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ASSESSMENT OF RADIOECOLOGICAL RISKS AND THE SUITABILITY OF WATER QUALITY FOR DRINKING AND AGRICULTURAL USE IN GUBADLI DISTRICT OF THE REPUBLIC OF AZERBAIJAN

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Summary. In the last 30 years, monitoring and research works have not been carried out in the territory of Karabakh and the Eastern Zangezur economic regions, which include Gubadli region. The paper aims to assess the radioecological risk and ecological safety of the demined area in the Gubadli region of Azerbaijan. Radiation background levels were measured at 64 locations within the area and average radiation background was determined to be 7.5 μR/h, which provided comprehensive understanding of radiation levels in the region.

In addition to radiation background analysis, hydrochemical analysis and assessment of water quality in the area, suitable for domestic consumption, agriculture and industrial purposes, and to assist in water management were also carried out. Total 7 water samples were taken from various sources in the area including rivers and other water bodies. These samples were subjected to the detailed analysis to determine their suitability for domestic, livestock consumption, and irrigation purposes. Physicochemical processes in river systems are affected by various parameters of water quality, which makes continuous monitoring essential for environmental and scientific purposes.

The research results revealed that the mineral content in two water samples was higher than others but did not exceed the limits set by World Health Organization (WHO) standards. In addition, high concentrations of iron (Fe) were detected in three samples, and high concentrations of manganese (Mn) in one sample. These results indicate that these water sources are hazardous for drinking, livestock and irrigation, and highlight the need for additional monitoring and restoration efforts in the region.

Introduction

Gubadli district is one of 66 districts of Azerbaijan. It is located in the southwest of the country and is included in the Eastern Zangezur Economic Region. The district borders Lachin, Khojavand, Jabrayil and Zangilan districts and Syunik province of Armenia. The region is surrounded by the Karabakh range in the southwest, the Bergushad range in the east, and the Karabakh plateau in the southeast. It is here, in the southeast stream between the winding Bazarchay and the Hekari River, that is the continuation of the Karabakh Plateau which slowly descends up to 450 meters lies the Yaziduzu plain.

The Bargushad, Hekari and their tributaries (the Aga river, Kichic Hekari, Meydandersi, etc.) flow through the territory of the district. The water of these rivers was mainly used for irrigation purposes.

The length of the Bargushad river (also called the Bazarchay in some sources) is 178 kilometers. The river mainly takes its source from the Zangezur mountains, the Zalkha lake at an altitude of 3040 meters on the Karabakh plateau, and the Arikli mountains. It is called Bazarchay up to the Urud village. 93 kilometers of the river is in the territory of Armenia. The Bargushad river merges with the Hekari river near the Garalar village of Gubadli district and flows into the Araz. The area of the basin is 2711 square km. After joining the Hekari river, it flows through a relatively flat area and divides into a number of tributaries. The annual flow is underground (55%), snow (35%) and rain waters (10%). Snow waters flood the river in spring and summer.

Average annual water consumption is 19.0 cubic m/sec. 45% of it occurs in spring, 25% in summer, 18% in autumn, and 12% in winter.

The length of the Hekari river is 113 km, the area of its basin is 2570 km^2. It is the second largest river of the Lesser Caucasus after the Tartarchay (together with the Bazarchay) within Azerbaijan. It begins at an altitude of 2580 m, 3.5 km east of the peak of Shishtepe on the southern slope of the Mikhtoken ridge. It is formed by the confluence of Shelvachay and Hojazsuchay rivers (950 m), and connects with the Bargushad river near the Garalar village of Gubadli district (Hindverd Cape). The largest tributary in the Gubadli region is the Lesser Hakari river. Runoff comes from snow (23%), rain (1-5%) and groundwater (62%). Snow waters flood the river in spring and summer. 60-70% of its annual flow passes during the flood period (April-June). The least water consumption in the river is observed in winter.

The water of these rivers is widely used in irrigation and energy. At the same time, these water sources are also evaluated as potential sources of drinking water.

Currently, surface water resources in the territory of Azerbaijan are 27 cubic kilometers, and this figure decreases to 20-21 cubic kilometers in dry years. 70-72 percent of fresh water resources of the country are formed outside the borders of the country (Suleymanov et al., 2008; Ahmadov et al., 2017).

