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Relative Advantages of Local Natural and Economic Potential and Their Effective Use in the Context of Climate Change

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Relative Advantages of Local Natural and Economic Potential and Their Effective Use in the Context of Climate Change

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Abstract. This study examines the relative advantages of the natural and economic potential of the Republic of Karakalpakstan and their effective utilization under conditions of climate change. The research is based on statistical data analysis, comparative assessment methods, and elements of SWOT analysis to evaluate the region's production, resource, demographic, and infrastructural capacities. The findings indicate that changes in mineral resource exploitation, agro-climatic conditions, and energy production significantly influence industrial development, employment, and social stability. The study reveals that despite substantial reserves of mineral raw materials, including natural gas, iron ores, and salts, the regional economy remains insufficiently diversified. Environmental challenges such as desertification, water scarcity, and declining agricultural productivity further intensify socio-economic risks. At the same time, the region possesses strong competitive advantages related to its transport-geographical location, transit potential, renewable energy prospects, and demographic capacity. The results highlight priority directions for sustainable development, including economic diversification, efficient use of mineral and desert resources, expansion of renewable energy sources, and improvement of social infrastructure. The proposed recommendations aim to enhance regional competitiveness, reduce environmental vulnerability, and support long-term socio-economic stability in the context of climate change.

INTRODUCTION

Sustainable socio-economic development of regions under conditions of climate change has become one of the most important priorities of modern economic policy. In this context, the effective use of local natural and economic potential plays a decisive role in ensuring long-term growth, social stability, and environmental safety. Regions possessing rich natural resources and favorable geographical positions have significant comparative advantages; however, these advantages must be managed rationally to avoid negative ecological and social consequences.

The Republic of Karakalpakstan occupies a special place in the socio-economic development of Uzbekistan due to its vast territory, rich mineral resources, unique agro-climatic conditions, and strategic transport-geographical location. At the same time, the region faces serious environmental challenges caused by climate change, desertification, water scarcity, and the consequences of the Aral Sea crisis. These factors significantly influence agricultural productivity, industrial development, population living standards, and overall regional sustainability.

interaction of natural resources (land, water, climate, and mineral reserves), economic potential (industry, agriculture, and transport infrastructure), and environmental challenges such as desertification and climate change. The balanced management of these components determines the achievement of sustainable development outcomes, including economic growth, social stability, and environmental protection.

The presence of substantial reserves of mineral raw materials, favorable conditions for the development of desert-adapted agriculture and animal husbandry, as well as opportunities to become a major transit hub between Europe and Asia, create strong prerequisites for regional development. However, realizing this potential requires diversification of the economy, modernization of infrastructure, attraction of investments, and the introduction of environmentally friendly and resource-efficient technologies.

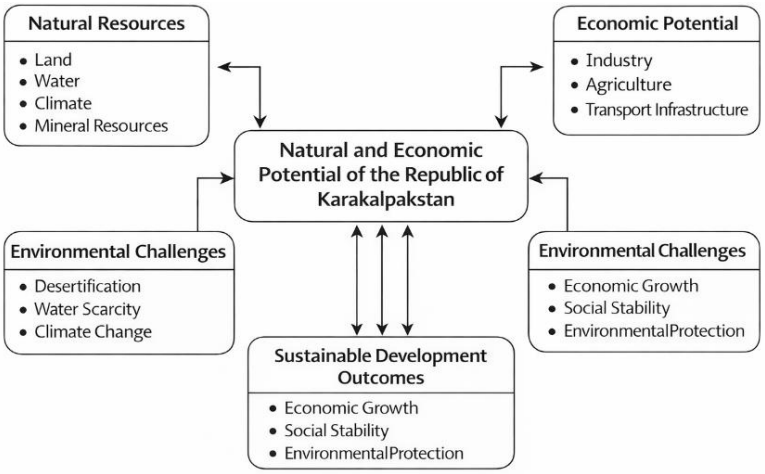

FIGURE 1. Structure of Natural and Economic Potential of the Republic of Karakalpakstan under Climate Change

As shown in Figure 1, the natural and economic potential of the Republic of Karakalpakstan is formed through the

Therefore, the study of the relative advantages of local natural and economic potential, as well as the identification of effective mechanisms for their use in the context of climate change, is of great scientific and practical importance. This research aims to assess the existing resources and development opportunities of the Republic of Karakalpakstan and to propose strategic directions for ensuring sustainable socio-economic development under changing climatic conditions.

