5.95
3	Istisu (Astara) in emergence	121	8.64	8.35	8.5
4	Istisu (Astara) focus	152	11.3	8.69	9.46
5	Yanarbulaq (Astara)	76	11.6	9.01	10.1
6	Istisu (Lyankyan-Lerik)	94	17.3	11.2	14.2
7	Yanardaq (Masalli)	96	20.3	6.26	13.9
8	Buludul (Yardimli) bottom emergence	172	72.1	62.6	66.6
9	Buludul (Yardimli) focus	178	93.3	86.1	90.6

Correlation between radon concentrations in dwellings and longevity

**Table 3**

Mean radon concentration (Bq/m <sup>3</sup> )	Period of residence (year)	Number of people over 90
20-100	>40	5
100-200	>40	14
200-300	>40	4
>300	>40	1

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## ОЦЕНКА КОНЦЕНТРАЦИИ РАДОНА ВНУТРИ И ВНЕ ЖИЛЫХ ПОМЕЩЕНИЙ В ТАЛЫШСКОМ РЕГИОНЕ (АЗЕРБАЙДЖАН)

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**Резюме.** В статье описаны результаты современного радиационного мониторинга окружающей среды, проведенного в Талышском регионе Азербайджана. Радиометрические исследования охватили пять районов Талышской области: Масаллинский, Лянкяранский, Астаринский, Ярдымлинский Лерикский. При радиометрических исследованиях проведены мониторинги уровня концентрации радона в жилых помещениях. Измерения объемной активности радона в жилых домах проводились в населенных пунктах исследуемого региона. Объемную активность радона в воде оценивалась с помощью радиометров RAD7 (DURRIDGE). Для определения уровня радиации использовался дозиметр-радиометр МКС-АТ1125. Объемная активность радона внутри помещений в Талышском районе колеблется в пределах 20-660 Бк/м<sup>3</sup>. На основе полученных данных построена карта распределения объемной активности радона для Талышского региона. Согласно этой карте Лерикский район, известный своими долгожителями, характеризуется относительно высоким уровнем радона. Результаты проведенных исследований показали, что существует определенная корреляция между уровнем радона в жилищах и продолжительностью жизни. Содержание радона в термальных водах изменяется в широких пределах от 8.34 Бк/л до 93.3 Бк/л. По санитарно-гигиеническим нормам содержания радона термальные воды Талыша не представляют опасности здоровью населения при приеме ванн и использовании в качестве питьевой воды, за исключением источника Бюльюдюл в Ярдымлинском районе. В воде этого источника содержание радона более чем в 1.5 раза превышает предельно-допустимую концентрацию, принятую для питьевой воды (60 Бк/л).

**Ключевые слова:** объемная активность радона, радоновая опасность, Талыш, термальные воды, здоровье человека, продолжительность жизни

## TALİŞ REGIONUNUN (AZƏRBAYCAN) YAŞAYIŞ VƏ QEYRİ-YAŞAYIŞ YERLƏRİNDE RADON QAZININ KONSENTRASIYASININ QİYMƏTLƏNDİRİLMƏSİ

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**Xülasə.** Məqalədə Azərbaycanın Talış regionunda aparılan müasir radioekoloji monitorinqin nəticələri təqdim edilmişdir. Aparılmış radiometrik tədqiqatlar Talış bölgəsinin beş rayonunu-Masallı, Lənkəran, Astara, Yardımlı və Lerik rayonlarını əhatə etmişdir. Radiometrik tədqiqatlar zamanı yaşayış rayonlarında radonun həcmi aktivliyinin səviyyəsi və su nümunələrinin radionuklid analizi aparılmışdır. Yaşayış binalarında radonun həcmi aktivliyinin ölçülməsi tədqiq olunan regionun yaşayış məntəqələrində aparılmışdır. Radonun yaşayış sahələrində həcmi aktivliyinin səviyyəsi SARAD firmasının Radon Scout və Radon Scout Plus radiometrləri ilə ölçülülmüşdür. Radonun suda həcmi aktivliyi RAD7 (DURRIDGE) radiometrləri ilə təyin edilmişdir. Radiasiya səviyyəsi MKC-AT1125 radiometri ilə ölçülmüşdür. Müəyyən olılmışdır ki, Talış bölgəsinin yaşayış məntəqələrində radonun həcmi aktivliyi 20-660 Bk/m<sup>3</sup> arasında dəyişir. Alınan məlumatlar əsasında Talış regionu üçün radonun həcmi aktivliyinin paylanması xəritəsi yaradılmışdır. Bu xəritəyə əsasən, uzunömürlüləri ilə tanınan Lerik bölgəsi radonun həcmi aktivliyinin nisbətən yüksək səviyyəsi ilə xarakterizə olunur. Aparılan tədqiqatların nəticələri göstərdi ki, yaşayış binalarında radon həcmi aktivliyinin səviyyəsi ilə əhali arasında müşahidə olunan uzunömürlülük halları arasında müəyyən korrelyasiya mövcuddur. Regionun termal sularında radonun həcmi aktivliyinin göstəriciləri 8.34 Bq/l-dən 93.3 Bq/l-ə qədər çox geniş hüdudlarda dəyişir. Alınmış nəticələrə əsasən Büyüdül bulağından başqa Talışın termal sularının içməli su kimi və balneoligiyada istifadəsi heç bir təhlükə törətmir. Büyüdül bulağında isə radonun həcmi aktivliyi içməli su üçün yol verilən maksimum yol verilən həddən (60 Bq/l) 1.5 dəfə çoxdu.

**Acar sözləri:** radonun həcmi aktivliyi, radon təhlükəsi, Talış, termal sular, insan sağlığı, ömür uzunluğu