The water resources of rivers in the territory of the Karabakh economic region are 831.7 million cubic meters. The river water reserve formed in the territory of the East-Zangazur economic region is equal to 1622.6 million cubic meters in total. On the territory of Karabakh and East Zangezur economic districts, freed from occupation, the river water reserve is 2508.4 million cubic meters in total. This is equal to 22 percent of the river water reserve formed in the territory of Azerbaijan.

In the last 30 years, monitoring and research works have not been carried out in the territory of Karabakh and the Eastern Zangezur economic regions, which include Gubadli region. During this period, deliberate change of topography of the region, merciless looting of natural resources, and the use of heavy military equipment and various types of explosives polluted the area, disturbed the ecological balance and caused pollution of existing water sources.

For this reason, it is of particular importance to measure the radiation background in the area and to determine the physical-chemical and biological characteristics of the river in order to control the water quality.

Hydro-chemical analysis and subsequent water quality evaluation often reveals quality of water that is suitable for domestic consumption, agriculture and industrial purposes, as well as aiding in the management of the water resource. Furthermore, it is possible to understand the change in water quality due to either rock water interaction or anthropogenic influence. Water often consists of seven major chemical ions which include cations Ca^{2+}, Mg^{2+}, Na^+, K^+ and anions Cl^-, HCO_3^-, SO_4^{2-}. Other parameters include pH, Colour, Turbidity, Free Carbon Dioxide and Total Dissolved Solid. These chemical parameters play a significant role in classifying and assessing water quality. In this paper, we present the results of our studies on the radiation measurement and water quality in the territory of Gubadli district of Azerbaijan Republic. The water samples were collected from different water sources of the Gubadli district, were analyzed and compared with water quality standards for domestic, industrial, livestock and irrigation usage.

Materials and methods

It is known that natural background radiation is the main source of exposure for most people. Background radiation is a measure of the level of ionizing radiation present in the environment at a given location that is not due to the intentional application of radiation sources. Background radiation comes from a variety of sources, both natural and man-made. In order to assess the radioecological risk during the research, the radiation background was measured in 64 locations cleared of mines in the territory of Gubadli region (Fig. 1). Gamma radiation exposure dose rates were measured using the IndetiFINDER-2 dosimeter-spectrometer according to the recommendations of the International Atomic Energy Agency (UNSCEAR 1988; UNSCEAR 1993; UNSCEAR 2000a; UNSCEAR 2000b).

Measurements were made according to standard operating procedures, and the average radiation background was determined to be 7.5 μR/h, with the natural radiation background observed for these locations varying in the range of 2.5-14.5 μR/h. The dose rate of radiation at the measurement points is presented in Fig. 2.

As it can be seen, only one point has a relatively high result. Relatively high radiation levels were observed in the point 22-Davudlu area, which necessitates continuous monitoring. In general, the observed results for radiation background measurements indicate that there are no risks in terms of radiation safety in the study area.

Fig. 1. The measurement of radiation background was carried out in the areas of Gubadli district

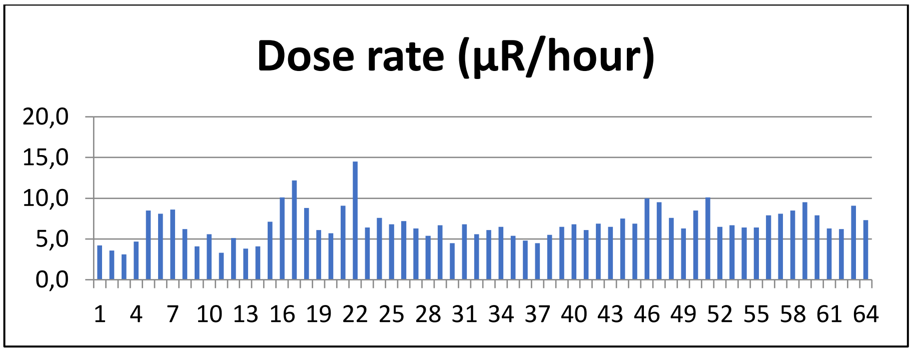

Fig. 2. The dose rate of radiation at the measurement points in the Gubadli district

Water samples were taken from 7 different points of Gubadli area. Water samples were collected using a standard polyethylene water sampler, which was rinsed several times with river water from the sampling point before obtaining representative samples from 30 cm below the water surface. A 200 ml water sample was filtered through a 0.45 μm membrane filter using a manual plastic filtration assembly. A few drops of high-purity nitric acid (HNO_3) were added to the filtrate to adjust the pH. The sample was then securely stored at 4°C during transport to the laboratory. Water sampler was rinsed with deionized water between each sampling event. All plastic ware including sample bottles, pipette tips, filtration units, and flasks were soaked in 10% v/v HNO_3 for 24 hours and rinsed with deionized water before use.

