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MEASUREMENT OF ENVIRONMENTAL INDICATORS OF THE QUALITY OF LIFE IN A REGION WITH EXTREME CLIMATIC CONDITIONS. EVIDENCE FROM AROUND THE ARAL SEA

Izimbet TURDIMAMBETOV
Karakalpak State University, Economic and Social Geography Department, Nukus, Uzbekistan, e-mail: izimbet76@karsu

František MURGAŠ
Technical University of Liberec, Department of Geography, Liberec, Czech Republic, e-mail: fmtren@gmail.com

Fedorko VICTOR
Secondary school No. 233, Tashkent, Uzbekistan, e-mail: viktor-f-89@mail.ru

Medetbay OTEULIEV*
Karakalpak State University, Economic and Social Geography Department, Nukus, Uzbekistan, e-mail: medetbay.oteuliev@gmail.com

Amet MADREIMOV
Karakalpakstan Medical Institute, Nukus, Uzbekistan, e-mail: madreimovamet@mail.ru

Gulnaz SHAMURATOVA
Karakalpak State University, Ecology and Soil Science Department, Nukus, Uzbekistan, e-mail: sh_gulnaz@karsu.uz

Sarvarbek ATABAYEV
National University of Uzbekistan, Department of Cartography, Tashkent, Uzbekistan, e-mail: atabayev_s@nuu.uz

Ahmed REYMOV
Karakalpak State University, Chemical Technology Department, Nukus, Uzbekistan, e-mail: r.axmed@exat.uz

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Abstract: One of the urgent problems of humanity is global warming. The paper focuses on the Karakalpakstan Republic adjacent to the Aral Sea. Its drying up caused by human activity has significantly contributed to the emergence of extreme climatic conditions that are also manifested in neighbouring countries. The region characterized by extreme continentality and the effects of cold, heat and drought can be described as a laboratory of future environmental development with a significant impact on the quality of life of its inhabitants. The article evaluates the spatial differentiation of environmental indicators of residents' quality of life in the Karakalpakstan Republic districts as part of Uzbekistan. Considering the extreme climatic conditions not only in this part of Uzbekistan, adjacent to the Aral Sea, but also in neighbouring countries and the urgency of solving the problem of climate change eroding the environmental quality of life, it is proposed to create. When evaluating the quality of life, 10 indicators were selected, which were measured by district. The indicators of the districts were compared with the average indicators of Karakalpakstan. The districts were then ranked and divided into high, medium and low levels. Takhiatash and Turtkul districts are rated as less affected by environmental factors and have a higher quality of life than other districts.

Keywords: quality of life, environmental quality of life, climate, Aral Sea, Karakalpakstan, Uzbekistan

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INTRODUCTION

In recent years, the study of quality of life has been expanding into new areas, including the study of people's quality of life after natural disasters (Cui and Han, 2018; Shigemoto and Kawachi, 2020; Ritchie and Rosado, 2024). These disasters are generally short-lived and in the case of earthquakes cause the death of thousands of people. In contrast to them, in our paper, we are focused on slow and long-term environmental degradation and its impact on quality of life. Quality of life is a concept by which people evaluate satisfaction with their life. It has two dimensions, subjective and objective. In the subjective dimension, also referred to as psychological, people subjectively evaluate their lives, resulting in subjective data.

In the objective dimension, also referred to as geographical, there are two measurement options. In the first, scientists identify available statistical indicators and use them to create a quality of life index for a given spatial unit. Statistical indicators are objective data. An example of such a measurement is Murgaš and Klobučník (2016), who created the

* Corresponding author

"Golden Standard of the Quality of Life" with 10 indicators, including one environmental indicator, which was the emission balance. Quality of life was measured at the level of municipalities, districts and regions of the Czech Republic. The second option is to measure satisfaction with place quality indicators using anonymous questionnaires. Data is obtained using social networks or personally, that is, by the face-to-face method. The subjective quality of life is usually measured on the Cantril scale of 0-10 (Glatzer and Gulyas 2014). Currently, the concept of quality of life is gaining attention in developing countries (Izakovičová, 2005; Madrigal et al., 2008; Zaid and Popoola, 2010; Singh and Kaur, 2014; Silva et al., 2017; Izakovičová et al., 2018; Purba et al., 2018, Duboz et al., 2021). Scientists paid attention to the quality of life also in the Soviet Union (Herlemann and Murphy, 1987) and its successor countries (Srapyan et al., 2006; Karkashadze et al., 2017; Berkalov et al., 2018; Taspenova et al., 2019; Shchekotin et al., 2021).

THEORETICAL BACKGROUND

The term "quality of life" expresses a multidisciplinary concept with many interrelated variables. It has two dimensions, a subjective one, usually referred to as well-being, and an objective one, usually referred to as quality of place. At a lower hierarchical level, the dimensions are divided into environmental, economic, social, medical and other domains. The quality of life is determined taking into account the relationship between psychological well-being, health, social relations, the standard of living of a person, social and spiritual development and the level of the environment. There is no consensus on whether wealth or prosperity belongs to the quality of life. The mentioned domains, both tangible and intangible, co-create a feeling of satisfaction with life. We can say that quality of life is a good life lived in a good place. Veenhoven (2013) considers the quality of life to be closely related to the phenomenon of the "good life". Quality of life is one of the important categories of social sciences, including socioeconomic geography. Geographers prefer the term "geography of the quality of life" from the point of view of this science, the definition of the term "quality of life" includes not only the subjective idea of "personal well-being", but also the objective environmental quality of life. Geographer Merkushev (1996) provides the following definition of the term quality of life - it is "an integral term that comprehensively describes the level of well-being of the environment of human life and activity and the level of well-being, social and spiritual development". The geographical definition of quality of life should focus more on residential areas. Quality of life is assessed from the point of view of a comprehensive and systematic approach and is defined as a holistic concept, taking into account regional differences at individual taxonomic levels, as well as at global, regional and local levels. The article deals with the environmental domain of the quality of life in Karakalpakstan, which is part of the Republic of Uzbekistan. The reason for our interest is that the environmental conditions for living a good life are extremely difficult. For this reason, we propose the term "environmental quality of life". The term is used by the OECD (2014) and the World Happiness Report (Krekel and MacKerron, 2020).

