

RECREATIONAL AND FUNCTIONAL ZONING OF TERRITORIES WITH TECHNOGENIC IMPACT FOR THE PURPOSE OF SUSTAINABLE DEVELOPMENT OF THE REGION

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Citation: Berdenov, Zh.G., Yeginbayeva, A., Zinabdin, N., Beketova, A., Mendybayeva, G., Assylbekova, A. & Önal, H. (2024). RECREATIONAL AND FUNCTIONAL ZONING OF TERRITORIES WITH TECHNOGENIC IMPACT FOR THE PURPOSE OF SUSTAINABLE DEVELOPMENT OF THE REGION. *Geojournal of Tourism and Geosites*, 55(3), 1354–1363. <https://doi.org/10.30892/gtg.55336-1308>

Abstract: The article delves into the development of a comprehensive concept for the sustainable development of regions characterized by intensive environmental management. This concept is rooted in the interplay of several key factors, including the environmental component, social attractiveness, and infrastructural accessibility. By meticulously analyzing these factors and juxtaposing them with the geographical distribution of recreational facilities, the authors propose the innovative concept of a recreational and functional zone. This concept aims to harmonize environmental, economic, and social considerations to foster sustainable development. In this study, particular attention is given to three districts within the steppe zone of the Aktobe region, which are notable for their high levels of economic development and intensive environmental management practices. The analysis encompasses a thorough examination of the ecological, economic, and sociological dimensions of these areas. The authors explore the intricate dynamics between these components to understand the challenges and opportunities they present for sustainable regional development. Building on this analysis, the article offers specific recommendations and strategies designed to optimize environmental management practices. These recommendations are not only aimed at mitigating potential environmental impacts but also at enhancing the development of recreational areas as a pivotal element of the region's sustainable development strategy. The authors argue that such an approach is crucial for ensuring the long-term viability and resilience of the region, balancing economic growth with the preservation of its natural and social environments.

Keywords: man-made impacts, environmental management, recreational areas, sustainable development, sustainable tourism, tourism potential.

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INTRODUCTION

Technogenesis is the process of changing the natural environment under the influence of various types of human activity, including production and agriculture. It is characterized by the transformation of landscapes and the biosphere under the influence of mechanical, geochemical and geophysical processes caused by human actions (Zotova, 2021; Weaver et al., 2022; Kamann and Nijkamp, 1991).

The study of man-made impacts is an important factor in the development of recreational areas, since:

- understanding how technologies affect the environment helps to develop strategies and methods to reduce negative environmental impacts and protect natural resources for sustainable development in the regions (Berdenov et al., 2017; Esparza-Huamanchumo et al., 2024; Bhammar et al., 2021).

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- the study of man-made impacts helps to assess the consequences of human activities for the sustainable development of society. This makes it possible to take measures for more efficient use of resources and conservation of biodiversity [00];
- the analysis of man-made impacts helps to identify potential hazards and risks to human health, which allows us to develop measures to prevent and minimize them (Berdenov et al., 2021; Beketova et al., 2019);
- the study of man-made impacts is important for understanding its impact on the economy, including the costs and benefits associated with certain technologies and types of production (Mazhitova et al., 2018). Thus, the study of man-made impacts plays a key role in ensuring the sustainable development of society, preserving the environment, ensuring human safety and health, as well as in the formation of ethical and social norms and values. From all this, it can be concluded that technogenesis is an important factor in the creation of recreational areas for the sustainable development of the region. The purpose of this article is to calculate the recreational potential of the Aktobe region and systematize ideas about sustainable recreational environmental management with justification of its geoeological principles.

There are many interpretations of sustainable recreational environmental management, but they all boil down to three basic principles of sustainable development in general: social justice, economic efficiency and environmental safety (Dwyer, 2023; Ivancsó Horváth et al., 2023). According to the definition of the World Tourism Organization, sustainable recreational environmental management meets the current needs of tourists and host regions, preserving and increasing opportunities for the future (Imrani et al., 2024; Ozgeldinova et al., 2017). All resources should be managed in such a way as to satisfy economic, social and aesthetic needs, preserve cultural integrity, important ecological processes, biological diversity and life support systems. In our study, by sustainable recreational environmental management, we understand a harmonious system of relations between society and the natural environment in the process of satisfying recreational needs, in which a balance of social, economic and environmental interests is achieved, effective use of natural and recreational potential is ensured, and optimal quality of the recreational environment is preserved for future generations (Khrabovchenko, 2006; Lysenkova, 2006; Oborin et al., 2014). Since 40% of the study area is subject to man-made changes, our research serves as a prerequisite for the creation of recreational areas in order to preserve and protect natural resources. Through the development of specially designated recreation areas, unauthorized intrusion into ecologically important territories can be prevented and the negative impact on the environment can be reduced.