When water samples are brought in sterile containers and cannot be measured immediately, they are stored in a refrigerator. The samples are transferred from the containers to the measuring beakers for immediate measurements.

The pH meter is calibrated first and then used to take measurements. The pH meter electrodes are rinsed with distilled water to prevent cross-contamination between different samples.

If immediate measurement is not possible, water samples are usually carefully stored in sterile containers in the refrigerator to preserve their integrity. Once ready for analysis, these samples are transferred to measuring containers. This meticulous process helps maintain the integrity and accuracy of pH measurements.

To assess total dissolved solids (TDS), conductivity (Cond), and salinity, a conductivity meter is utilized with its electrodes rinsed using distilled water following each sample measurement. The conductivity meter provides crucial insights into water conductivity levels. The dedicated DO meter is employed for measuring dissolved oxygen (DO) after being cleaned with distilled water offering rapid results within seconds allowing swift analysis of oxygen levels in the samples. Measurements are iterated multiple times ensuring reliable data collection to enhance precision. The results obtained from the water samples are tabulated (Table 1) providing a comprehensive overview of their respective characteristics. This approach guarantees accurate assessment of water composition and quality.

Table 1

Water parameters of samples taken from Gubadli district

	Parameters	Source Coordinates		pH	COND	TDS	DO
N	**Sampling points**	longitude	latitude		mksm/cm	mg/L	mg/L
1	Mahmudlu v. Bargushad river	$39^0 26^/ 207^{//}$	$046^0 33^/ 591^{//}$	8.3	250	173	7.29
2	Aliguluushagı-Davudlu, Bargushad river	$39^0 48^/ 53.12^{//}$	$046^0 28^/ 149^{//}$	8.1	256	187	7.71
3	Spring - Drinking water source	$39^0 26^/ 297^{//}$	$046^0 27^/ 286^{//}$	8.1	544	339	7.36
4	Armenian border, Bargushad River	39°25'50.0"	046°23'21.4"	8.2	239	164	7.71
5	Lachın border, Gulabird v., Hekari river	$39^0 28^/ 368^{//}$	$046^0 37^/ 054^{//}$	8.2	292	186	7.64
6	Armenian border, Eyvazlı-Shahverdiler v. (Technical water)	39°25'50.0"	046°23'21.4"	8.5	213	146	6.88
7	Davudlu river	$39^0 26^/ 240^{//}$	$046^0 25^/ 342^{//}$	8.2	453	301	6.24
	WHO (World Health Organization)			6.5-8.5	500-1000	500	–

Water samples collected for the assessment of metal pollution is a complex process need to ensure accurate analysis. Initially, the collected samples are filtered. These prepared samples are seperated as filter and then total sample stored in containers suitable for heavy metal analysis. The water samples were collected after 30 minutes of pumping to avoid stagnant and contaminated water. White plastic containers were rinsed out 3-4 times with sample water. Then the containers were filled up to capacity and were immediately sealed to avoid exposure to air. After collecting the samples, the containers were labelled for identification and brought to the laboratory.

Water samples were tested for pH, TDS, sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sulfate (SO_4^{2-}), chloride (Cl^-), bicarbonate (HCO_3^-) and metal concentrations were analyzed for Cu, Fe, Mn, Mo, Ni, Zn. Na^+, K^+, Ca^{2+}, and Mg^{2+} were determined among the analysed parameters using a flame atomic absorption spectrometer.

After some stages, element concentrations in each sample are measured utilizing an Agilent 7700x ICP-MS (Inductively Coupled Plasma Mass Spectrometry) system operating in helium mode (Mammadzada et al., 2021; Ahmadov et al., 2016). Before analytical measurements, the instrument is allowed thermally equilibrating minimum of 30 minutes. Prior to analysis, mass calibration and resolution checks are performed in the specified mass regions of interest to ensure the accuracy and reliability of the measurements. Metal concentration of samples are given below (Table 2).