In the past, several geographers have studied the influence of climate and other environmental components on the living conditions of people in this region. Lopatina and Nazarevsky (1972) conducted research on the assessment of the natural living conditions of the population, Popov (2005) on a comprehensive assessment of the comfort of the natural environment of the Aral Sea, Oksenich (1981) on the arid climate of Turkmenistan and its impact on humans and Misevich and Ryashenko (1988) on the geographical environment and living conditions of the people of Siberia. The aim of the article is a comprehensive investigation of the geographical differentiation of the environmental quality of life in the Republic of Karakalpakstan.

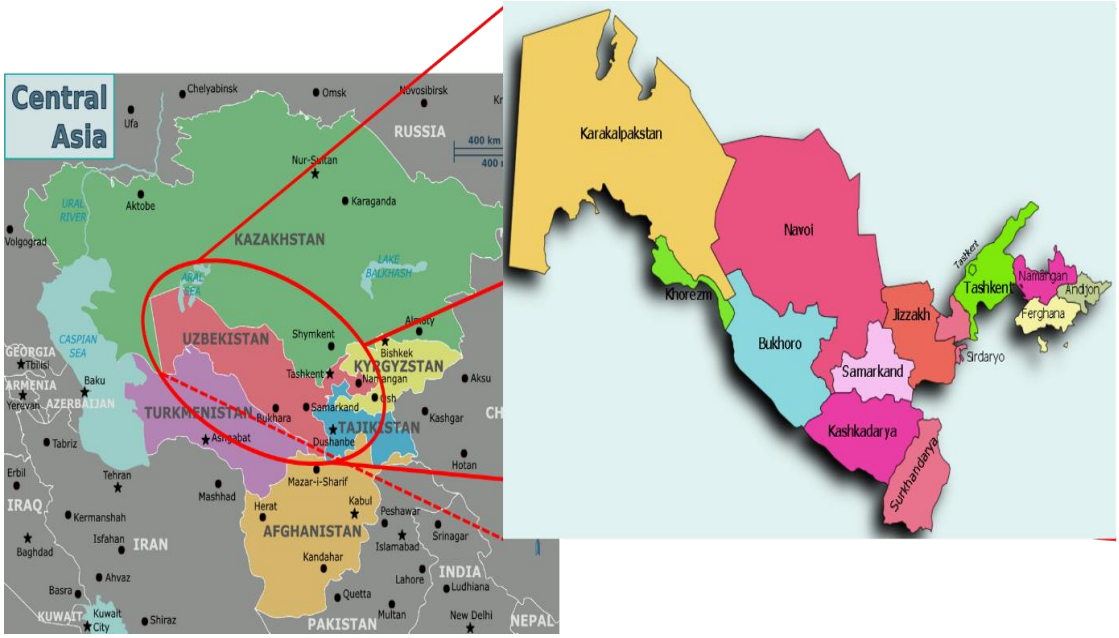


Figure 1. Location of Uzbekistan (Source: edited by the authors from Google)

BRIEF GEOGRAPHIC CHARACTERISTICS OF UZBEKISTAN

Uzbekistan is located almost in the middle of Eurasia and Central Asia (Figure 1). The republic, with a population of 36

million, borders Kazakhstan to the north; Kyrgyzstan to the northeast; Tajikistan to the southeast; Afghanistan to the south and Turkmenistan to the southwest. Administratively, it consists of the Karakalpakstan Republic, 12 regions and the city of Tashkent. The most important feature of the natural, economic and political geographical location of Uzbekistan is that it is located far from the world's oceans, inside the Eurasian continent. Such a geographical location affects not only the formation of the country's climate but also its socio-economic and geopolitical development.

Changes in the state of the natural environment under the influence of humans, strong anthropogenic influence on living and non-living components cause local, regional and global environmental problems. In particular, such effects led to the "Aral Sea problem", which is the most dangerous point of the ecological crisis in the region. The Aral Sea has become almost a "dead" sea with a dry bottom covering an area of 4.2 million hectares, a source of dust and sand-salt aerosols. It releases 80 to 100 million tons of dust into the atmosphere annually. At the same time, soil degradation and desertification are increasing in the Amudarya and Syrdarya river deltas.

In the paper, we are focused on the administrative part of Uzbekistan, which is the Republic of Karakalpakstan. Its location as the gateway to Uzbekistan from European countries creates favorable conditions for its development. The surface structure of Karakalpakstan is not complicated: the highest point is the ridge of Sultan Uvays, which is located at an altitude of 473 m above sea level. The western part of the Republic of Karakalpakstan is occupied by the Ustyurt Plateau, the rest by the Turan Plain. The climate is extremely continental; The amount of annual precipitation is around 90-100 mm. Therefore, despite the large area of land in the Republic of Karakalpakstan (which is in the first place in Uzbekistan in this regard), the possibilities for the development of irrigated agriculture are considerably limited (Popov, 2005).

The northern regions of Karakalpakstan are directly connected to the Aral Sea. It is known that this "sea" has been continuously drying up for the last 58-60 years and a large area of the "Aralkum" desert has appeared in its dry part. Like other regions of Central Asia, Karakalpakstan is located in a closed basin, and its extremely continental climate has a strong influence on the formation and distribution of groundwater and surface water throughout the region.

In Table 1, we present a comparison of Uzbekistan with the top 5 countries in the world, Russia, and the neighboring republics of Turkmenistan, Tajikistan and Kyrgyzstan. Uzbekistan ranks 44th in CEO Happiness, 100th in Legatum and 53rd in the World Happiness Report (Table 1).

Table 1. Country ranking in the quality of life in selected measurements and Uzbekistan's position in them (Source: CEO World 2020, Legatum 2021, World Happiness Report 2019-2021) Note: CEO Happ.: CEO Happiness, WHR: World Happiness Report

Rank	Country		
	CEO Happ.	Legatum	WHR
1.	Switzerland	Denmark	Finland
2.	Finland	Norway	Denmark
3.	Iceland	Sweden	Iceland
4.	Netherland	Finland	Switzerland
5.	Canada	Switzerland	Netherland
Uzbekistan	44.	100.	53.
Rusko	58.	70.	80.
Kazakhstan	59.	64.	40.
Kyrgyzstan	90.	90.	64.
Turkmenistan	67.	108.	78.
Tajikistan	78	110.	83.