Natural, recreational development and sustainable development of territories are closely interrelated, and in this regard, research in this area may be of priority importance both for industrial regions and for surrounding territories. Unfortunately, today the poorly regulated territorial organization of tourist and recreational facilities of the Aktobe region prevails. Significant imbalances in the tourist development of many districts of the region are characteristic.

The Southern Urals is a promising area for the development of recreation and tourism, where there are a large number of remarkable natural objects of various genesis (Beketova, 2019; Makhanova et al., 2022). The recreational potential of a territory is a combination of natural, cultural-historical, economic-geographical, social, and economic prerequisites for the organization of recreational activities. The main components of the recreational potential are natural and recreational resources. Recreational potential can be assessed at the world, country, region, etc. Levels (Kuskov, 2005).

The issues of assessing the natural potential of the territory for the development of tourism have been studied by many domestic and foreign scientists (Moldagaliyeva et al., 2024; Ospan et al., 2024; Osipov, 2010).

Recreational potential characterizes the extent to which the territory is able to meet the needs of the population in recreational activities. The assessment of recreational potential is subjective, variable in space and time.

Recreational assessment of the territory is necessary primarily for information support of environmental management in order to increase its ecological and economic efficiency and the development of tourism in the region. Recreational potential characterizes the extent to which the territory is able to meet the needs of the population in recreational activities. Assessment of recreational potential is subjective, variable in space and time (Keukenov et al., 2023; Berdenov et al., 2021).

Recreational assessment of the territory is necessary primarily for information support of environmental management in order to increase its ecological and economic efficiency and the development of tourism in the region (Beketova, 2019).

MATERIALS AND METHODS

In order to identify objects of natural and recreational potential of the studied territory, the main method was field, when the aesthetic landscape attractiveness was determined directly on the ground and the coefficient of significance of all landscape components, their ecological condition, accessibility, possibilities of use, etc. The research uses a landscape-ecological approach (Bennett and Armstrong, 2001; Iovanovis and Negush, 2008; Thongsri and Chang, 2019; Sukhova, 2015).

According to (Smykova, 2015; Sutiksno et al., 2024; Wendt, 2020), the territorial interpretation of the concept of sustainable development presupposes the territorial co-organization of natural, economic and social subsystems according to its natural and man-made characteristics. The criterion for the sustainable development of regional recreational environmental management is the achievement of a certain socio-ecological and economic balance, that is, mutual alignment, coordination and unity of priority goals of the three main areas of recreational environmental management - social, economic and environmental. When developing the conceptual foundations of a regional development strategy, one should keep in mind the desire for internal balance in each of the spheres. The justification and development of the concept of sustainable development in the region should be based on the results of research in three areas:

1. Analysis of the prerequisites for sustainable development: analysis and assessment of natural and environmental factors of development; biological and landscape diversity of the territory; the place of protected natural territories in the system of regional environmental management.

2. Assessment of the basic level of sustainable development: conducting or analyzing the existing system of functional zoning; identifying the interests and contradictions of nature users and the local population in the region; identifying and diagnosing the most pressing problems of recreational zones and their territorial differentiation of recreational zones.

3. Theoretical and methodological justification and calculation of recreational potential with the development of models of sustainable development of the region. Development of constructive solutions for sustainable development in the region.

The research scheme is shown in Figure 1.