EXPERIMENTAL RESEARCH

The theory of sustainable development has been studied from various perspectives. In world practice, the organization of socio-economic development in harmony with environmental factors is considered the main criterion for sustainable development. Local studies conducted in Karakalpakstan focus on industry, agriculture, and the standard of living of the population. It should also be taken into account when developing scenarios and options for the Development Strategy. The natural and economic potential of the Republic of Karakalpakstan is distinguished by its unique characteristics.

TABLE 1. Relative assessment of the natural and economic potential of the Republic of Karakalpakstan (index)

№	Types of competence	Republic of Karakalpakstan, (Uzbekistan - 1,000)	Interregional role
1.	Production infrastructure	0,618	14
2.	Social infrastructure	0,977	7
3.	Water reserves	0,330	14
4.	Land reserves	0,300	14
5.	Fixed assets	0,462	11
6.	Reserves of mineral raw materials	1,415	3
7.	Labor reserves	0,917	9

Agroclimatic conditions. The Republic of Karakalpakstan is located in the northernmost part of Uzbekistan, and compared to other regions of our country, solar radiation and thermal resources are relatively less. Also, the region is favorable for cold air currents to enter from the north. Conditions suitable for a dry subtropical climate have formed in the region (Table 2).

TABLE 2. Opportunities of agro-climatic conditions in the Republic of Karakalpakstan (SWOT-analysis)

Strengths (advantages)	Weaknesses (adverse effect)
Thermal resources are suitable for cotton, grain, rice, polys, fruits, fodder crops and medicinal plants	The lack of water for irrigation and its deterioration in quality, salinity of the soil, and the negative impact of desertification on the agro-climate reduce agricultural productivity and efficiency and lead to drought

Availability of available thermal resources is relatively favorable (especially in southern zones) for heat-loving agricultural products such as cotton, grain, rice, sugarcane, fruit and fodder crops.

The desertification process remains the main factor shaping the nature of the Republic of Karakalpakstan (Table 3). This condition is determined by high air temperatures, low precipitation, and low groundwater reserves. More than 90% of the area of the region is located in the desert zone. The main reason for the increase in desertification is the sharp decrease in the level of the Aral Sea.

TABLE 3. Desertification Indicator System in the Republic of Karakalpakstan (as of 2024)

Districts and cities	Air temperature in the atmosphere Number of days above +35o (more than 50 days)- security level	Number of days of sandstorms per year (more than 30)- security level	Annual rainfall (less than 150 mm)- security level	Groundwater reserves are at least 0.045 m3/day per person - a safety level
Districts:				
Amudaryo	-	-	105	0,001
Beruniy	51	-	104	-
Kanlikul	-	-	97	0,001
Karauzyak	-	-	94	0,001
Kegeili	-	31	94	-
Kungirot	-	-	121	0,001
Muynoq	-	35	134	0,001
Nukus	51	-	101	-
Taxtakupir	50	-	101	-
Tortkul	51	-	105	-
Taxiatosh	-	-	106	-
Xodjeili	51	-	101	0,01
Chimboy	-	-	101	-
Shumanay	51	-	110	0,01
Ellikkala	-	-	108	-
City:				
Nukus	51	-	101	0,01

Desert zones have their own flora and fauna, and their effective use remains an urgent issue.

TABLE 4. Opportunities of desertification conditions in the Republic of Karakalpakstan (SWOT-analysis)

Strengths (advantages)	Weaknesses (disadvanages)
There is an opportunity to develop animal husbandry adapted to desert conditions, including increasing the number of black sheep, camels, gazelles, and saigas. There are also opportunities to use desert plants in the pharmaceutical and food industries	Lack of water, low efficiency of use of pastures, lack of special programs, increased desertification

Karakul and camel breeding can only develop in desert conditions. The products made from them (karakul skins, meat, and dairy products) are in high demand not only in the domestic market, but also abroad.

Some desert plants (licorice root, konrak) are widely used in food, pharmaceutical, and perfume industries. In general, the effective use of the unique potential of the desert has a positive effect on the strategic development of the region.

Geographical location. The formation of competitive advantages in the region also depends on its geographical location. Unlike other regions of Uzbekistan, transport and geographical location is of great importance for the Republic of Karakalpakstan.