MATERIALS AND METHODS

Environmental conditions are important for the quality of life of population, which create one of the domains of quality of life - the environmental domain (Murgaš, 2015). This domain consists of measurable indicators that together with other indicators form the quality of place as an objective dimension of quality of life. The structure of the quality of life concept, its dimensions, domains and indicators are analyzed by Petrovič and Murgaš (2020). Environmental conditions not only directly, but also indirectly affect human health and well-being, which is why several authors pay attention to them (Streimikiene, 2015; Murgaš and Petrovič 2020; Grabowska et al., 2021). From numerous environmental indicators, we have identified 10 that we consider significant in terms of impact on the quality of life of Karakalpakstan:

1. Heat index (1990-2019)
2. Coldness index (1990-2019)
3. Drought Index (1990-2019)
4. Climate Tension Index (1990-2019)
5. The proportion of saline lands in total irrigated lands (2018-2020)
6. The average volume of water per 1 hectare of irrigated land (2018-2020)
7. Percentage of water samples from open water reservoirs that do not meet chemical standards (2018-2020)
8. Percentage of well water samples that do not meet hygienic requirements in terms of chemical indicators (2018-2020)
9. Percentage of tap water samples exceeding the maximum allowable concentration of chemicals and indicators (2018-2020)
10. Disadvantages of ecological geographical location

When evaluating the values of environmental quality of life indicators, calculations were made based on the data of the Hydrometeorological Service Center of the Republic of Uzbekistan, the Karakalpakstan Department of Sanitary and

Epidemiological Peace and Public Health and the Central Asian Irrigation Research Institute. According to the experts of the Hydrometeorological Department of the Republic of Karakalpakstan, the days with temperatures below -10° C are cold days, the days with temperatures above +40° C are hot days in Karakalpakstan. Therefore, we calculated the number of days in the 30-year period, i.e. 1990-2019, which fell below the average -10° C during the year. In the ArcGIS 10.6.1 program, the territory of Karakalpakstan was divided into three zones by interpolation, taking into account the number of values calculated at the meteorological stations in the districts and taking the meteorological stations as reference points.

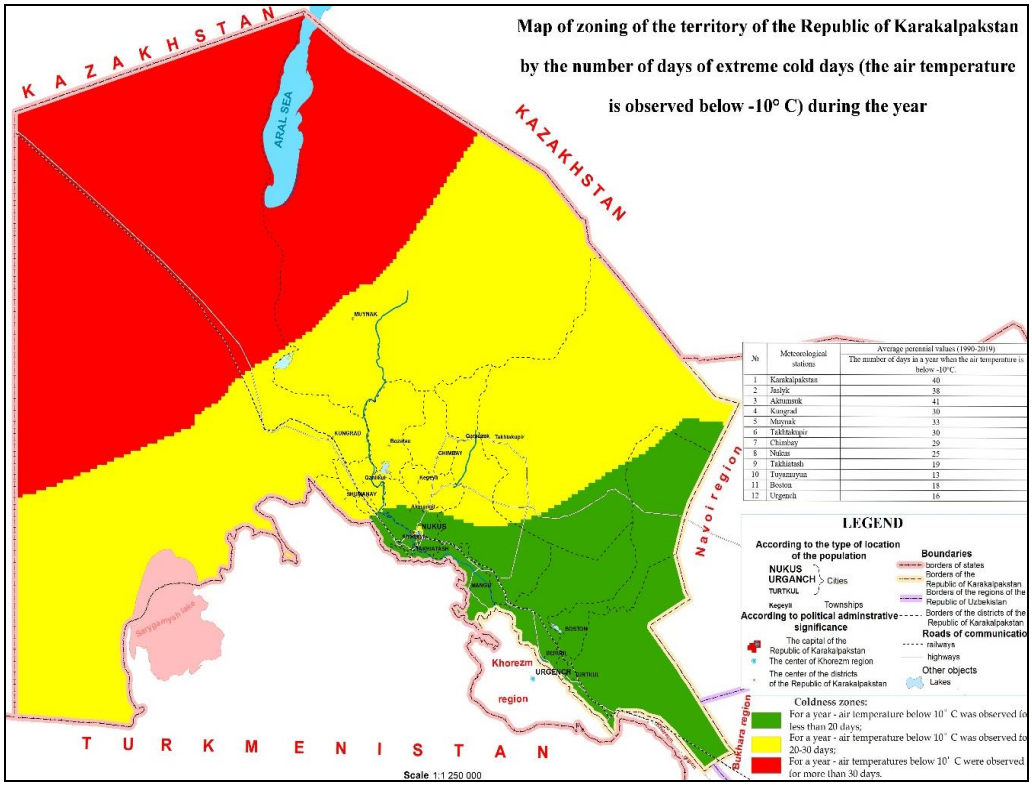
Coldness zones: Zone 1: For a year - air temperature below 10° C was observed for less than 20 days;
Zone 2: For a year - air temperature below 10° C was observed for 20-30 days;
Zone 3: For a year - air temperatures below 10° C were observed for more than 30 days.

Heat zones: Zone 1: Air temperature above + 40° C was observed for less than 4 days during the year;
Zone 2: Air temperature above + 40° C was observed for 4-7 days during the year;
Zone 3: Air temperature above + 40° C was observed for more than 7 days during the year.

Drought zones: Zone 1: Relative humidity below 20% for one year was observed for less than 30 days;
Zone 2: Relative humidity below 20% for one year was observed for 30-60 days;
Zone 3: Relative humidity below 20% for one year was observed for more than 60 days.

Climate tension zone: Zone 1: The average long-term value of the annual amplitude of air temperature is below 60°C;
Zone 2: The average long-term value of the annual amplitude of air temperature is 60-65°C;
Zone 3: The average long-term value of the annual air temperature amplitude is above 65°C.

The residents of each district were divided into three zones according to cold, heat, drought, and amplitude. At the same time, at the level of settlements, the residents were calculated by zones. Then, in each district, the proportion of the residents corresponding to the first, second and third zones in the total residents of the district was obtained. Then the proportion of the residents living in the first zone was multiplied by one, the proportion of the residents living in the second zone was multiplied by two, the proportion of the residents living in the third zone was multiplied by three, and we added the numbers in the three zones formed to each other. The sum of these three numbers gave the coldness index. Taking into account the distribution of the entire residents of Karakalpakstan in three zones, the coldness index was calculated for the entire territory of Karakalpakstan and the relative coefficient of the coldness index of each district was determined by comparing it with that of Karakalpakstan. Conditionally, the relativity coefficient of Karakalpakstan is equal to one and the average cold days in other districts will be less than one if less than in Karakalpakstan, and more than one if more than in Karakalpakstan. However, this does not take into account the zoning of the territory, but the zoning of the residents. Because the assessment of the resident is going on. While a large area is located in the cold zone, where there are small residents, this is not a big problem for the residents. The index was based on which cold zone the lands of the area where the majority of the residents fell into. However, detailed calculations were made taking into account the zone in which each village was located. No settlement, city or village remained (Figure 2).