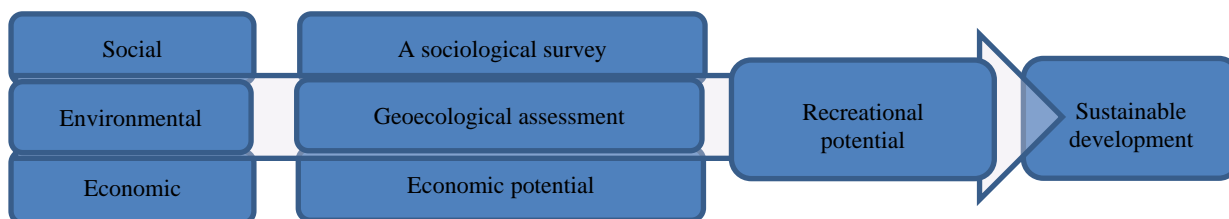


Figure 1. Research scheme

For the purpose of geoecological assessment of the studied territory (the state of natural components: relief, water, soil, vegetation, economic development of the landscape as a whole), the results of primary data and observation materials of the State Institution "Tobyl-Torgai Department of Ecology" (2019-2023)*, as well as semi-annual "Newsletters on the state of the environment of the Republic of Kazakhstan" were analyzed RSE "Kazhydromet"**; also stock materials of the Kazakh Scientific Research Institute of Ecology and for the last 5 years (2019-2024)**, as well as field observations and research by the authors within the framework of scientific project № AP19575017, funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

In particular:

- the relief and technogenic factors of relief formation (dumps, tailings dumps, quarries) have been studied;
- the dynamics of wastewater discharge by industrial enterprises into water bodies was studied, the Index of surface water pollution of the study area was calculated (Ilek river, Kargaly river, Or river, reservoirs: Kargaly, Oysylkara, Zharlybutak;
- the geoecological condition of soils in key areas has been studied;
- polluting enterprises have been identified;
- the mapping of natural and historical-cultural recreational and tourist sites has been identified and carried out.

The cartographic research method is widely used (topo-maps of scales – 1:100000, 1:200000; survey-topographic, thematic maps, satellite images of scale 1:50000) (Tikunov and Eremchenko, 2015; Omarzadeh, 2022) are analyzed.

A key method was used for a more detailed study. The key sites were selected: the city of Khromtau, the village of Badamsha, the village of Martuk (district centers and the surrounding area for describing economic activities and sampling soil for chemical analysis. The areas ranged from 100x500 (m) to 1000x3000 (m). Individual interesting recreational and tourist sites (Kargaly reservoir, Mugalzhar hills, Martuk nature reserve) were selected as reference sites.



Figure 2. Map of the study area

The work also uses the method of geoinformation mapping, which made it possible to identify the features of the spatial distribution of the studied qualitative and quantitative characteristics of the components of the natural environment using the ArcGIS 10.1 software. The use of geoinformation technologies has made it possible to digitize

various landscape zones, calculate their areas and fix their contours on a digital map (Rahayuningsih et al., 2016). Spatial analysis made it possible to compare natural and industrial zones with the possibility of developing infrastructure and recreational areas. Aktobe region is defined by its landscape richness and diversity. Three districts of the region were studied: Khromtau, Kargaly and Martuk districts, where mining and agriculture are most developed (Figure 2).

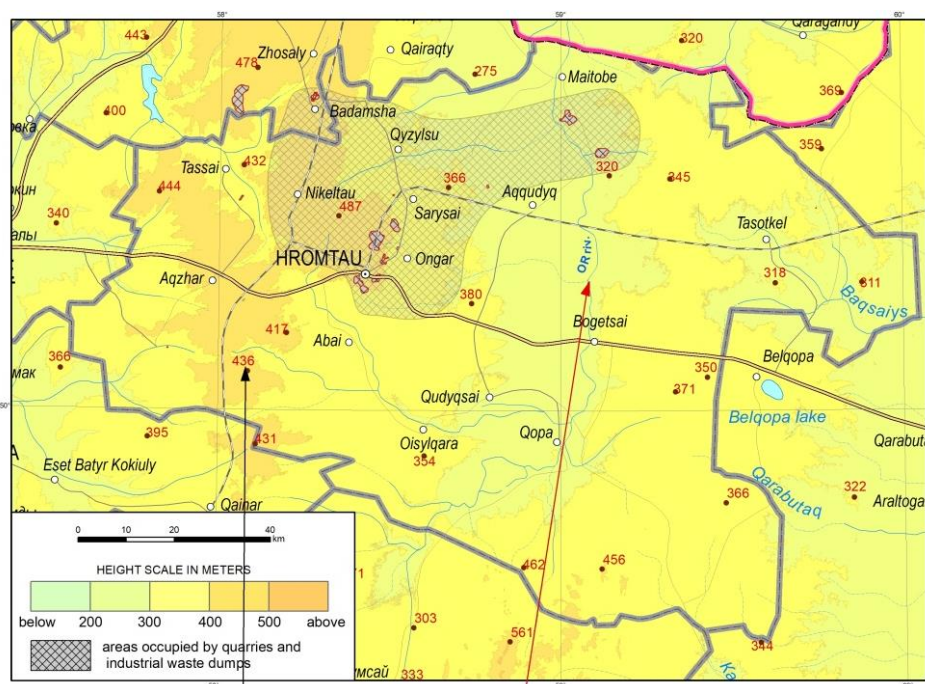
The research area is located in the northwestern part of the Aktobe region and Kazakhstan as a whole. The nature of the research area is isolated by phenomena inherent in the steppe zone. The primordial Mugalzhar, which are considered ancient mountains, are the Southern spurs of the Ural Mountains that penetrated into the steppe. The main water resources of the districts are the rivers Or, Kargaly and Ilek, regulated by three large reservoirs, other small rivers, as well as steppe lakes. Currently, in these areas of Aktobe region, in addition to visiting sacred and cultural and historical sites, the following types of tourism are popular, such as eco-tourism:

- Kargaly reservoir (sturgeon ponds, Aschelisai ("wolf") waterfall)**;
- Martuk district ecotour (visiting natural attractions (aspen and birch forests with thousand-year-old ferns, springs), visiting «Ice» LLP, pantotherapy, maral breeding farm, apiary, horse riding, etc.).***

RESULTS AND DISCUSSION

The environmental problems of the Kargaly and Khromtau districts of the Aktobe region, which arose as a result of the activities of mining and processing plants, are due to the composition of the processed ores and the technology of their extraction. Ore minerals unstable in the oxidation zone are brought to the surface. Geosystems and their elements in the area of operation of a mining enterprise are experiencing significant anthropogenic stress. Landscape and geochemical conditions are changing, migration and accumulation of heavy metals in toxic concentrations are increasing. An increase in concentrations of chemical elements disrupts the geochemical environment familiar to the biosphere and leads to a deterioration in the conditions of biodiversity and the vital activity of society.

A comprehensive analysis of the morphological and dynamic features of the formation of landscape systems, the modern structure of land use acts as a methodological basis for studying the technogenic transformation of natural landscapes. The natural components of the landscape and various forms of nature management serve as the main elements of the territorial systems of the region, in which the location of various natural and economic elements is interconnected - agricultural land, transport network, residential territories, quasi-natural landscapes and steppe massifs.



Mugodzhar Hills



Or River



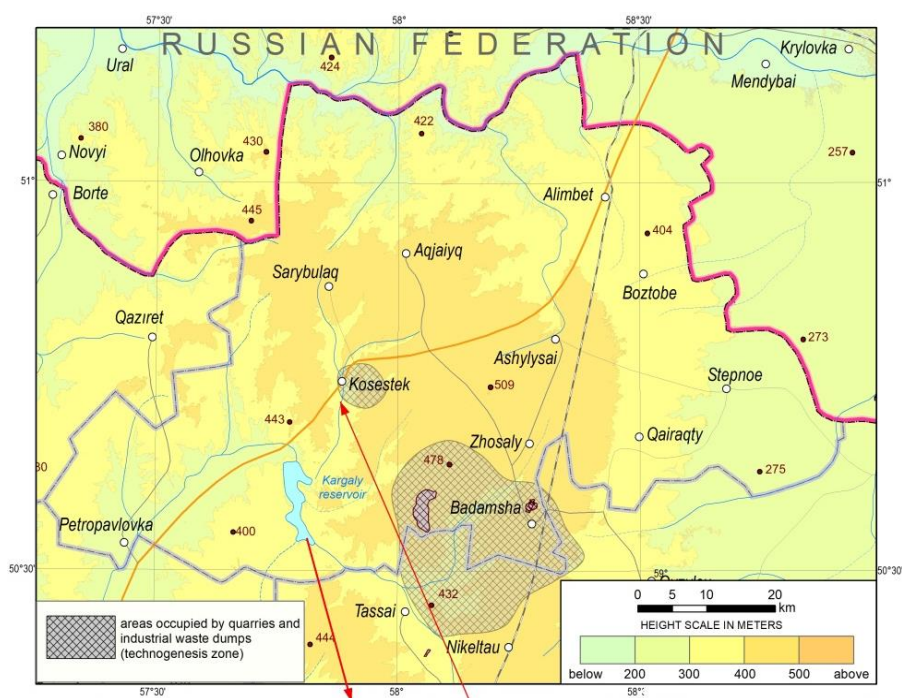
Dumps near the village of Nikeltau

Figure 3. Map of Khromtau district (Source: Authors)