Table 2

Comparison of metal concentration with WHO recommended limit values

No	Sampling Point	Cu, µg/L	Fe, µg/L	Mn, µg/L	Mo, µg/L	Ni, µg/L	Zn, µg/L
1	Mahmudlu v. Bargushad river	3.41	425	170	<MDL	7.04	55.4
2	Aliquluushagı-Davudlu,Bargushad river	8.22	314	40.5	6.86	8.6	100
3	Spring - drinking water source	6.16	209	31.2	<MDL	1.54	10.9
4	Armenian border, Bargushad River	5.9	251	32.7	<MDL	7.7	10.2
5	Lachınborder, Gulabird v., Hakari river	4.61	214	42.8	1.06	<MDL	6.3
6	Armenian border, Eyvazlı-Shahverdiler v. (Technical water)	9.93	134	20.4	25.4	1.36	2.3
7	Davudlu river	5.1	325	48.4	<MDL	2.83	2.74
	WHO (World Health Organization)	2000	300	100	70	70	5000

Results and discussion

As shown in Table 1, the electrical conductivity measured for the samples taken from the Davudlu River and the spring (sample number: 3.7) has a higher value than other sources but does not exceed the recommended limit according to the guidelines of the World Health Organization (WHO) and can be recommended as drinking water sources. The relatively high electrical conductivity of the mentioned water sources indicates the high mineralization of these sources. In all the water samples analyzed, the levels of Cu, Mo, Ni and Zn are notably below the thresholds set by the WHO (Table 2). However, at the first sampling point, concentrations of Fe and Mn exceed the recommended limits, while at the second and seventh points, only Fe surpasses the guidelines. Although the average iron concentration in rivers is typically around 0.7 mg/L, post-treatment, Fe levels are usually maintained below 0.3 mg/L for safe drinking water.

Hence, it's not advisable to utilize the mentioned water sources (sampling points 1, 2, and 7) directly for drinking purposes.

Comparing the received conductivity results with the standards showed that all samples complied with the requested standards and may be used in livestock drinking purposes and irrigation. Anions and cations analysis results in samples demonstrate that HCO_3^-, Cl^-, SO_4^{2-}, Na^+, K^+, Mg^{2+}, and Ca^{2+} ions dominate in the studied areas.

Comparison of the cation concentrations of the studied water samples showed that water samples 1 and 5 have 1) Ca>Mg>Na>K sequence, water samples 2,3,4,7 have 2)Ca>Na>Mg>K sequence, and water sample 6 have 3)Na>Ca>Mg>K sequence of cations. This means that Na ions prevail over K ions and Ca ions prevail over Mg ions for all sequences of cations. It is known that, observation of the existence of Ca and Mg in water samples is the result of the weathering of crystalline dolomitic limestones and Ca-Mg silicates (amphiboles, pyroxenes, olivine, biotite and others (Zakir et al., 2013; Singh et al., 2009). The origin of Na and K in water may be atmospheric deposition, evaporate dissolution, and silicate as albite, anorthite, orthoclase and microcline weather (Zakir et al., 2013; Ghosh et al., 1983, Singh et al., 2007; Ayers and Westcot, 1985; Singh et al., 2010). As it is noted in (Zakir et al., 2013), if Na concentration in water is less than 50mg/L, it is not dangerous for human drinking and if it is less than 920 mg/L it is not dangerous for irrigation. The concentration of sodium changes in the range of 5.6-38 mg/L and has an average of 15.87 mg/L on the studied water samples. As shown in Table 3, all water samples are suitable for irrigation and for human drinking. K concentration obtained for water samples changes from 2.3mg/L to 6.4mg/L and has the average of 3.5mg/L. Comparison of potassium concentration in the studied water samples with standards (Table 4) shows that K concentration is less than 100mg/L for all samples and this water is suitable for drinking but the studied water sources are problematic for irrigation. The concentration of Ca for the measured samples changes from 15mg/L to 48 mg/L and has average of 32.7mg/L. If the concentration of Ca in water is less than 800 mg/L, it has no danger for irrigation. Therefore, all measured water samples can be implemented for irrigation and using water of this standard for irrigation is not problematic for soil (Zakir et al., 2013). We can note that all water samples are suitable for human drinking according to Ca results considering the opinion of authors (Zakir et al., 2013; Ghosh et al., 1983, Singh et al., 2007). The concentration of Mg on the studied samples changes in the range of 6.2mg/L – 12.2mg/L, and has the average of 8.67mg/L. As shown in Table 4, if the concentration of Mg in water is less than 120 mg/L, this source has no danger for irrigation. The maximum acceptable concentration of Mg is 30 mg/L for human drinking water (Ghosh et al., 1983). Therefore, all measured samples, may be used as human drinking water. HCO_3^- anion concentration on the studied river waters changes in the range of 61 mg/L –105 mg/L and has average of 78mg/L. Only samples 3 and 7 have more than 92mg/L HCO_3^- anion concentration and these samples are not suitable for irrigation according to the HCO_3^- anion concentration rate. The HCO_3^- anion concentration of the studied samples complies the requested standards (Ghosh et al., 1983) and they are suitable for being used as drinking water.