№	Meteorological stations	Average perennial values (1990-2019) The number of days in a year when the air temperature is below -10°C.
1	Karakalpakstan	40
2	Janbyk	38
3	Aktumsuk	41
4	Kungrad	30
5	Moynak	33
6	Takhtakupir	30
7	Chimbay	29
8	Nukus	25
9	Takhiatash	19
10	Toyatamyas	13
11	Boston	18
12	Urgench	16

Figure 2. Map of zoning of the territory of the Republic of Karakalpakstan by the number of days of extreme cold days (the air temperature is observed below -10° C) during the year (Source: own research)

All residents of Amudarya, Beruni, Takhiatash, Turtkul, Khodjeyli and partly Ellikkala districts were included in the first zone or the zone where the air temperature was below -10 °C for less than 20 days. In this first zone there are 66% of the residents of Nukus district, 3% of the residents of Qarauzak district and 1% of the residents of Nukus city. 99% of Nukus residents, 97% of Qarauzak district residents, 92% of Kungrad district residents and 34% of Nukus district residents live in the second zone. Only 8% of the residents of the Kungrad district are located in the zone where the air temperature was below -10°C for more than 30 days a year. This means that about 11,000 residents of the Kungrad district live in colder days than in other areas. Of course, it is clear that the high risk of catching a cold due to the unfavorable climate of the residents will lead to more energy consumption for heating their homes, as a result of which the residents will also suffer financially.

When the Republic of Karakalpakstan was divided into heat zones, only 1% of the total residents of Kungrad district is located in this first zone in the zone where the air temperature was above + 40° C for less than 4 days a year. The residents of the remaining districts were mainly 19% in the second zone and 81% in the third zone (Figure 3).

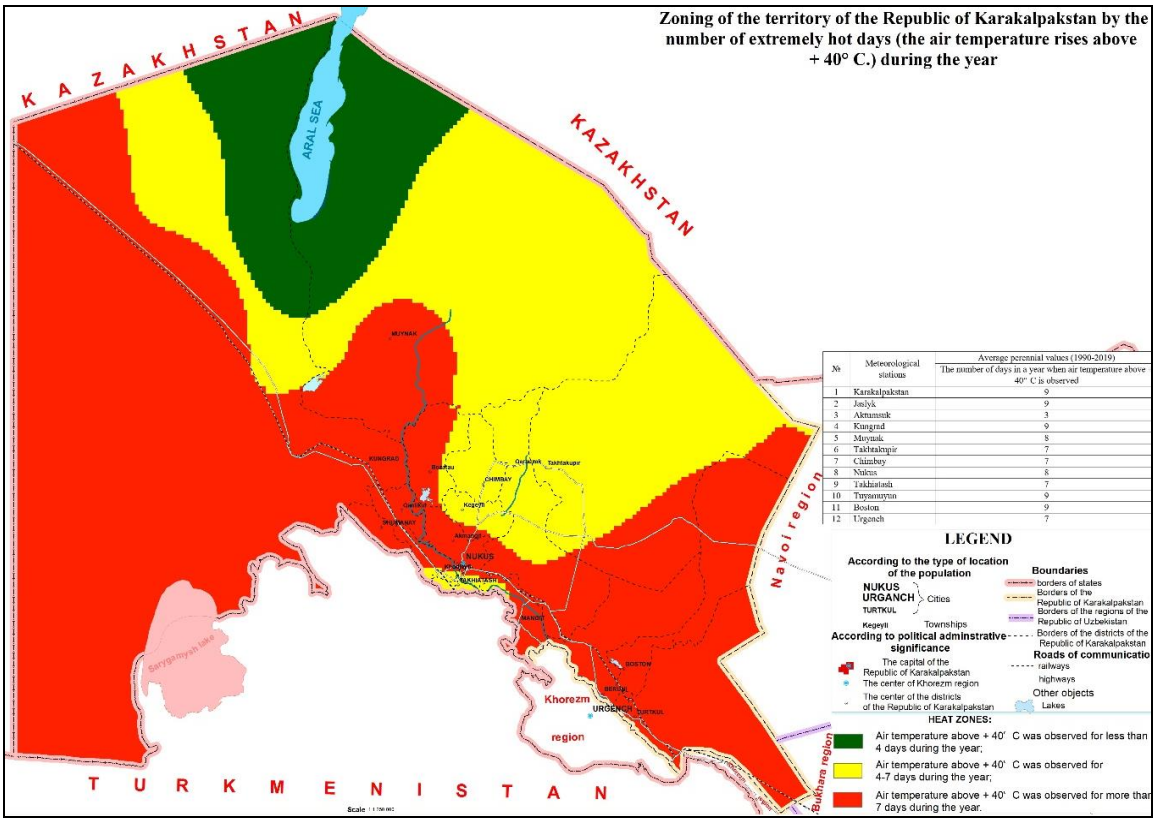
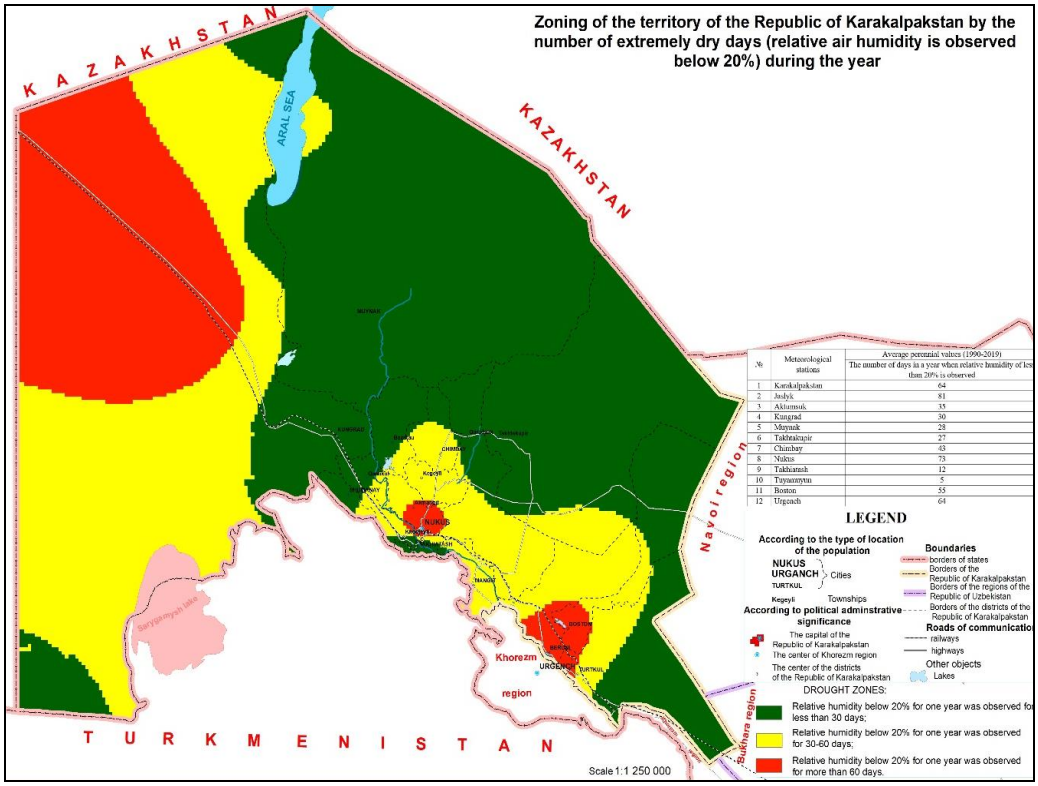