Khromtau district (Figure 3). According to the surface structure, the territory of the Khromtau district is located within the Mugalzhar mountains and adjacent plains. The mountains reach their highest heights in the western part of the district, where peaks with marks of 360–440 meters are concentrated. The absolute heights of the foothill plains are 280–350 meters. On the territory of the district, five natural areas are clearly distinguished by the commonality of geomorphological, geological, hydrogeological, soil and other natural conditions. The Khromtau district represents ancient strongly smoothed low mountains with numerous chains of rounded domed peaks having the highest elevations of 500–619 and within the described administrative region – 320–360 meters. The relief is strongly dissected, ridge-bumpy. Numerous mounds, rounded and smoothed, are composed of dense rocks overlain by low-power gravelly eluvium. 20% of the district's territory is represented by dumps, artificial embankments from mining activities.

From a brief description of the natural areas, it can be seen that the relief of the Khromtau district is extremely uneven, strongly dissected by rivers, streams and gullies. The flat areas are confined to the gentle slopes of large watersheds, to the interstitial and interstitial depressions.

Kargaly district (Figure4). The territory of the district is an accumulative plain. The terrain of the area is mountainous, rocky and flat. The subsoil has a large supply of nickel, cobalt, coal, and natural building materials. The territory of the district is geomorphologically quite complex. Here you can observe all the transitions from a typical small-scale hill to a plateaued plain. The most elevated is the central part of the district, which belongs to the foothills of the southern Urals and is a slightly undulating denudation basement plain. The plain is poorly divided, the absolute marks are 506,9–420 m. To the east, the basement plain turns into a stratum with absolute elevations of 384,8–260 m. The formation is dissected by numerous ravines and gullies. The hills have soft outlines, rounded smoothed shapes of the peaks and gentle slopes, replete with rocky outcrops, especially in the lower parts of the slopes. River valleys have very steep slopes, replete with rocky outcrops, especially in the lower parts of the slopes. This is the nature of the sites located along the banks of the Ebita, Kayrakty, Kuagash, Aitpaika and Kos-Istek rivers. Due to the development of existing and already abandoned large deposits of nickel-cobalt ore, iron ore, titanium-magnetite ore, flux limestone, refractory clays, silicon dioxide, marble, ochre (paint), etc., new naturally artificial landscapes have appeared in the Kargaly district, these are dumps and storage of rocks of the mining industry and they occupy 10% of the district's territory.