The concentration of SO_4^{2-} ions in the measured water samples varies from 31 mg/L to 116 mg/L with average of 66.85 mg/L. Water for agriculture usage purposes has a permissible level equal to 20 mg/L for SO_4^{2-} ions according to Tables 3 and 4. Therefore, not all water samples from the investigation areas can be used for irrigation. The recommended levels are 200 mg/L and <250 mg/L for human and livestock drinking water according to (Zakir et al., 2013; NAS 1983). Therefore, all the studied water samples are suitable for usage. The suitability of water for irrigation purposes depends on its mineral constituents. Several criteria for judging its suitability have been proposed in (Wilcox, 1955; Eaton, 1950). Irrigation water containing large amounts of sodium is of special concern due to sodium effects on the soil and its potential to pose sodium hazard. The high concentration of sodium in irrigation water may negatively affect soil structure and decrease soil hydraulic conductivity in fine-textured soil. The degree to which sodium will be absorbed by soil is a function of the amount of sodium to divalent cations (Ca and Mg) and is regularly stated by sodium adsorption ratio (SAR) (Bouwer and Idelovitch, 1987).

Table 3

Data for investigated water parameters

№	pH	Conduc-tivity	TDS	Chlo-ride (Cl^-)	Sul-phate (SO_4)	Bicar-bonate	Sodium (Na)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
		mkSm/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	8.3	250	173	5.3	52	76	8.3	2.3	28	8.6
2	8.1	256	187	7.8	54	78	9.4	2.8	29	9.3
3	8.1	544	339	26	116	105	38	6.4	48	8.9
4	8.2	239	164	9.9	48	62	7.8	3.2	26	6.2
5	8.2	292	186	11.4	66	61	5.6	2.3	33.2	8.7
6	8.5	213	146	14	31	62	16	4.4	15	6.8
7	8.2	453	301	24	101	102	26	3.1	46	12.2
min	**8.1**	**213**	**146**	**5.3**	**31**	**61**	**5.6**	**2.3**	**15**	**6.2**
max	**8.5**	**544**	**339**	**26**	**116**	**105**	**38**	**6.4**	**48**	**12.2**
mean	**8.23**	**321**	**213.7**	**14.05**	**66.85**	**78**	**15.87**	**3.5**	**32.17**	**8.67**

Table 4

Geochemical parameters in the water samples compared to desirable standard values for drinking, livestock and irrigation use

Parameters	Range	Mean	Max. desirable value for drinking water	Max. desirable value for livestock drinking water	Max. desirable value for irrigation
pH	**8.1-8.5**	**8.23**	6.5-8.5	6.8-7.5	6.0-8.4
EC(μS/cm)	**213-544**	**321**	750	-	-
TDS(mg/L)	**146-339**	**213.7**	500	<500	-
HCO_3^- (mg/L)	**61-105**	78	200	<400	92
SO_4^- (mg/L)	**31-116**	**66.85**	200	<250	20
Cl^- (mg/L)	**5,3-26**	**14.05**	250	-	142
Ca^{2+}(mg/L)	**15-48**	**32.17**	75	-	800
Mg^{2+}(mg/L)	**6.2-12.2**	**8.67**	30	-	120
Na^+ (mg/L)	**5.6-38**	15.87	50	-	920
K^+ (mg/L)	**2.3-6.4**	3.5	100	-	2.0

The Sodium Absorption Ratio (SAR) can be calculated from the ratio of sodium to calcium and magnesium (Asadollahfardi G. and Asadollahfardi R., 2011).