Figure 3. Zoning of the territory of the Republic of Karakalpakstan by the number of extremely hot days (the air temperature rises above + 40° C) during the year (Source: own research)

In the second part of this zone, all residents of Takhiatash, Takhtakupir and Chimbay districts are located. 98% of the residents of Qarauzak district, 79% of the residents of Kegeyli district, 19% of the residents of Bozatau district, 14% of the residents of Muynak district, 4% of the residents of Khodjeyli district and 2% of the residents of Amudarya district live in the zone where the temperature is above + 40° C for 4-7 days. 100% of the residents of Nukus city, Beruni, Nukus, Shumanay, Ellikkala, Turtkul and Qanlikul districts live in the zone where the air temperature was above +40° C for more than 7 days. 99% of the residents of Kungrad district, 98% of the residents of Amudarya district, 96% of the residents of Khodjeyli district, 86% of the residents of Muynak district, 81% of the residents of Bozatau district, 21% of the residents of Kegeyli district and 2% of the residents of Qarauzak district live in the third zone. 23% of the residents live in the first drought zone of the Republic of Karakalpakstan, i.e. in an area with relative humidity less than 20% per year for less than 30 days, 40% of the total residents live in the second zone with a relative humidity less than 20% per year for 30-60 days, and 37% of the residents live in the third zone with a relative humidity less than 20% per year for more than 60 days (Figure 4).

It was found that the residents of Muynak, Takhiatash and Takhtakupir districts live in the first zone. 93% of the residents of Kungrad district, 88% of the residents of Qarauzak district, 84% of the residents of Qanlikul district, 71% of the residents of Bozatau district, 69% of the residents of Shumanay district, 14% of the residents of Chimbay district, 7% of the residents of Turtkul district and 1% of the residents of Ellikkala district live in the first zones.

In the second zone, all residents of Amudarya, Kegeyli and Khodjeyli districts live in this zone. 93% of the residents of Turtkul district, 86% of the residents of Chimbay district, 34% of the residents of Nukus district, 29% of the residents of Bozatau district, 31% of the residents of Shumanay district, 16% of the residents of Qanlikul district, 12% of the residents of Qarauzak district, 6% of the residents of Beruni district and 1% of the residents of Nukus live in the second zone, where relative humidity is observed below 20% for 30-60 days.



№	Meteorological stations	Average perennial values (1990-2019) The number of days in a year when relative humidity of less than 20% is observed
1	Karakalpakstan	64
2	Jaslyk	81
3	Aktumsuk	35
4	Kungrad	30
5	Mayanak	28
6	Takhiatashi	27
7	Chimbay	43
8	Nukus	73
9	Takhiatash	12
10	Tuyamuyun	5
11	Boston	55
12	Urgench	64

Figure 4. Zoning of the territory of the Republic of Karakalpakstan by the number of extremely dry days (relative air humidity is observed below 20%) during the year (Source: own research)

The third zone is inhabited by only 5 districts, of which 99% of the residents of Nukus city and Ellikkala district, 94% of the residents of Beruni district, 66% of the residents of Nukus district, 7% of the residents of Kungrad district. 49% of the population of the Republic of Karakalpakstan live in the first zone, where the average long-term value of the annual amplitude of air temperature in terms of climate tension is below 60° C, 50% of the population live in the second zone, where the average long-term value of the annual amplitude of air temperature is 60-65° C and in the last third zone i.e. 1% of the population in the zone where the average long-term value of the annual amplitude of air temperature is higher than 65° C.