Kargalinskoye Reservoir



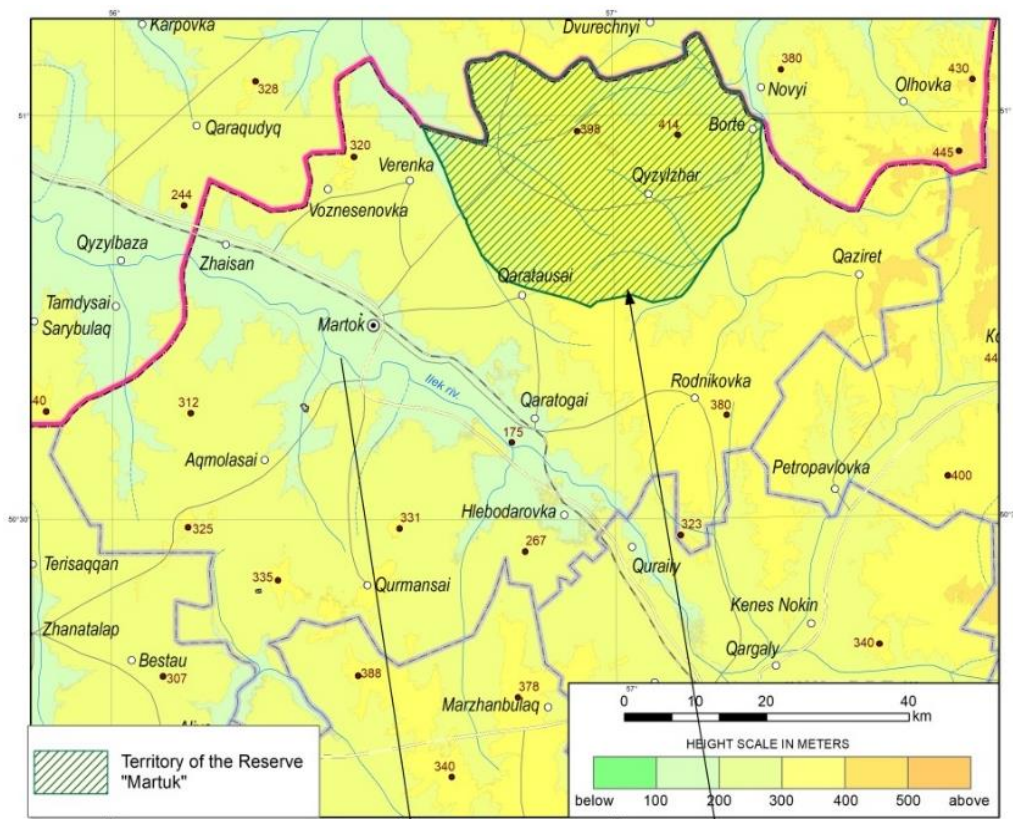
Valley of the river Zhaksy Kargaly

Figure 4. Map of Kargaly district (Source: Authors)

In our study of the technogenic landscapes of two districts of the Aktobe region (Kargaly and Khromtau), a wide range of chemical elements in water systems and soil cover has been established. The issues of technogenic pollution of the surface waters of the Zharlybutak, Akzhar, Zhaman Kargaly, Zhaksy Kargaly rivers with heavy metals, chromium, copper, iron and other pollutants on the territory of a number of mining enterprises within the districts have been studied in detail. Chemical analysis showed that all rivers have a pollution index of 6-7, "very dirty" waters. Studies of the Kargaly reservoir have shown that the waters have a pollution index of 2-3, slightly polluted waters, obviously this is due to the dilution of the waters of the Zhaksy Kargaly river by small tributaries of the springs of the Karabutak, Kosistek and Shandy rivers.

Studies in the period 2023-2024 in the Kargaly and Khromtau districts of Aktobe region based on the results of chemical analyses of soils and hydrochemical composition (HCO₃, SO₄, Cl, Cu, Mn and Fe) indicate that the soils of the studied area and surface waters of rivers are contaminated with chemicals that accumulate through erosion in the mining industry. According to the results of the analysis, the landscapes with the highest anthropogenic load were identified. Geosystems near the city of Khromtau, the village of Badamsha, and the village of Nikeltau are particularly exposed to man-made stress, as they are located in the epicenter of man-made cores, and are surrounded by overburden rocks and dumps. These geosystems are directly influenced by dumps and nickel ore mining, as well as indirectly influenced by wind erosion, by the mining industry of chrome mining in the city of Khromtau.

Martuk district (Figure 5). The relief of the area is an elevated undulating-hilly plain, which is characterized by an alternation of significant elevations reaching heights up to 300-400 meters. The territory of the district is located in steppe and dry steppe zones with the allocation of two soil subzones: southern chernozems and dark chestnut soils. Characterizing the vegetation cover, it should be noted that in its natural state it has been preserved only on pasture lands and hay plots (40% of the district's territory, 60% are used as arable land).



Ilek River Valley



The territory of the Martuk reserve

Figure 5. Map of Martuk district (Source: Authors)

The main purpose of the study at these sites was to identify the features of all components of the landscape, their genesis, signs of attractiveness, and remoteness from polluting enterprises. A sociological survey of the local population of all districts showed that the most important element is the landscape of landscapes. According to the research results, it was revealed: a small role of recreation in the employment of the local population; lack of socially oriented types of recreational services; insufficient information about recreational resources, attractions in the regions; lack of a strategy for diversifying the regional tourist product; low level of innovation and investment activity in the field of recreation (lack of infrastructure, roads in recreational areas); lack of government support, regional tourism development programs.