The equation is expressed as follows:

$$SAR=\frac{Na^+}{\sqrt{(Ca^{2+}+Mg^{2+})/2}}$$

where, all the ions are expressed in meq/L.

Variation from 0.2230 to 1.3182 average value of 0.6244 (Table 5). Sodium Absorption Ratios for all water samples are less than 10. The potential for sodium hazard increases in waters with higher sodium adsorption ratios (SAR) values. The sodium absorption ratio (SAR) content in the study area has shown and indicates excellent quality for irrigation. The samples fall in the excellent (S1) category (Table 6).

Soluble Sodium Percent (SSP) is also used to evaluate sodium hazard. SSP is defined as the ratio of sodium to the total cations (Asadollahfardi G. and Asadollahfardi R., 2011; Todd and Mays, 2005):

$$SSP=\frac{Soluble(Na^{+}+K)*100}{Total\ cations\ consentration}$$

where, all the ionic concentrations are expressed in meq/L.

Soluble Sodium Percent (SSP) values less than 50 or equal to 50 indicate good quality water and those more than 50 indicate water quality unsuitable for irrigation. The values of Soluble Sodium Percent (SSP) range from 11.3 to 38.0 and average 23.7. 100% Soluble Sodium Percent (SSP) for water in test areas is less than 50 and indicates good quality water for irrigation purposes (Table 6).

KR: Sodium measured against Ca^{2+} and Mg^{2+} is used to calculate Kelley's ratio. The formula used in the estimation of Kelley's Ratio (Wilcox, 1955; Who 2008):

$$KR=Na^+/(Ca^{2+}+Mg^{2+}).$$

Kelley's Ratio (KR) of more than one indicates an excess level of sodium in water. Hence, water with Kelley's Ratio less than one are suitable for irrigation, while those with a ratio of more than one are unsuitable for irrigation. The values of Kelley's Ratio (KR) range from 0.10 to 0.53 and average 0.29. 100% of Kelley's Ratio values for the water of the test area are less than 1 and indicate good quality water for irrigation purpose (Table 6).

Residual sodium carbonate (RSC): The Residual Sodium Carbonate (RSC) was also calculated and used for irrigation water quality assessment. This parameter is used for the assessment of effect of carbonate and bicarbonate on quality of water for agricultural purposes. RSC is calculated as follows:

$$RSC= (CO_3^{2-} +HCO_3^-)-(Ca^{2+}+Mg^{2+})$$

where, all the ions are expressed in meq/L.

The potential for sodium hazard increases as RSC increases, and much of the calcium and the magnesium are precipitated out of solution when water is applied to the soil. Salts become concentrated when soil dries out, as less soluble ions (as Ca^{2+} and Mg^{2+}) tend to precipitate out of solution (Omotoso and OJO, 2012; Zafar and Ahmad, 2018; Howladar et al., 2017). The values of RSC ranges from -1.64 to -0.30meq/L with average value of -1.05 (Table 5). In the test area, the RSC is negative showing that Na^+ build-up is unlikely, with practically no Na^+ hazard and therefore classified as suitable for irrigation. Water having less than or equal to 1.25 epm of RSC is safe for irrigation purposes. The water having a RSC from 1.25 to 2.5 epm is marginally suitable for irrigation purposes, whereas water having more than 2.5 epm of RSC is not suitable for irrigation purposes. Based on RSC values, all the samples of the test area have values less than 1.25 epm and are safe for irrigation (Table 6).

Table 5

The results of the geochemical analysis of water samples collected from Gubadli district of Azerbaijan

№	Na, meq/L	K, meq/L	Ca, meq/L	Mg, meq/L	Cl^-, meq/L	SO_4, meq/L	Bicarbonate meq/L	SAR	% Sodium	RSC	KR
1	0.36	0.06	1.4	0.72	0.15	1.08	1.25	0.3508	16.6	-0.87	0.17
2	0.41	0.07	1.45	0.78	0.22	1.13	1.28	0.3875	17.8	-0.95	0,18
3	1.65	0.16	2.4	0.74	0.73	2.42	1.72	1.3182	36.6	-1.42	0.53
4	0.34	0.08	1.3	0.52	0.28	1.00	1.02	0.3558	18.8	-0.80	0.19
5	0.24	0.06	1.66	0.73	0.32	1.38	1.00	0.2230	11.3	-1.39	0.10
6	0.70	0.11	0.75	0.57	0.39	0.65	1.02	0.8574	38.0	-0.30	0.53
7	1.13	0.08	2.3	1.02	0.68	2.10	1.67	0.8778	26.7	-1.64	0.34
min								0.2230	11.3	-1.64	0.10
max								1.3182	38.0	-0.30	0.53
mean								0.6244	23.7	-1.05	0.29