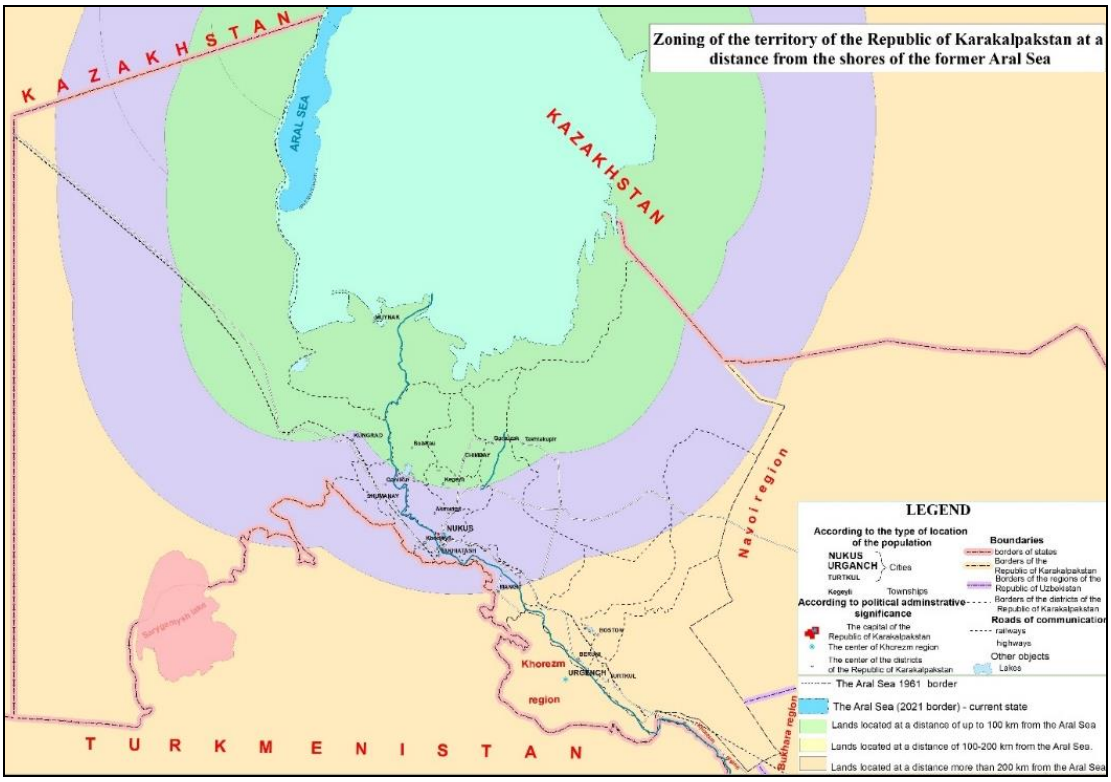


Figure 6. Zoning of the territory of the Republic of Karakalpakstan at a distance from the shores of the former Aral Sea (Source: own research)

Zone 1: Lands located at a distance more than 200 km from the Aral Sea. Zone 2: Lands located at a distance of 100-200 km from the Aral Sea. Zone 3: Lands located at a distance of up to 100 km from the Aral Sea. At the same time, the disadvantages of ecological geographical location are less in the first zone, moderate in the second zone, and the third zone is located within a radius of 100 km that suffers the most from the drying up of the Aral Sea. The residents of each district were calculated in three zonal sections. Based on the resident statistics, the residents of the districts were divided into three zones based on which of the three zones they were located in. Then the share of the total residents of the district was determined in fractional form, and the fractional shares were multiplied by the zone number. This mathematical sum formed the index of disadvantages of ecological-geographical location of the district (Table 4). Based on the distribution of the population of the Republic of Karakalpakstan in these three zones, the index of general ecological-geographical location disadvantages of the Republic of Karakalpakstan was calculated and the coefficient of relativity was determined by comparing the districts with the general index of the republic (Table 5). This index is negative, so no inverse coefficient was used for it. Only one index out of 10 is positive, the average volume of water per 1 hectare of irrigated land index is positive, and the remaining nine indices are negative. Therefore, in order for the general direction of the analysis to be the same, a reverse coefficient was used in a single indicator that was positive, and the sum of the 9 final indicators was the sum of the negative natural environmental characteristics of that district or Nukus city. The greater this sum, the more pronounced the negative aspects of the natural ecological situation, and the less this sum, the less the negative properties of the natural ecological situation are felt (Table 2).

Table 2. Stratification of districts of the Republic of Karakalpakstan on natural and ecological indicators of quality of life of the population (Source: own research)

№	Administrative territorial units	Heat index (1990-2019)		Coldness index (1990-2019)		Drought index (1990-2019)	
		Index	Relativity coefficient	Index	Relativity coefficient	Index	Relativity coefficient
1	Nukus city	3.00	1.07	1.99	1.34	2.99	1.40
	districts:						
2	Amudarya	2.98	1.06	1.00	0.68	2	0.94
3	Beruni	3.00	1.07	1.00	0.68	2.94	1.38
4	Bozatau	2.81	1.00	2.00	1.35	1.29	0.61
5	Kegeyli	2.21	0.79	2.00	1.35	2	0.94
6	Muynak	2.86	1.02	2.00	1.35	1	0.47
7	Nukus	3.00	1.07	1.34	0.91	2.66	1.25
8	Takhiatash	2.00	0.71	1.00	0.68	1	0.47
9	Takhtakupir	2.00	0.71	2.00	1.35	1	0.47
10	Turtkul	3.00	1.07	1.00	0.68	1.93	0.91
11	Khodjeyli	2.96	1.05	1.00	0.68	2	0.94
12	Chimbay	2.00	0.71	2.00	1.35	1.86	0.87
13	Shumanay	3.00	1.07	2.00	1.35	1.31	0.62
14	Ellikkala	3.00	1.07	1.00	0.68	2.99	1.40
15	Qanlikul	3.00	1.07	2.00	1.35	1.16	0.54
16	Qarauzak	2.02	0.72	1.97	1.33	1.12	0.53
17	Kungrad	2.98	1.06	2.08	1.41	1.15	0.54
18	**Karakalpakstan Republic**	**2.81**	**1.00**	**1.48**	**1.00**	**2.13**	**1.00**

Table 3. Stratification of districts of the Republic of Karakalpakstan on natural and ecological indicators of quality of life of the population (Source: own research)

№	Administrative territorial units	Climate Tension Index (1990-2019)		The proportion of saline lands in total irrigated lands (2018-2020)		Percentage of water samples from open water reservoirs that do not meet chemical standards (2018-2020)	
		Index	Relativity coefficient	Index	Relativity coefficient	Index	Relativity coefficient
1	Nukus city	1.99	1.32	100	1.42	48.7	1.02
	districts:						
2	Amudarya	1.02	0.68	68	0.96	64.5	1.35
3	Beruni	1.00	0.66	74	1.05	77.8	1.62
4	Bozatau	2.00	1.32	86	1.22	42.1	0.88
5	Kegeyli	1.99	1.32	63	0.89	37.8	0.79
6	Muynak	2.00	1.32	94	1.33	56.4	1.18
7	Nukus	2.00	1.32	62	0.88	46.9	0.98
8	Takhiatash	1.00	0.66	73	1.04	20.5	0.43
9	Takhtakupir	1.00	0.66	67	0.95	100	2.09
10	Turtkul	1.00	0.66	63	0.89	53.3	1.11
11	Khodjeyli	1.96	1.30	73	1.04	43.8	0.91
12	Chimbay	1.90	1.26	77	1.09	12	0.25
13	Shumanay	2.00	1.32	66	0.94	39.2	0.82
14	Ellikkala	1.00	0.66	69	0.98	93.5	1.95
15	Qanlikul	2.00	1.32	65	0.92	53.6	1.12
16	Qarauzak	1.10	0.73	68	0.96	42.4	0.89
17	Kungrad	2.08	1.38	65	0.92	38	0.79
18	**Karakalpakstan Republic**	**1.51**	**1.00**	**70.5**	**1.00**	**47.9**	**1.00**