First, the region borders Turkmenistan and Kazakhstan, and is characterized by convenient access to European countries, including Russia, and low transport costs.

Another feature of the transport-geographic location in the region is that it can serve as a large transit center, that is, it can act as a trans-Euro-Asian bridge (Table 5).

TABLE 5. Opportunities of the transport and geographical location of the Republic of Karakalpakstan (SWOT analysis)

Strengths (advantages)	**Weaknesses (disadvantages)**
Being directly neighboring foreign countries (Kazakhstan, Turkmenistan) and having high opportunities to develop foreign economic relations with them. The convenience and proximity of the formation of economic ties between the regions of Uzbekistan and European countries, including the regions of Russia. The possibility of becoming a transit center connecting European and Asian countries	Renovation and expansion of existing transport infrastructure and logistics, adapting them to world standards

Increasing the efficiency of using the Nukus-Kungirot-Beyneu-Astrakhan-Moscow railway, making good use of the potential of the Nukus-Kungirot-Beyneu strategic highway, and the high potential of the Nukus International Airport will pave the way for increasing the export potential through transit services in the future.

Transit competitive advantage creates favorable conditions for the use of cost-recovery features of transport-geographical location. In a certain sense, in the future, it is possible to carry out large-scale export-import operations for the delivery of goods from Europe to Asia (China, India, Pakistan, the Great Silk Road, etc.), including the Indian Ocean.

In general, the advantages of the transport-geographic location of the Republic of Karakalpakstan can be used in the strategic plan in the following directions:

- sharp increase of export potential of the region in terms of raw materials, semi-finished and finished products;
- expanding the scale of international transit cargo transportation;
- expanding a number of new production capacities in order to reduce transportation costs.

All this creates a clear opportunity for increasing the competitiveness and strategic development of theregion.

Mineral resources. The current structure of the region's economy is disproportionate to its rich mineral resources potential. Of the 62 identified large mineral deposits (as of January 1, 2022), only 13 are being exploitedIf we take into account deposits of natural gas condensate, oil, iron, salt and sulfate salts in the region, the potential of existing mineral raw materials is high and has certain competitive advantages. The region also has deposits of precious stones, vermiculite, cement raw materials, agro-ore, and about 40 construction materials (limestone, gypsum, expanded clay, silicate brick raw materials). The Republic of Karakalpakstan occupies the leading positions in the country in terms of natural gas, iron ores, talc and talc-like stone, and limestone reserves (Table 6).

TABLE 6. Mineral resource potential of the Republic of Karakalpakstan (as of 2023)

№	**Raw materials**	**On future reserves of the region**
		Share in Uzbekistan
1.	Iron ores	100,0
2.	Table salt	70,0
3.	Sulfate salt	100,0
4.	Limestone	81,8

The future development of the country's fuel and energy sectors is largely dependent on the discovery and development of gas fields on the Ustyurt Plateau and in the Opal Sea basin. The Ustyurt region has a very high potential to become the center of the largest gas and chemical complex in Uzbekistan. Currently, about 30 gas and gas condensate fields have been discovered here.

The largest of them are Karazhambas, North Buzachi, Kalamkas, Lower Surgul, etc. During the period 2010–2024, significant changes were observed in the volume of oil production in Karakalpakstan. For example, in 2010, 2017. 9 thousand tons of oil were produced across the country, but by 2024 this figure had decreased to 713.1 thousand tons.

This situation also affects the industrial potential of the region, indicating the need for diversification and the development of new production sectors.

A program for the development of geological exploration for oil and gas has been developed in our country. According to this program, more than half of the gas reserves fall on the Ustyurt region. The Cabinet of Ministers of the Republic of Uzbekistan approved a program for conducting geological exploration in Ustyurt. According to this program, it is planned to carry out deep drilling in more than 100 objects and they are allocated for foreign investors. The main geological exploration work is being carried out in the Akcholak, Kuanish, Farbiy Urgin, Aktumsuk, Nasambek, and Shahpakht investment blocks. In general, the national company "Uzbekneftegaz" plans to discover more than one trillion cubic meters of natural gas reserves in the Aral Sea basin.