Table 6

Classification of water based on SAR, KR, SSP and RSC

Parameter	Range	Water Class	Samples	% age
SAR	<10 10-18 18-26 >26	Excellent (S1) Good (S2) Doubtful (S3) Unsuitable (S4)	7	100
SSP	<50/>50	Good/Bad	7/0	100/0
KR	<1/>1	Good/Unsuitable	7/0	100/0
RSC	<1.25 1,25-2.5 >2.5	Good Doubtful Unsuitable	7	100

Conclusion

In order to assess the radioecological risk during the research, the radiation background was measured in 64 locations cleared of mines in the territory of Gubadli region, and the average radiation background was determined to be 7.5μR/h. For estimation water quality water samples were collected and analyzed for their hydrochemical characteristics and an evaluation of water quality for drinking and irrigation purposes was made. Water samples were tested for pH, TDS, sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sulfate (SO_4^{2-}), chloride (Cl^-), bicarbonate (HCO_3^-) and metal concentrations were analyzed for Cu, Fe, Mn, Mo, Ni, Zn.

In all the water samples analyzed, the levels of Cu, Mo, Ni, and Zn are notably below the thresholds set by the WHO. However, at the first sampling point, concentrations of Fe and Mn exceed the recommended limits, while at the second and seventh points, only Fe surpasses the guidelines. The high concentration observed for Fe and Mn elements can be explained by the leaching of minerals in mountain rivers.

Comparison of the cation concentrations of the studied water samples showed that water samples 1 and 5 have the 1)Ca>Mg>Na>K sequence, water samples 2,3,4,7 have 2)Ca>Na>Mg>K sequence, and water sample 6 have 3)Na>Ca>Mg>K sequence of cations. This means that Na ions prevail over K ions and Ca ions prevail over Mg ions for all sequences of cations. SAR values and sodium percentage (Na %) in test locations indicate that all water samples are suitable for use in irrigation.

Hydrochemical analysis demonstrates that samples are typical of shallow fresh waters. The EC values in the studied samples range from 213 to 544 μS/cm. Similarly, pH value of all the collected samples range from 8.1 to 8.5 compared to the recommended WHO guideline range of 6.5-8.5 for drinking water. The anion chemistry of the analyzed water samples show HCO_3^-, Cl^-, and SO_4^{2-} to be the dominant anions at the test area. With respect to HCO_3^- and SO_4^{2-} content, all water samples were found suitable for drinking and livestock usage. The concentration of SO_4^{2-} ions in the measured water samples varies from 31 mg/L to 116 mg/L with average of 66.85 mg/L. Water for agriculture usage purposes has a permissible level equal to 20 mg/L for SO_4^{2-} ions, according to Tables 3 and 4. Therefore, not all water samples from the studied areas can be used for irrigation. With regards to Cl^-, all water samples under the studied area were found suitable for drinking and livestock purposes. Based on RSC values, all samples of the test area have values less than 1.25 epm and are safe for irrigation.

The study underscores the necessity for continuous monitoring and comprehensive analysis of water quality in the Gubadlı district. Given the observed high levels of certain metals, further efforts are needed to ensure the safe use of these water sources, especially for drinking purposes.

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ОЦЕНКА РАДИОЭКОЛОГИЧЕСКИХ РИСКОВ И ПРИГОДНОСТИ КАЧЕСТВА ВОДЫ ДЛЯ ПИТЬЕВОГО И СЕЛЬСКОХОЗЯЙСТВЕННОГО ИСПОЛЬЗОВАНИЯ В ГУБАДЛИНСКОМ РАЙОНЕ РЕСПУБЛИКИ АЗЕРБАЙДЖАН

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Резюме. За последние 30 лет на территории Карабаха и Восточно-Зангезурского экономических районов, куда входит Губадлы, мониторинг и исследовательские работы не проводились. В статье приводятся результаты работ по оценке радиоэкологического риска и экологической безопасности разминированной территории в Губадлинском районе Азербайджана. Уровень радиационного фона был измерен в 64 точках данной территории, и средний радиационный фон составил 7.5 мкР/час, что дало полное представление об уровне радиации в регионе.