Table 4. Stratification of districts of the Republic of Karakalpakstan on natural and ecological indicators of quality of life of the population (Source: own research)

№	Administrative-territorial units	Percentage of well water samples that do not meet hygienic requirements in terms of chemical indicators (2018-2020)		Percentage of tap water samples exceeding the maximum allowable concentration of chemicals and indicators (2018-2020)		Disadvantages of ecological geographical location	
		Index	Relativity coeffic.	Index	Relativity coeffic.	Index	Relativity coeffic.
1	Nukus city	99.4	1.62	19.4	0.82	2.00	1.08
districts:							
2	Amudarya	54.1	0.88	26.4	1.11	1.84	0.99
3	Beruni	96.9	1.58	73.7	3.10	1.00	0.54
4	Bozatau	57.4	0.93	33.3	1.40	3.00	1.61
5	Kegeyli	46.2	0.75	13.7	0.58	2.41	1.30
6	Muynak	99	1.61	13.8	0.58	3.00	1.61
7	Nukus	100	1.63	32.6	1.37	2.00	1.08
8	Takhiatash	36.6	0.60	13.2	0.55	2.00	1.08
9	Takhtakupir	96.9	1.58	14.2	0.60	2.97	1.60
10	Turtkul	92.8	1.51	18.2	0.76	1.00	0.54
11	Khodjeyli	56.2	0.92	29	1.22	2.00	1.08
12	Chimbay	24.7	0.40	17.4	0.73	3.00	1.61
13	Shumanay	37.4	0.61	25.9	1.09	2.00	1.08
14	Ellikkala	61.8	1.01	15.4	0.65	1.01	0.54
15	Qanlikul	94.8	1.54	39.2	1.65	2.00	1.08
16	Qarauzak	90.6	1.48	15.4	0.65	2.86	1.54
17	Kungrad	44.2	0.72	12.5	0.53	2.31	1.24
18	**Karakalpakstan Republic**	**61.4**	**1.00**	**23.8**	**1.00**	**1.86**	**1.00**

Table 5. Stratification of districts of the Republic of Karakalpakstan on natural and ecological indicators of quality of life of the population (Source: own research)

№	Administrative-territorial units	Average volume of water per 1 hectare of irrigated land (2018-2020)			Sum of indicator values (coefficients)	Ranking place	Level
		Thousand m^3/ha	Relativity coefficient	Reverse coefficient			
1	Nukus city	15.12	1.26	0.80	11.88	14	Low
districts:							
2	Amudarya	19.55	1.63	0.62	9.26	3	Medium
3	Beruni	19.45	1.62	0.62	12.29	15	Low
4	Bozatau	2.48	0.21	4.85	15.18	17	Low
5	Kegeyli	16.41	1.36	0.73	9.43	4	Medium
6	Muynak	2.93	0.24	4.11	14.58	16	Low
7	Nukus	12.89	1.07	0.93	11.41	12	Low
8	Takhiatash	13.84	1.15	0.87	7.08	1	High
9	Takhtakupir	9.67	0.80	1.24	11.25	11	Low
10	Turtkul	15.17	1.26	0.79	8.92	2	High
11	Khodjeyli	14.84	1.23	0.81	9.94	10	Medium
12	Chimbay	9.22	0.77	1.30	9.59	5	Medium
13	Shumanay	13.03	1.08	0.92	9.81	7	Medium
14	Ellikkala	14.41	1.20	0.83	9.77	6	Medium
15	Qanlikul	9.67	0.80	1.24	11.84	13	Low
16	Qarauzak	11.26	0.94	1.07	9.88	9	Medium
17	Kungrad	9.49	0.79	1.27	9.85	8	Medium
18	**Karakalpakstan Republic**	**12.03**	**1.00**	**1.00**	**10.00**		

RESULTS

After calculating all indicators and determining relativity coefficients based on all criteria, the sum of 10 relative coefficients was found in each district and township of Nukus and compared with the number 10 in Karakalpakstan (Table 5). After that, the sum of the relative coefficients on all indicators was determined, and then the ranking of the territories was determined. In the Republic of Karakalpak, the medium level of the environmental quality of life indicators are set at values of 9-11, as the state of territorial differences in the natural-ecological factors of the quality of life of the population is equal to 10 coefficients. Territories with a coefficient lower than 9 were classified as high-level and territories with a negative coefficient greater than 11 were classified as low-level (Figure 7).

Our measurement shows that the best environmental conditions in terms of quality of life are in Takhiatash (coefficient 7.08) and Turtkul (coefficient 8.92) districts. Amudarya (9.26 coefficient), Kegeyli (9.43 coefficient), Chimbay (9.59

coefficient), Ellikkala (9.77 coefficient), Shumanay (9.81 coefficient), Kungrad (9.85 coefficient), Qarauzak (9.88 coefficient), Khodjeyli (9.94 coefficient) districts are included in the medium level. On the contrary, as it follows from our measurement, the worst environmental conditions in terms of quality of life are in the districts of Takhtakupir (11.25 coefficient), Nukus (11.41 coefficient), Qanlikul (11.84 coefficient), Nukus city (11.88 coefficient), Beruni (12.29 coefficient), Muynak (14.58 coefficient) and Bozatau (15.18 coefficient) districts. If the quality of life in Karakalpakstan is to improve, it is necessary to pay primary attention to the improvement of environmental indicators of the quality of life.