The largest and only gas-chemical complex in Central Asia, worth $4.0 billion, has been built in Ustyurt. The complex's capacity is designed to produce 400,000 tons of polyethylene and 100,000 tons of polypropylene per year. High-ethane gas from the Surgul field is being processed here. In accordance with government decisions, it is planned to produce 700 million cubic meters of natural gas in the Middle Kuanish and Akcholak investment blocks by 2030. In order to further expand geological exploration and increase gas production in the Ustyurt region, it is planned to allocate more than $ 1.0 billion in investments.

Among the mineral deposits in the region, iron ores, sodium and sulfate salts, and talc are among the most valuable in terms of their efficiency and meeting domestic and external demand.

The amount of iron in the Tebinbulok iron ore deposit (Korauzyak district) corresponds to 16-18%, its forecast reserves are more than 1.1 billion tons. By using efficient technology, high quality steel can be produced from this mine. Currently, a project for the development of this deposit has been developed. According to it, the development of the deposit will be carried out in two stages. In the first stage, it is planned to produce 1 million tons of steel. The total cost of the project is $1.5 billion, with annual ore production of 33 million tons (65% iron), 1.5 million tons of iron, 900 thousand tons of fittings, and 375 thousand tons of channels. The enterprise employs 2 thousand people, and 3.5% of production is exported. The decline in oil production is increasing the resource dependence of the Karakalpakstan economy. Therefore, it is important to diversify the economy in the region, introduce renewable energy sources, and develop new industrial sectors. At the same time, it is necessary to improve the living standards of the population, create new jobs, and improve infrastructure to ensure social stability. Borsakelmas salt deposits are used as raw materials at the Kungrad Soda Plant. There are also opportunities to use the Koroumbet salt deposit. Research is being conducted to find ways to widely use the Akkala sulfate salt deposits in practice. It is possible to organize the production of sodium sulfate, potassium sulfate, table salt, and bishofite (magnesium metal) from this mineral. It is possible to use the Zinelbuloq talc mine as a raw material for the production of fire-resistant bricks, ruberoid, and rubber products.

In general, the region's large mineral raw material deposits are distinguished by their competitive advantages (Table 7).

TABLE 7. Demand for certain mineral raw materials in the Republic of Karakalpakstan (SWOT analysis)

Strengths (advantages)	**Weaknesses (disadvantages)**
Availability of strategically important gas and gas condensate deposits. Establishment of a gas-chemical complex based on local natural gas processing. The possibility of sustainable development of a large chemical complex based on local raw materials (deposits of salt and sulfate salts). In the future, it is possible to form the ferrous metallurgy sector of Uzbekistan based on strategically important iron ore deposits	The problem of attracting foreign direct investors. The need for large investment funds. Rapid development of infrastructure is necessary

It is important to develop the rich mineral raw material reserves located mainly in the north of the region and to develop the social infrastructure facilities proportionately. It is also desirable to organize residential areas, to turn the city of Kungirot, the center of mineral reserves, into a driver of economic development and a center of growth. There are all possibilities for it to be included in the category of medium-sized cities.

The competitive advantages of the Republic of Karakalpakstan include its existing recreational (leisure and tourism) potential. There are opportunities for the development of historical architectural monuments associated with world civilization, ecotourism, health-oriented mud treatments, and other types of tourism services.

The main wealth of the region is its population. As of January 1, 2023, the population of the Republic of Karakalpakstan was 2.0 million people, or 5.4% of the country's population. According to the analysis of demographic processes, on the one hand, there is a tendency to reduce the birth rate, and on the other hand, there is a high level of population migration.

TABLE 8. Demographics of the Republic of Karakalpakstan capacity (thousand people)

Indicators	2022y.	2025y.	2030y.	2040y.	2040 Compared to 2028, %
Average annual population - total	2002,7	2050,0	2179,5	2452,2	108,8
Composition (percentage)					
0-15 years	28,6	28,2	27,0	25,0	-
16-59/54 years	60,1	58,2	58,0	57,0	-
60/55 above years	11,3	13,6	15,0	18,0	-

According to the survey results, almost 20% of families have someone participating in external labor migration. A distinctive feature of the population distribution is that almost 74.0% of them live in villages with a population of less than 1,000, the distance between them is 50-100 km. The region has the lowest population density (12.0 inhabitants per 1 sq. km). Nevertheless, the labor potential is relatively high, and the growth rates of labor resources remain relatively high (Table 2.2.8). Providing employment for the growing population will remain the most pressing problem now and in the future.