Кроме анализа радиационного фона, также были проведены гидрохимический анализ и оценка в этом районе качества воды, пригодного для бытового потребления, сельского хозяйства и промышленных целей. Всего было взято 7 образцов воды из различных источников, включая реки и другие водоемы. Эти образцы подверглись детальному анализу с целью определения их пригодности для бытового использования, потребления скотом и орошения. Физико-химические процессы в речных системах зависят от различных параметров качества воды, что делает постоянный мониторинг необходимым для экологических и научных исследований.

Результаты исследования показали, что содержание минералов в двух образцах воды было выше, чем в других, но не превышало пределов, установленных стандартами ВОЗ. Кроме того, в трех образцах были обнаружены высокие концентрации железа (Fe), а в одном образце – высокая концентрация марганца (Mn). Эти результаты свидетельствуют о том, что данные источники воды непригодны для питья, использования для скота и орошения, что подчеркивает необходимость дальнейшего мониторинга и устранения загрязнений в этом регионе.

Ключевые слова*: Губадлинский район Азербайджана, радиоэкология, управление качеством воды, остаточный карбонат натрия (ОКН), коэффициент поглощения натрия (КПН), процент растворимого натрия (ПРН)*

AZƏRBAYCAN RESPUBLİKASININ QUBADLI RAYONUNDA RADİOEKOLOJI RİSKLƏRİN VƏ SU KEYFİYYƏTİNİN İÇMƏLİ VƏ KƏND TƏSƏRRÜFATI ÜÇÜN YARARLILIĞININ QİYMƏTLƏNDİRİLMƏSİ

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Xülasə. Son 30 ildə Qarabağ və Şərqi Zəngəzur iqtisadi rayonlarında, o cümlədən Qubadlıda monitorinq və tədqiqat işləri aparılmayıb. Tədqiqatın əsas məqsədi Azərbaycanın Qubadlı rayonunda yerləşən minadan təmizlənmiş ərazilərdə radioekoloji riskin qiymətləndirilməsi və ekoloji təhlükəsizliyin öyrənilməsidir. Ərazinin 64 nöqtəsində radiasiya fonu ölçülmüş və orta radiasiya fonu 7.5μR/saat olaraq müəyyən edilmişdir ki, bu da həmin ərazilərdə radiasiya səviyyəsi haqqında geniş məlumat əldə etməyə imkan verir.

Radiasiya fonunun təhlili ilə yanaşı, ərazidəki suyun məişət istehlakı, kənd təsərrüfatı və sənaye məqsədləri, həmçinin su ehtiyatlarının idarə edilməsində kömək üçün uyğun olan hidrokimyəvi təhlil və qiymətləndirmə aparılmışdır. Müxtəlif su mənbələrindən, o cümlədən çaylardan və digər su hövzələrindən 7 su nümunəsi götürülmüşdür. Bu nümunələr məişət, heyvandarlıq və kənd təsərrüfatı üçün yararlılığını müəyyən etmək üçün analiz edilmişdir. Çay hövzələrində başverən fiziki-kimyəvi proseslər suyun keyfiyyət parametrlərindən asılıdır və bu parametrlərin davamlı monitorinqi elmi tədqiqatlar və ekoloji nəzarət üçün vacibdir.

Tədqiqatın nəticələri iki su nümunəsindəki mineral tərkibin digərlərinə nisbətən daha yüksək olduğunu, lakin ÜST standartları ilə müəyyən edilmiş həddləri keçmədiyini göstərmişdir. Bundan əlavə, üç nümunədə dəmirin (Fe) başqa bir nümunədə isə manqanın (Mn) yüksək konsentrasiyası aşkar edilmişdir. Bu nəticələr göstərir ki, həmin su mənbələri içməli su, heyvandarlıq və suvarma üçün yararsızdır, bu isə bölgədə əlavə monitorinq və təmizləmə işlərinin vacibliyini vurğulayır.

Açar sözlər: *Azərbaycanın Qubadlı rayonu, radioekologiya, suyun keyfiyyətinin idarə edilməsi, natrium karbonat qalığı (NKQ), natrium udulma əmsalı (NUƏ), həll olunan natrium faizi (HNF)*