The identification and assessment of the influence of the visual qualities of natural territories and elements of nature on the psycho-emotional state of a person and the comfort of rest is the newest aspect of the study of landscape studies and other geographical sciences (Guerra et al., 2024; Wu et al., 2024; Liu et al., 2024; Ma et al., 2024).

Most researchers note as the main problem the difficulty of identifying the objective properties of the landscape of the landscape, ensuring its attractiveness, which differ from person to person. We have formed our own vision in determining the attractiveness of recreational and tourist facilities (Table 1).

Table 1. Factors ensuring the attractiveness of recreational and tourist facilities

1	The presence of a variety of relief, contrast
2	Population, diversity of vegetation, mosaic landscape
3	The presence of water bodies and their diversity (rivers, lakes, waterfalls, reservoirs)
4	The presence of geological and geomorphological objects (caves, gorges)
5	Accessibility of infrastructure (roads, campgrounds, recreation areas)

To classify the zones, we have compiled a matrix of three main types of environmental management in the region: recreational, environmental, and economic. Economic use is understood here as a combination of component-by-component and sectoral resource management (crop production, animal husbandry, mining). Thus, from the point of view of recreational zoning, modern natural and cultural complexes of the Southern prisons of the Urals can be combined into recreational and nature conservation zones, nature conservation and recreation, recreational and economic economic and recreational.

The recreational and nature protection zone includes the Mugodzhzar upland, where groves of birch, aspen, willow, and cherry trees are found in ravines. The slopes are covered with shrubby steppes of wild cherry, bobberry, and caragan. Saigas, moose, wild boars, hares, korsaks live in the valleys of the mountains. These are mainly territories with established and developing complexes of organized recreation. In the future, it is advisable to focus on recreation as the main type of nature management with the accompanying preservation and maintenance of the natural environment. Also, the northwestern part of the Kargaly district, in order to preserve unique forest communities, among which rare and endemic plants are found, where three sites have been allocated, which have been given the status of wildlife monuments of regional importance. These are relict fishing lines in the vicinity of Petropavlovsk, the village of Kherson and inter-fishing lines in the vicinity of the pond farm. These wildlife monuments are under the protection of the Kargaly forestry.

The nature protection and recreation area includes the Martuk Nature Reserve, which was established on December 6, 2017 to preserve the natural diversity of the Aktobe region. On the territory of the Martuk Reserve, forest landscapes and trees such as birches, oaks, pines are protected, as well as animals such as elk, roe deer, wild boar, beaver, marmot, and many species of birds: owl, crane, lapwing, kestrel, golden eagle, peregrine falcon.

Tourist routes are being created in the Martuk Nature Reserve. The development of recreational activities here should be focused on the protection of natural and natural cultural complexes. The allocation of recreational and nature protection territories in the environmental management system will reduce the severity of the environmental situation and preserve their natural and cultural potential from depletion and degradation. Recreational nature management here should be an incentive and support for traditional nature management.

The recreational and economic zone includes part of the Kargaly district: the valley of the Zhaksy Kargaly river, the Aschelisai ("wolf") waterfall, the Kargaly reservoir. These are unique landscapes, forest clearings, habitats of aquatic and near-aquatic birds and animals: elk, roe deer, wild boar, marten, European mink, marmot, grouse, etc. Along with the development of recreation, economic activities are also carried out here. Mainly agriculture and animal husbandry. In addition, mining and exploration of minerals is under way.

The economic and environmental protection zone includes the Khromtau district. There are small recreational areas along the valleys of the Or, Uysyl-Kara, Kargaly rivers and their tributaries. Poplar, willow, creeping wheatgrass, bonfire, meadow bluegrass, spring adonis, plantain, tansy, immortelle, etc. grow along the floodplains of rivers and lakes. Here, economic activity (agriculture, mining) must be correlated with protected areas.

The social significance of different types of environmental management varies, which, of course, should be taken into account in economic practice. In each specific case, priority should be given to certain types of use of the territory (recreational or environmental), based on the urgency of the relevant social needs, as well as the importance of specific territorial natural or economic properties for certain functions. Table 2 shows the directions of modern recreational use of the allocated areas and suggests ways to optimize them.