According to estimates, the population growth rate (108.8%) in 2022-2040 is expected to be almost in line with the national average (11.0%) and will increase by 177,000 people. In the future, the share of young people aged 0-15 in the population is expected to decrease slightly and the share of people of retirement age to increase.

CONCLUSIONS

The study demonstrates that the Republic of Karakalpakstan possesses substantial natural and economic potential that can serve as a key driver of sustainable socio-economic development under conditions of climate change. The region’s competitive advantages include rich mineral resource reserves, a strategically favorable transport-geographical location, and a relatively high demographic capacity. However, the current structure of the regional economy remains unbalanced, with a high dependence on extractive industries and insufficient diversification, which increases economic and environmental vulnerability.

The research findings indicate that environmental challenges such as desertification, water scarcity, and climate variability significantly affect agricultural productivity, industrial development, and the overall quality of life. At the same time, these challenges create new opportunities for the development of alternative economic activities, including desert-adapted livestock farming, mineral processing industries, transit logistics, and the expansion of renewable energy sources. The effective utilization of desert resources and renewable energy has the potential to reduce environmental pressure while supporting economic growth.

The analysis also highlights the importance of improving the investment climate and attracting both domestic and foreign investments to unlock the region’s untapped potential. Large-scale infrastructure projects, modernization of transport networks, and the development of energy-efficient and environmentally friendly technologies are essential for enhancing regional competitiveness. In addition, human capital development, employment creation, and improvements in social infrastructure are critical for maintaining social stability and addressing demographic challenges.

In conclusion, the sustainable development of the Republic of Karakalpakstan requires an integrated approach that balances economic growth, environmental protection, and social development. The strategic use of natural and economic advantages, combined with effective governance and long-term planning, can ensure resilience to climate change, increase regional competitiveness, and improve the living standards of the population.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan No. PF-60 “On the Development Strategy of New Uzbekistan for 2022–2026.” January 28, 2022. Available at: https://lex.uz

2. Resolution of the President of the Republic of Uzbekistan “State Program for Comprehensive Development of the Republic of Karakalpakstan for 2020–2023.” November 10, 2020. https://lex.uz
3. United Nations Development Programme (UNDP). Socio-Economic Assessment of Needs in the Aral Sea Region. Tashkent, 2018.
4. World Bank. Uzbekistan Country Environmental Analysis. World Bank Publications, Washington DC, 2022.
5. Soliev, A. Economic and Social Geography of Uzbekistan. Tashkent: University Press, 2014.
6. Madenova, E. N., Nazarbaev, O. Ways to Develop a Strategic Plan for Sustainable Regional Development. Monograph, Nukus, 2019.
7. Asian Development Bank. Climate Change and Sustainable Development in Central Asia. Manila, 2021.
8. International Energy Agency (IEA). Renewables 2023: Analysis and Forecast to 2030. Paris, 2023.
9. FAO. Climate Change Impacts on Agriculture and Water Resources in Central Asia. Rome, 2020.
10. OECD. Green Growth Indicators for Central Asia. OECD Publishing, Paris, 2021.
11. Uzbekneftegaz JSC. Annual Report on Oil and Gas Production. Tashkent, 2023.
12. Ministry of Economy and Finance of the Republic of Uzbekistan. Regional Development Statistics. Tashkent, 2024.
13. United Nations Environment Programme (UNEP). Desertification and Land Degradation in Arid Regions. Nairobi, 2019.
14. Karimov, A., Rakhimov, B. “Sustainable Use of Natural Resources under Climate Change Conditions.” Journal of Environmental Management, vol. 312, 2022.
15. Abdullaev, U., Mamatkulov, S. “Economic Diversification and Regional Development in Uzbekistan.” Central Asian Economic Review, vol. 4, no. 2, 2021.
16. Intergovernmental Panel on Climate Change (IPCC). Sixth Assessment Report: Climate Change 2023. Geneva, 2023.
17. Asian Infrastructure Investment Bank (AIIB). Infrastructure and Connectivity in Central Asia. Beijing, 2022.
18. World Economic Forum. Global Competitiveness Report. Geneva, 2023.
19. State Committee on Statistics of the Republic of Uzbekistan. Demographic and Economic Indicators of Karakalpakstan. Tashkent, 2024.