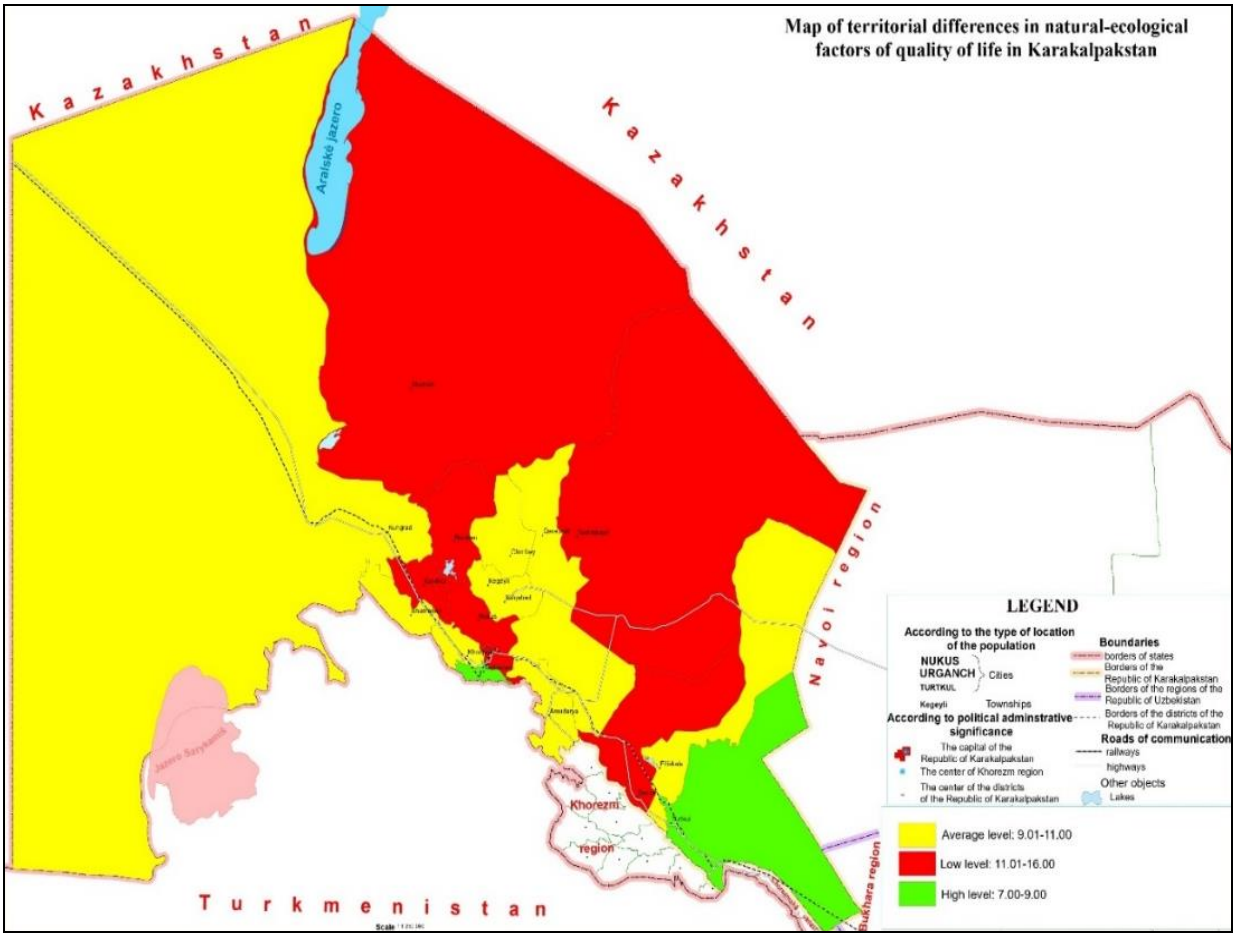


Figure 7. Map of territorial differences in natural-ecological factors of quality of life in Karakalpakstan (Source: own research)

CONCLUSION

In the districts of the Republic of Karakalpakstan, territorial differences in natural-ecological factors were assessed on the basis of a total of 10 criteria. We evaluated the climatic indicators on the basis of 30-year measurements (Table 2 and Table 3), the ecological geographical disadvantage of the zone from the coast of the Aral Sea in 1961, and the other remaining indicators were evaluated on the basis of 3-year official statistics, and the territorial indicators were compared with the average indicator of the Karakalpak Republic. As a result of comparison, the natural and ecological conditions of Takhiatash and Turtkul districts are relatively high, Amudarya, Kegeyli, Chimbay, Ellikkala, Shumanay, Khodjeyli, Qarauzak and Kungrad districts are in line with the average level of the republic, and Nukus city, Nukus, Qanlikul, Beruni, Muynak, Bozatau districts, the situation is lower than the republic average. This means that the natural ecological situation is one of the most pressing problems in these districts, and in improving the environment, mitigating the ecological situation, it is necessary to pay special attention to these districts.

Karakalpakstan is considered to be one of the regions where the reduction of the volume of water from the Amudarya River and the processes of natural desertification under the influence of anthropogenic factors have reached their peak. Therefore, it is necessary to pay special attention to natural environmental factors when assessing the quality of life. Moreover, the territory is quite large, and there are certain differences between different administrative divisions. This is a pressing issue. In order to solve this problem, a comprehensive approach was used in our research to assess the natural ecological conditions of the districts of Karakalpakstan. The natural ecological conditions of the districts were considered as a climate-water-soil system. Various natural environmental factors affecting the quality of life have been taken into account.

Districts with a low quality of life are typical of the districts closest to the Aral Sea zone, and at the same time, due to some factors, Beruni district, which is far from the Aral Sea, even the city of Nukus fell into the low level. We can conclude from this that it is wrong to define the quality of life in Karakalpakstan by one tragedy of the Aral Sea or water. Our research showed that it was approached from a complex point of view. The further away from the Aral Sea does not

mean the better the quality of life. The fact that the situation of Turtkul and Takhiatash is characterized by the fact that the quality of life is better than the medium level is also a problem. Out of 17 regions, only two districts are above the medium level. This means that, in general, the situation in the region is not good.

Favourable or unfavourable natural environmental conditions affect the migratory behaviour of people in many ways, and today the Republic of Karakalpakstan is one of the regions of Uzbekistan with a negative balance of migration. Of course, this is not only influenced by environmental conditions. Socio-economic factors are also important. However, the general environmental condition of the region determines that natural factors have a great influence on people's behaviour.

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