Table 2. Recreational and functional areas

Recreational and functional area	Recreational use	Ways to optimize environmental management
Recreational and environmental protection	Family holidays, fishing, active health tourism.	Creation of specially protected natural territories of regional significance. The development of infrastructure for targeted visits by recreants.
Environmental and recreational	Ecological routes, health and wellness tourism	Regulation of the flow of tourists, calculation of the permissible recreational load, assessment of environmental degradation and appropriate measures.
Recreational and economic activities	Local tourism, family holidays, hunting and fishing.	The development of infrastructure, the suppression of poaching, the development of sports and recreation and educational recreation.
Economic and environmental protection	Family holidays	Artificial planting of the green belt around the mining industry, reclamation of dumps and overburden. Development of infrastructure around reservoirs

In order to develop recreational areas in territories developed by economic activity, the following rules of sustainable development have been identified:

- The rule of operational management (coordination of work) – local governments, having a clear territorial organization, direct, coordinate and unite the efforts of representatives of various organizations to develop infrastructure and inform the local population about recreational areas.
- The rule of conservation of the natural environment – tourist infrastructure should be created, and tourist activity should be programmed in such a way as to protect natural ecosystems and biological diversity.
- The rule of taking into account social conditions – the management of recreational activities should be carried out in such a way as to minimize the negative consequences of a social nature.

Further, according to these rules, we have developed measures and solutions aimed at sustainable development in the region.

- 1) Creation and operation of monitoring stations. To date, they exist so far only in the Martuk Nature Reserve.
- 2) Calculation of the permissible recreational load.
- 3) Compiling a cadastre of unique natural monuments and cultural and historical monuments of the region, in order to compile tourist routes.

CONCLUSION

It is time to address the issue of reserving recreational areas. We must create buffer zones with special protection regimes. This will regulate the loads and flows of vacationers to certain recreational and tourist sites. This is the only way to preserve the quality of natural complexes for future use. To optimise environmental management, rules and recommendations have been developed for the protection and rational use of recreational and tourist facilities. The research area with intensive nature management and active economic activity was divided into two distinct zones: recreational and functional. The comprehensive analysis has reliably established that the entire territory of the region is suitable for involvement in recreational environmental management. In some areas, this is the main type of environmental management. In others, it is secondary, but still present.

Recreational areas bring significant social and environmental benefits, making them a crucial component of regional development. It is essential to adopt a balanced approach when creating and maintaining these zones, taking into account the interests of all stakeholders and natural resources.

This work involved developing the recreational and functional zones of the study area, as well as rules for developing recreational zones. This is crucial for the sustainable development of the region.

Thus, the development of recreational areas in regions of intensive nature management and economic activity is necessary for several important reasons.

1) Mitigation of the environmental impact. The establishment of recreational zones serves to diminish the impact on ecosystems by providing designated areas for recreation and leisure, which consequently alleviates the strain on other natural resources. Green spaces in recreational areas contribute to the absorption of carbon dioxide and the release of oxygen.

2) Enhancing the quality of life for the population. In regions with high levels of economic activity, issues pertaining to air, water quality and the broader environmental situation are frequently observed. Recreational areas provide residents with the opportunity to unwind in a natural setting, which can positively impact their physical and psychological well-being.

3) Promoting economic growth. The development of recreational areas can assist in attracting tourists and investments to the region. This can lead to the creation of new employment opportunities, contribute to the expansion of infrastructure and generate additional revenue for local budgets.

The creation of recreational areas in regions that are subject to intensive nature management and economic activity represents a strategic initiative that is designed to achieve a balance between the interests of sustainable development, social sustainability and environmental preservation.

Author Contributions: Conceptualization, Zh.B. and A.Y.; methodology, Zh.B, A.B. and A.A.; software, G.M. and Zh. B.; validation, A.Y., H.O. and G.M.; formal analysis, A.B. and G.M.; investigation, Zh.B.; data curation, A.Y., N.Z. and A.A.; writing - original draft preparation, A.B. and Zh.B.; writing - review and editing, A.Y., H.O. and N.Z.; visualization, N.Z; supervision, Zh.B. and A.B.; project administration, Zh.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19575017).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study may be obtained on request from the corresponding author.

Acknowledgements: The research undertaken was made possible by the equal scientific involvement of all the authors concerned.

Conflicts of Interest: The authors declare no conflict of interest.

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